

Volumen 11, Número 27 -- e20251127 January -- December - 2025

ISSN 2444-5010

Journal of Business and SMEs

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Journal of Business and SMEs, Volume 11, Issue 27- e20251127 January-December 2025, is a journal edited biannual by ECORFAN. 38 Matacerquillas street, Postcode: 28411. Moralarzal –Madrid WEB: www.ecorfan.org/spain, journal@ecorfan.org. Editor in Chief: Suyo-Cruz, Gabriel. PhD, ISSN On-line: 2444-5010. Responsible for the latest update of this number ECORFAN Computer Unit. Escamillabouchán, Imelda. PhD, Luna-Soto, Vladimir. PhD, 38 Matacerquillas street, Postcode: 28411. Moralarzal – Madrid, last updated December 30, 2025.

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Journal of Business and SMEs

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Presentation of Content

In the first article we present, *Business plan for the creation of a microenterprise producing habanero chili sauce in Villahermosa, Tabasco* by Morejón-Sánchez, Juana María, Notario-Priego, Ezequiel, Martínez-Izquierdo, Carlos Mario and Sierra-Morejon, José Luis, with adscription in the Instituto Tecnológico de Villahermosa, as next article we present *The importance of innovation in micro and small enterprises (MIPES) in León, Guanajuato, Mexico* by Serrano-Torres, Ma. Guadalupe & Kaczmarek-Chavarría, Marcela, with adscription in the Universidad Tecnológica de León, as next article we present *Participatory and solidary management for the implementation of a dried armored catfish fillet plant in fishing cooperatives of the municipality of Centro, Tabasco, Mexico* by Rivera-Rodríguez, María, Sepúlveda-Quiroz, César Antonio, Hernández-Martínez, Maria del Carmen and González-Izquierdo, Karina, with adscription in the Instituto Tecnológico de Villahermosa, as next article we present *Diagnostic study of digital skills based on the DigComp 2.2 framework in a union of cooperatives in the state of Puebla, México* by Alonso-Calpeño, Mariela Juana & Pérez-Jiménez, Carlos, with adscription in the Instituto Tecnológico Superior de Atlixco and Universidad de Investigación e Innovación de México, as next article we present *Market study on craft beer consumption in southern Tamaulipas* by Díaz-Flores, Jorge, Soto-Hernández, Ana María and Florencia-Castillo, Irma Beatriz, with adscription in the Instituto Tecnológico de Ciudad Madero, as next article we present *Calli: A Proposal for an Accommodation Platform for the Huasteca Region of Hidalgo* by Felipe-Redondo, Ana María, Del Carmen-Morales, Yucels Anaí, Del Carmen-Morales, Heidi and Nuñez-Cárdenas, Felipe de Jesús, with adscription in the Universidad Tecnológica de la Huasteca Hidalguense and Universidad Autónoma del Estado de Hidalgo, as last article we present *Analysis of generic and specific competencies of Industry 4.0 in Engineering students from the Laguna region* by Escobar, Héctor, Cárdenas, Víctor, Araiza, María and Rodríguez, Ana, with adscription in the Instituto Tecnológico Superior de San Pedro and Universidad Autónoma de Nuevo León.

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Article

Business plan for the creation of a microenterprise producing habanero chili sauce in Villahermosa, Tabasco

Plan de negocio para la creación de una microempresa fabricante de salsa de chile habanero, en Villahermosa Tabasco

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SECIHTI Classification:

Area: Social Sciences

Field: Administration and Business

Discipline: Business and accounting

Subdiscipline: Business and commerce

<https://doi.org/10.35429/JBS.2025.11.27.1.1.11>

History of the article:

Received: July 25, 2025

Accepted: November 10, 2025

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Abstract

The objective of this project is to develop a business plan proposal for the creation of a microenterprise that produces habanero pepper sauce in the city of Villahermosa, Tabasco. The methodology used will be a Market Survey technique, which includes a sample of 384 people. The results showed that this project supports Tabasco society by contributing to job creation and the utilization of a natural resource from a crop in the state of Tabasco.

Resumen

El objetivo de este Proyecto, es desarrollar una propuesta de un Plan de Negocio, para la creación de una microempresa fabricante de salsa de chile habanero en la ciudad de Villahermosa del estado de Tabasco. En la metodología se utilizará la técnica de Encuesta de Mercado, donde se considera una muestra de 384 personas. De los resultados que se obtuvieron se pudo determinar que este Proyecto viene a apoyar a la Sociedad tabasqueña contribuyendo a la generación de empleos y la utilización de un recurso natural de un cultivo del estado de Tabasco.

Objectives	Methodology	Contribution
<p>Prepare a market study, conduct a technical study, and design the organizational and administrative structure.</p> <p>Conduct a financial analysis and prepare a description and analysis of the impacts.</p>	<p>Market Survey Method and an instrument was designed through a questionnaire</p> <p>Sample of 384 with a confidence level of 95% and a margin of error of 5%.</p> <p>The information will be analyzed using statistical tools.</p>	<p>Proposal for the creation of a microenterprise manufacturing habanero chili peppers</p>

Objetivos	Metodología	Contribución
<p>Elaborar un estudio de Mercado, Realizar un estudio técnico, Hacer el diseño organizativo y administrativo</p> <p>Realizar un análisis financiero y Elaborar una descripción y Análisis de los Impactos</p>	<p>Método de Encuesta de Mercado y se diseñó un instrumento a través de un cuestionario</p> <p>Muestra de 384 con un nivel de confianza de 95% y un margen de error de 5%.</p> <p>Se analizará la información a través de herramientas estadísticas</p>	<p>Propuesta para la creación de una microempresa fabricante de chile habanero</p>

Microenterprise, Production proces Organizational Chart

Microempresa, Proceso producción, organigrama

Area: Advocacy and attention to national problems

Citation: Morejón-Sánchez, Juana María, Notario-Priego, Ezequiel, Martínez-Izquierdo, Carlos Mario and Sierra-Morejon, José Luis [2025]. Business plan for the creation of a microenterprise producing habanero chili sauce in Villahermosa, Tabasco. Journal of Business and SMEs. 11[27]1-11: e11127111



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]- in the contribution to the scientific, technological and innovation **Peer Review Process** through the training of Human Resources for the continuity in the Critical Analysis of International Research.



Introduction

In this project, a business plan was developed for the creation of a micro-enterprise. Micro-enterprises are known to be small businesses with a limited number of employees. In general, micro-enterprises specialise in offering goods or services in their local areas. The technique used is market research, which provides information about the existing market for the product being manufactured: habanero chilli sauce. This is one of the most widely used techniques in the business world because it allows important market strategies to be designed, such as product, price, promotion and place. Currently, the state of Tabasco lacks micro-enterprises and companies in the industrial sector, and there are not enough jobs.

The project first presents its general characteristics, followed by the market study. Then comes the technical study to determine the location of the company, the machinery, the materials, among other things. The administrative organisation of the micro-enterprise. The financial analysis and, finally, the impact of the project.

General characteristics of the project

Project background

In the 1990s, many countries failed to implement sound economic policies and did not achieve the expected growth, leading to a wave of unemployment. In this context, citizens were forced to use their ingenuity to get ahead. Many created family businesses or micro-enterprises, which have gradually become part of the economic norm in different countries around the world. They have even become an important part of the economy. Today, most countries in the Caribbean, Central America and South America have a local variety of habanero chilli, each of which has a common name, *Capsicum Chinense*. In the Yucatan Peninsula, including Belize and El Petén, *Capsicum Chinense* is called 'Habanero'. Currently, its production is concentrated in the coastal areas of Tabasco, Yucatan, Quintana Roo and Campeche in Mexico; the Caribbean islands, Costa Rica, Belize and El Petén in Guatemala. Mexico is known for having an excellent variety of sauce companies, such as chipotle chilli and serrano chilli, among others.

The creation of this micro-enterprise seeks to be one of the first to manufacture habanero chilli sauce in the state of Tabasco. In Tabasco, there is a high unemployment rate due to the few job opportunities available in the state. Furthermore, habanero chillies are not used in the state, as despite being one of the states that harvests the most of this type of chilli, the vast majority is exported and very little is used to make products derived from habanero chillies.

According to INEGI (2024), the unemployment rate in Tabasco in 2024 was 4.0% in the second quarter and 4.1% in the fourth quarter, according to INEGI's [National Occupation and Employment Survey \(ENOE\)](#). In the first quarter of 2024, the economically active population (EAP) of the state of Tabasco, i.e., those who were employed or unemployed in the week prior to the interview, was 1,118,282.

This figure is 25,510 more than in the same period of the previous year. By gender, the male EAP was 711,649, an increase of 24,996 men. The female EAP was 406,633, 514 more women than in the first quarter of 2023. The unemployment rate in Mexico stood at 2.7% in the second quarter of 2025, the same as in the same period of 2024, although higher than the 2.5% recorded in the period from January to March, according to a report released on Tuesday by the National Institute of Statistics and Geography (INEGI, 2025). The entities with the highest unemployment rates during the second quarter of 2025 were Tabasco (4.4%), Mexico City (4%) and Coahuila (3.8%). As can be seen, Tabasco leads the national unemployment rate in the second quarter of 2025.

Justification

The reason for proposing the creation of a micro-enterprise manufacturing habanero chilli sauce is because it is considered to have a potential market, given that Mexico is one of the largest producers of habanero chillies, which most people consume as a condiment to flavour their dishes. Therefore, it is envisaged that there is a reliable market because in Mexico most people eat spicy food and this micro-enterprise will benefit these people. Another important benefit for the state of Tabasco will be a micro-enterprise that generates jobs.

General Objective:

To propose a business plan for the creation of a micro-enterprise manufacturing habanero sauce in Villahermosa, Tabasco.

Specific Objectives:

Conduct a market study, carry out a technical study, develop an organisational and administrative design, perform a financial analysis, and prepare a description and impact analysis.

Scope of the project:

The project on the micro-enterprise manufacturing habanero chilli was developed with the city of Villahermosa in mind, considering its location in this city in the state of Tabasco.

Project limitations:

There is a lack of documentary information on the raw material to be used.

Theoretical framework

This section mentions some of the theoretical foundations considered in the business plan project.

Market study

According to Fisher and Espejo (2011), market research is a process of collecting and interpreting facts and data that help a company's management make the right decisions and establish the right market policy, focusing on the usefulness of the information for the company's strategic decisions.

Market

According to Mankiw (2012), a market is a group of buyers and sellers of a particular good; buyers determine the demand for the product and sellers determine the supply. And according to McCarthy (1978), a market is the group targeted by the marketing strategy. He is credited with popularising the '4Ps' model (product, price, place and promotion) to satisfy that target market. Market research:

For Kinnear and Taylor (1998), market research is the systematic and objective approach to developing and providing information for the marketing management decision-making process. Malhotra (2004) considers market research to be the systematic and objective identification, collection, analysis, dissemination and use of information for the purpose of improving decision-making related to the identification and resolution of marketing opportunities.

Production process

According to Moyano, J. & Cayán, J. et al. (2024), production processes are an orderly set of activities and operations necessary to transform inputs (raw materials, energy, labour) into products or services that add value for the customer. These processes are at the heart of manufacturing and service companies, driving the creation of wealth and social well-being. Meanwhile, Buffa, E. (1983) defines a production system as the means by which input resources are transformed to create useful goods and services. The production process is a process of transformation or conversion. Input resources can take a wide variety of forms. In manufacturing operations, inputs include various materials and raw materials, energy, labour, machinery, facilities, information, and technology.

Job descriptions

Reynoso, C. (2015) considers that a job description stipulates the essential characteristics and skills that a person working in that area must have, since this will determine whether the characteristics of the staff match the requirements of the position in such a way that the worker perceives a safe and clear working environment, knowing what is expected of them and how far they can go based on the responsibilities and lines of communication that are established

Break-even point

Baca, G. (2010) considers that break-even analysis is a useful technique for studying the relationships between fixed costs, variable costs and income. If a company's costs were only variable, there would be no problem in calculating the break-even point.

The break-even point is the level of production at which sales revenue is exactly equal to the sum of fixed and variable costs.

Product description

This will be a high-quality sauce made from habanero peppers, containing 65% freshly harvested habanero pepper pulp and homemade vinegar made from aromatic herbs. It does not require refrigeration and will come in a 150-gram PET bottle for easy handling.

Sustainability

According Mejjia, M. & Vazquez, L. et al. (2025), the exercise of sustainability in companies goes beyond implementing environmental care practices, as it must be accompanied by the implementation of social responsibility actions and the adoption of an organisational culture that guarantees the needs of the present are met without compromising those of future generations. In turn, for these practices to be sustainable, the environmental, social and economic aspects of the organisation must be in balance. Social sustainability measures are related to the well-being of society in general and of the company's employees in particular. The main measures are corporate ethics and employee well-being. Economic sustainability measures, shareholder value creation and economic development seek to contribute to the creation of responsible companies that are also focused on achieving their financial goals.

Methodology

Habanero chillies are the second most popular in the state of Tabasco, with most of the population consuming chillies and very few micro-enterprises producing them, such as Chimay. Therefore, there is a great opportunity to create a micro-enterprise, as Villahermosa has a population of 777,900 inhabitants, ranging in age from 10 to 70, of which a sample of 384 is considered with a confidence level of 95% and a margin of error of 5%. The Market Survey Method was used and a questionnaire was designed to determine customer preferences and identify whether there is demand for a micro-enterprise manufacturing habanero chilli sauce, see Figure 1.

Box 1

Table 1

Market Survey

From the following options, choose the one you consider most appropriate. This information will help us determine whether it is feasible to propose the creation of a micro-enterprise manufacturing habanero chillies in Villahermosa, Tabasco.

1. How old are you?
 - a) 18 to 25 years old
 - b) 26 to 30 years old
 - c) 31 to 45 years old
 - d) 46 to 50 years old
 - e) Over 51 years old
2. Have you tried habanero chilli sauces?
 - a) Yes
 - b) No
3. From the following options, select the one(s) that are the reason why you consume habanero chilli sauce.
 - a) Good flavour
 - b) No artificial colourings
 - c) Low sodium content
 - Different levels of spiciness
4. How often do you buy habanero chilli sauce?
 - a) 1 to 2 times per week
 - b) 1 to 3 months
 - c) More than 3 months
5. Would you be interested in purchasing habanero sauce once every two weeks?
 - a) Yes
 - b) No
6. What features would you like the product to have?
 - a) Good quality at an affordable price
 - b) Larger size
 - c) More variety
 - d) Other (please specify) _____
7. If this product were on the market, would you buy it?
 - a) Yes
 - b) No
 - c) Perhaps.
8. Where would you like to buy this product? Habanero chilli sauce
 - a) Shopping centres
 - b) Supermarkets
 - c) Health food shops
 - d) Convenience stores
 - e) Other (please specify) _____
9. Where would you like this product to be promoted?
 - a) Social media
 - b) Television adverts
 - c) A website specifically for the product or micro-enterprise
 - d) Advertisements in magazines or newspapers
 - e) Other (please specify) _____
10. Would you agree to the opening of a micro-business manufacturing habanero chilli sauces in Villahermosa?
 - a) Yes
 - b) No
11. Where would you consider a suitable location for the micro-enterprise producing habanero chillies?
 - a) Industrial city
 - b) Cárdenas-Villahermosa motorway
 - c) Grill
 - d) Other (please specify) _____
12. How much would you be willing to pay for a 150-gram jar of habanero chilli sauce?
 - a) £30.00 to £50.00
 - b) £60.00 to £70.00
 - c) Over £70.00
 - d) Other (please specify) _____

Source: Own elaboration. 2025

Once the instrument has been applied, the results of the sample to which it was applied, 384 people, as mentioned above, are presented. The figures for the first four questions will be shown with their answers, and the answers given by the people to whom the instrument was applied will be discussed for the remaining questions.

Box 2

Figure 2

1.-How old are you??

a) 18-25 years old	157
b) 26-30 years old	74
c) 31-45 years old	82
d) 45-50 years old	55
e) Over 50 years old	16
total	384

Source: Own Elaboration. 2025

40.88% of respondents were between the ages of 18 and 25, indicating that they were the youngest group among those surveyed.

Box 3

Figure 3

2.-Have you tried habanero chilli sauces?

Yes	289
No	95
Total	384

Source: Own Elaboration. 2025

Of the 384 respondents, 75.26% have tried habanero chilli sauce, so it is considered that there is a good consumer market.

Box 4

Figure 4

3. From the following options, select the one(s) that are the reason why you consume habanero chilli sauce.

a) Good flavour	219
b) No artificial colourings	28
c) Low sodium content	37
d) Different levels of spiciness	100
Total	384

Source: Own Elaboration. 2025

Here we can see that 57.03% of respondents consume habanero chilli sauce because of its good flavour. And 26.04% because of its different types of spiciness. This means that there is a good percentage of consumers of this sauce.

Questions 4 to 12 yielded the following results: For question 4, 65% buy sauces once or twice a week. For question 5, 60% are willing to buy a sauce once every two weeks. In question 6, 67% of people prefer the sauce to be of good quality and affordable. 60% of people consider that they would buy the sauce and that they would buy it in shopping centres and convenience stores.

Fifty-five per cent of them would like the sauce to be promoted on social media. Seventy-eight per cent of respondents agree with the opening of a micro-business manufacturing habanero chilli sauce, and are willing to pay between 30 and 50 pesos for a 150-gram jar of sauce. The location where they would like the micro-enterprise to be located is in the Industrial City, as this is the area where most of Villahermosa's micro-enterprises are located. The identified target market is in the 18 to 45 age range. The commercial and advertising strategy will be through social media and traditional advertising, free samples, and limited-time offers.

In the project engineering for the location of the micro-enterprise, several factors that may influence the location of the facility were taken into account, such as: available raw materials, available labour, input costs, proximity to the market, and availability of transport. For the location of the facility, the weighted factors method was considered, as shown in Figure 5.

Box 5

Table 5

Weighted factors method

Factor	weight	Indeco Califi	Calif Weighted	Cd. Ind. Calif	Calif Weighted	Gavio tas Calif	Calif Weighted
M.P	0.35	8	2.8	10	3.5	8	2.8
M.DE O.	0.25	8	2.0	7	1.75	6	1.5
Cost Inputs	0.20	9	1.8	8	1.6	6	1.2
Neighbourhood Market	0.15	5	0.75	8	1.2	7	1.05
TranspOrte	0.05	8	0.4	8	0.4	9	0.45
Sum	1.00		7.75		8.45		7

Source: Own Elaboration. 2025

As can be seen, the micro-enterprise will be located in Ciudad Industrial, since according to the method used, the best weighted score is 8.45, so this will be the location of the micro-enterprise.

Production Process:

For the production of habanero chilli sauce.

1. Raw material cleaning and preparation section (2 operators) The following tasks are carried out at this workstation:

The chillies, carrots, onions and garlic are washed with drinking water and disinfectant.

Then the stems are removed from the chillies that still have them, the carrots are peeled and the onions and garlic are cleaned.

The chillies and vegetables are transferred to the cooking area.

2. Raw material cooking section (2 operators)

Two objectives are achieved in the cooking section: one is to cook the raw materials to eliminate any microbes they may contain, and the second is to soften them so that they can be ground or blended more easily.

The chillies are placed in a pressure cooker with drinking water and cooked until soft.

The same procedure is carried out with the carrots, onions and garlic, but separately from the chillies, and salt is added to the drinking water to cook them until soft.

3. Grinding or blending section (2 operators)

The habanero chillies are ground or blended and placed in a plastic barrel, which has been lined with a plastic bag and then a special aluminium-coated bag. Once in the barrel, sufficient salt is added and the mixture is ready for use as a raw material.

The carrots, onions, and garlic are ground or blended, and citric acid or lemon juice, pepper, vinegar, and sodium benzoate are added as preservatives. The quantities of each ingredient will depend on the amount of product to be packaged. The mixture is also placed in a barrel with the bags indicated in the previous section.

The spice mixture is transferred using a pneumatic pump to the tank located on a special platform 3.00 metres above the ground.

The ground chilli is also transferred to the tank to be mixed with the spices. The amount of chilli to be mixed depends on the amount of spice mixture previously added to the tank.

4. Packaging and capping section (2 operators)

In this section, 150 g bottles are filled. One or two operators may be used for this, depending on the number of bottles to be filled in a day. One or two operators are used for capping, depending on the number of operators filling the bottles, to avoid bottlenecks. They are responsible for placing the caps on the filled bottles and cleaning up any spills. In this operation, it is estimated that each operator has a filling productivity of four bottles per minute.

5. Labelling section (2 operators)

Two operators work in this area, whose job is to apply the labels to the bottles manually.

6. Quality control section (1 technician and 1 operator)

According to the quality specifications for the finished product, the quality supervisor verifies that the finished product complies with the following standards:

That the filling level of the bottles is correct.

That the labels are applied correctly (not crooked or wrinkled).

Verify that all bottles have the security seal.

That the bottles are completely clean of any dirt or product spills.

7. Packaging section (2 operators)

In this section, empty boxes are assembled and labelled manually to identify the product. The bottles previously checked by quality control are then placed in the boxes.

Each box contains 24 bottles of 150 g of chilli sauce, which are then sealed with adhesive tape and stored in the finished product warehouse. Figure 6 shows the production process for habanero chilli sauce, according to the sections mentioned above.

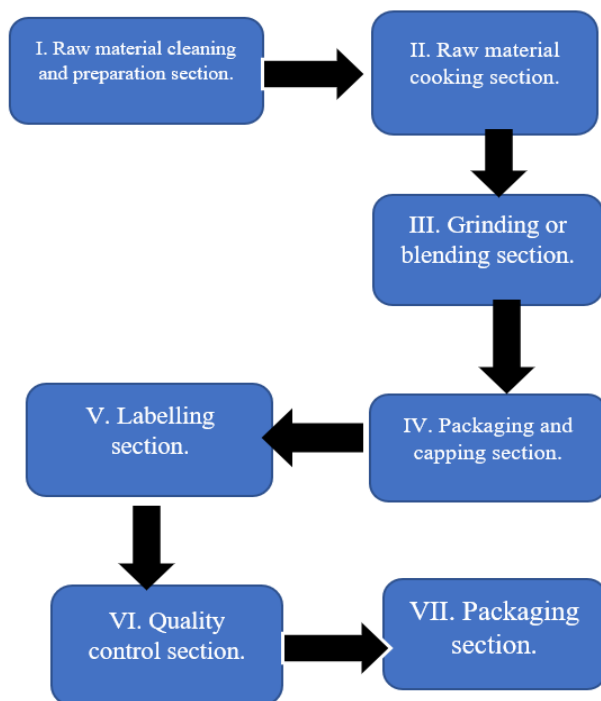
Organisational chart

The organisational structure for the micro-enterprise will consist of five professionals and seven operators, as shown in Figure 1.

Box 6

Figure 1

Production process.

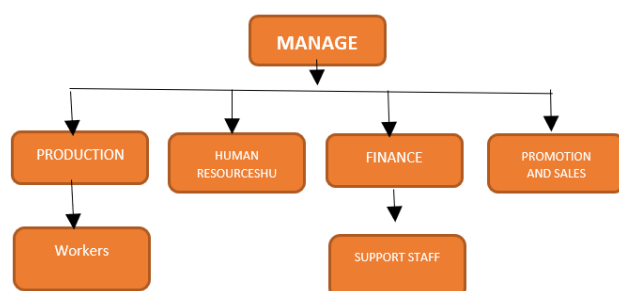


Source: Own elaboration. 2025

Box 7

Figure 2

Organisational chart of the micro-enterprise



Source: Own elaboration. 2025

Job description: Management

Responsible for coordinating the four departments of the micro-enterprise and its administration. This position must be filled by an industrial engineer or a business administration graduate

Production

Responsible for the entire production process, from the acquisition of raw materials to the finished product, i.e. the entire supply chain. This position can be filled by a food engineer or an industrial engineer.

Human resources

Responsible for coordinating the company's staff, payroll, staff training, staff selection and recruitment, staff attendance control, among other tasks. The position can be held by a graduate in business administration.

Finance

Responsible for the financial control of the company and for the financial management of the microenterprise's programmes.

Promotion and Sales

Responsible for designing product promotion strategies, identifying customers for the microenterprise, and maintaining good relationships with them. The position can be filled by a marketing graduate.

Operators

Responsible for participating in the production of the sauce during the manufacturing process. No professional degree is required, as this type of personnel can be trained to perform their activities.

Finance Support Staff

Responsible for controlling area budgets, requisition orders, and recording accounting operations. The position can be filled by accounting technicians.

Financial Analysis

Investment budget: This includes tangible fixed investment, intangible fixed investment, and working capital investment.

Tangible fixed investment

The cost of the land is considered. For the micro-enterprise, 543 square metres are required, and the square metre costs £4,850, so the land has a required investment of £2,633,550.00.

Box 8

Figure 8

Investment in tangible assets

Land	\$2,633,550.00
Machinery	45,000.00
Furniture and fixtures	46,677.00
Total	\$2,725,127.00

Source: Own Elaboration. 2025

Intangible Fixed Investment:

The costs of pre-feasibility studies, construction, electrical installation, plumbing, internet, website, accident insurance, and staff training are taken into account. With a total of \$127,199.60. Total investment: \$2,725,127.00 + \$127,199.60 = \$2,852,326.60

Sources of Funding:

Box 9

Figure 9

Sources of Funding

Concept	Amount	%
Total Investment	\$2,852,326.60	100
Partners (5)	\$ 285, 232.66	10
Fund credits	\$ 855, 697.98	30
Venture capital	\$1,426,153.30	50
Banco	\$ 285, 232.66	10

Source: Own elaboration. 2025

Analysis of financial statements:

Box 10

Figure 10

Pro forma income statement for the first month

Sales revenue	\$349,440.00
Production cost	\$281,600.00
Gross profit	\$ 67,840.00
Operating expenses	\$ 5,849.00
Operating profit	\$ 61,991.00
Taxes (30% income tax)	\$ 18,597.30
Net profit	\$ 43,393.70

Source: Own Elaboration. 2025

Box 11

Figure 11

Pro forma Income Statement 1st Year.

Sales revenue	\$4,193,280.00
Production cost	\$3,379,200.00
Gross profit	\$ 814,080.00
Operating expenses	\$ 70,188.00
Operating profit	\$ 743,892.00
Taxes (30% income tax)	\$ 223,167.60
Net profit	\$ 520,724.40

Source: Own Elaboration. 2025

Sales Projection:

Box 12

Figure 12

Annual sales projection

	Week	Month	Annual
Units	6400	25600	307200
Total Cost	\$ 70400	\$ 281600	\$3,379,200.00
Unit cost	\$ 25.00	\$ 25.00	\$ 25.00
35% profit on unit cost	\$ 8.75	\$ 8.75	\$ 8.75
Retail price	\$ 33.75	\$ 33.75	\$ 33.75

Source: Own Elaboration. 2025

Selling Price:

Retail price = Unit cost * (1+% profit)

Figure 12 details the units that will be produced during the year. As a micro-enterprise, it aims to earn 35% of the unit cost of \$25, which is \$8.75. Selling price = 25 *(1+0.35) = 33.75

Break-even point: This will determine how many units the microenterprise must sell in the first year in order to make a profit on the quantity sold.

$$PE = \frac{CF}{P - CV}$$

Where:

FC are fixed costs, P is the selling price minus variable costs

Fixed costs = labour + overheads

Fixed Costs = \$240,000.00+ \$70,118.00= \$310,118.00

PE = \$310,118.00/ 33.75- 25 = 35,442 habanero chilli sauces

Therefore, the micro-enterprise must sell 35,552 sauces to begin making a profit, and if it sells less than this amount, it will incur losses.

Description and analysis of impacts: Environmental impact

It will be an environmentally friendly micro-enterprise, seeking to operate in such a way that it does not cause negative impacts on the environment, and will therefore comply with the laws and regulations that make up Mexico's environmental legislation. The micro-enterprise will be socially responsible and will take care in its processes to avoid air, water, soil and other types of pollution that may result from the activities carried out by the micro-enterprise in the manufacture of habanero chilli sauce.

Economic Impact

The aim is to support people in the community by creating fairly paid jobs in accordance with the law and allowing people without experience to join the workforce. A training plan will be designed so that staff can learn how to operate the organisation's machines, equipment, tools and processes.

Social Impact

Through job creation, the micro-enterprise seeks to have a positive impact on society with fair wages in accordance with the law. As a socially responsible company, it will take care of its environment by preventing pollution so as not to affect the community where it will be located, the micro-enterprise that will be in the Industrial City.

Results

Based on a sample of 384 with a confidence level of 95% and a margin of error of 5%, derived from a population of 777,900 inhabitants, aged between 10 and 70 years. Through the market survey that was conducted, it was found that 67% of people prefer habanero chilli sauce to be of good quality and affordable. Therefore, it was determined that the price would be \$33.75 for a 150-gram sauce. Sixty per cent of people said they would buy the sauce and that they would buy it in shopping centres and convenience stores. This information gives us confidence that there is a good market for this product. 78% of respondents agree that a micro-enterprise should be opened in the industrial city of Villahermosa, because that is where most of Villahermosa's micro-enterprises are concentrated. It is worth mentioning that the market survey and the weighted factors method used coincided on the location where the company should be located, which is the industrial city. The production process for the sauce is shown in Figure 6, and Figure 7 shows the structure of the micro-enterprise and how each of the positions is described and who can fill them. In the financial analysis, it was determined that the selling price of a 150-gram sauce will be \$33.75 and that the micro-enterprise will be able to generate profits when it sells more than 35,552 sauces, according to the break-even point determination.

Conclusions

As can be seen in the development of the proposed business plan for the creation of a micro-enterprise manufacturing habanero chilli sauce in Villahermosa, Tabasco, it is considered that the micro-enterprise can be created to support the industrial growth economy of the state of Tabasco, in addition to taking advantage of its natural resources and generating more jobs for the state. This is supported by the tool used and the financial analysis carried out.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Morejón-Sánchez, Juana María: Contributed to the project idea and methodology.

Notario-Priego, Ezequiel: Contributed to the development of the financial analysis.

Martínez-Izquierdo, Carlos Mario: Contributed to the development of the project overview and the application of the market survey.

Sierra-Morejón, José Luis: Contributed to the development of the market study and the analysis of the market survey.

Availability of data and materials

The data were obtained by applying the instrument: Market Survey, directly to the study subjects.

Funding

This research was funded with support from the Villahermosa Institute of Technology and with the researchers' own income, as it is derived from an unfunded research project.

Acknowledgements

To the management of the Villahermosa Institute of Technology for allowing access to the facilities for the application of the instrument to some teachers and students. We would also like to thank the people who also helped in filling out the surveys who are external to the institution.

Abbreviations

PEA Economically active population

BE Break-even point

FC Fixed costs

P Price

CV Variable costs

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The importance of innovation in micro and small enterprises (MIPES) in León, Guanajuato, Mexico

La importancia de la innovación en las micro y pequeñas empresas MIPES de León, Guanajuato, México

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SECIHTI Classification:

Area: Social Sciences

Field: Negotiation and Management

Discipline: Administration and management

Subdiscipline: Business administration

 <https://doi.org/10.35429/JBS.2025.11.27.2.1.7>

History of the article:

Received: July 25, 2025

Accepted: November 10, 2025

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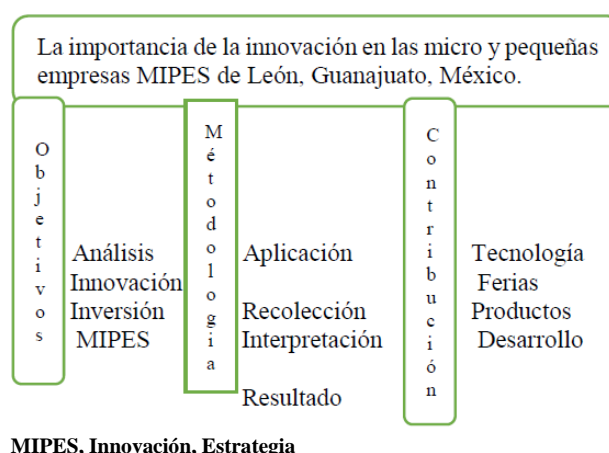
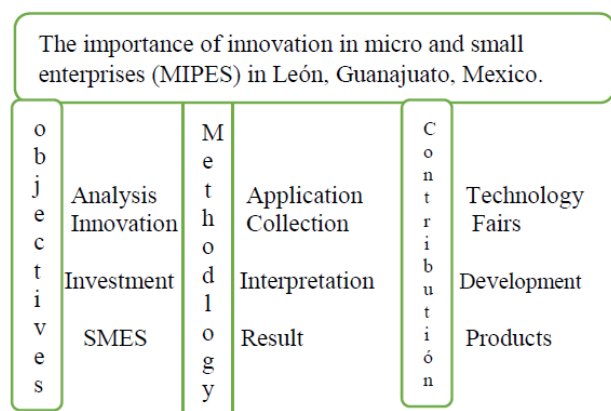


Abstract

Innovation is very important for companies in general. After the pandemic, it became even more strategic for their operation and survival. This research aims to demonstrate the importance of innovation in micro and small enterprises (MIPES) and to answer the research question: Why analyze the importance of innovation in micro and small enterprises in León, Guanajuato, ¿Mexico? The methodology used is mixed; quantitative, with 429 surveys applied to obtain results and create graphs, and qualitative, because part of the grounded theory is contrasted with findings from other national and international studies. The results show that MIPES do make full use of innovation. It is concluded that investment in technology, training in organization management, and attending fairs and conferences increases their levels of innovation.

Resumen

La innovación es muy importante para las empresas en general, después de la pandemia se hizo aún más estratégica para la operación y supervivencia de las mismas, es así que la presente investigación tiene por objetivo mostrar la importancia de la innovación en las micro pequeñas empresas (MIPES) y dar respuesta a la pregunta de investigación ¿Por qué analizar la importancia de la innovación en las micro y pequeñas empresas de León, Guanajuato, México?, la metodología utilizada es mixta, cuantitativa se aplicaron 429 encuestas para obtener los resultados y elaborar las gráficas, cualitativa porque parte de la teoría fundamentada se contrasta con hallazgos de otras investigaciones nacionales e internacionales, los resultados muestran que las MIPES si utilizan la innovación al máximo, se concluye que la inversión en tecnología, capacitación en la administración de la organización, en asistir a ferias y congreso incrementa sus niveles de innovación.



MSMEs, Innovation, Strategy

MIPES, Innovación, Estrategia

Area: Advocacy and attention to national problems

Citation: Serrano-Torres, Ma. Guadalupe & Kaczmarek-Chavarría, Marcela [2025]. The importance of innovation in micro and small enterprises (MIPES) in León, Guanajuato, Mexico. Journal of Business and SMEs. 11[27]1-7: e21127107



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]-in the contribution to the scientific, technological and innovation **Peer Review Process** through the training of Human Resources for the continuity in the Critical Analysis of International Research.



Introduction

To delve into the topic of innovation, we will broadly analyse Mexico's economy, which has been hit hard by the COVID-19 pandemic. This is because it was during this pandemic that innovation had to be used immediately to operate and carry out purchasing and sales activities in a different way than before the pandemic.

Although the country's economy currently achieved a significant quarterly GDP increase of 1.1 net, with a 1.5 increase in tertiary activities and a 0.7% increase in secondary activities, the GDP of primary activities decreased by 3.2% in the first quarter of 2023. This is shown by studies carried out in the first quarter of the year by INEGI (2023). This economic progress exceeds the median of 11 economic analysts surveyed by Reuters. *El Economista* (2023).

In 2020, GDP experienced one of the largest declines in history, with per capita GDP falling to 2010 levels. As a result, businesses and consumers rapidly shifted to digital and online channels to cope with social distancing measures. The aim was to be able to continue commercial operations, secure income and remain operational during the COVID-19 pandemic. CEPAL (2022).

Innovation was the main strategy used by companies around the world, operating differently while in lockdown to prevent the spread of COVID-19. Most companies operated behind closed doors, finding ways to deliver their materials by placing orders online, with staff working from home and distributing their products and services to customers' homes (Garcia, 2021). This was the innovation used immediately and rapidly to survive the economic crisis caused by a health pandemic such as that experienced in 2020 and 2021. Companies hired parcel delivery services or people to perform this function in order to make their deliveries. Well, these types of strategies will be the focus of our study.

It is very important to start from the research carried out by Cardona (2022), where he mentions that 'innovation is any new policy undertaken by a company to reduce costs, to find a new source of supply, to find a new market, used as a survival strategy'.

Thus, during the COVID-19 pandemic, companies faced an emerging challenge: either they made significant changes to their traditional way of operating, or it would simply not be possible to remain in business and they would have to close their doors temporarily or permanently.

Now, for Manzano (2021), innovation equals productivity, that is, increasing productivity by using innovation in each of the activities from the idea to the completion of the business. It is very important for MSMEs to continue to overcome the economic crisis left by the current pandemic.

The companies in our study had to make changes to their daily activities and processes in order to operate remotely and maintain their productivity, thereby guaranteeing the income necessary to cover their operating costs.

However, many of these SMEs continue to face barriers that prevent their implementation, such as digital illiteracy and financial inclusion [UNESCO, 2023].

Below is the global innovation index, which shows that Mexico ranks 58th out of 139 countries in terms of progress in invention and increase in education.

However, it is very important to mention that in 2021, this country ranked 55th out of a total of 132 countries analysed, and in 2020, it ranked 55th out of a total of 131. It is noteworthy that we have currently lost three places in overall innovation compared to the IMI in 2022.

This places us in a position where we need to work hard to continue advancing and recover the places lost after the pandemic. Now, by 2025 compared to 2020, we have fallen seven places, so Mexico must invest more in innovation to recover its global position before the pandemic.

Box 1**Table 1**

Global Innovation Index 2025

Index and Country	Index and Country
1 Switzerland	71 Colombia
2 Sweden	72 Costa Rica
3 United States	73 Kuwait
4 Republic of Korea	74 Republic of Moldova
5 Singapore	75 Seychelles
6 United Kingdom	76 Tunisia
7 Finland	77 Argentina
8 Netherlands	78 Mongolia
9 Denmark	79 Uzbekistan
10 China	80 Peru
11 Germany	81 Kazakhstan
12 Japan	82 Panama
13 France	83 Jamaica
14 Israel	84 Barbados
15 Hong Kong, China	85 Belarus
16 Estonia	86 Egypt
17 Canada	87 Botswana
18 Ireland	88 Brunei Darussalam
19 Austria	89 Senegal
20 Norway	90 Lebanon
21 Belgium	91 Namibia
22 Australia	92 Bosnia and Herzegovina
23 Luxembourg	93 Sri Lanka
24 Iceland	94 Azerbaijan
25 Cyprus	95 Cabo Verde
26 New Zealand	96 Kyrgyzstan
27 Malta	97 Dominican Republic
28 Italy	98 El Salvador
29 Spain	99 Pakistan
30 United Arab Emirates	100 Cambodia
31 Portugal	101 Ghana
32 Czech Republic	102 Kenya
33 Lithuania	103 Paraguay
34 Malaysia	104 Rwanda
35 Slovenia	105 Nigeria
36 Hungary	106 Bangladesh
37 Bulgaria	107 Nepal
38 India	108 Tajikistan
39 Poland	109 Lao People's Democratic R
40 Croatia	110 Côte d'Ivoire
41 Latvia	111 Bolivia
42 Greece	112 Zambia
43 Türkiye	113 Ecuador
44 Viet Nam	114 Trinidad and Tobago
45 Thailand	115 Algeria
46 Saudi Arabia	116 Cameroon
47 Slovakia	117 Togo
48 Qatar	118 Benin
49 Romania	119 Honduras
50 Philippines	120 Madagascar
51 Chile	121 United Republic of Tanzania
52 Brazil	122 Myanmar
53 Mauritius	123 Guatemala
54 Serbia	124 Uganda
55 Indonesia	125 Malawi
56 Georgia	126 Burkina Faso
57 Morocco	127 Burundi
58 Mexico	128 Mozambique
59 Armenia	129 Zimbabwe
60 Russian Federation	130 Nicaragua
61 South Africa	131 Mauritania
62 Bahrain	132 Lesotho
63 North Macedonia	133 Guinea
64 Montenegro	134 Ethiopia
65 Jordan	135 Mali
66 Ukraine	136 Venezuela
67 Albania	137 Congo
68 Uruguay	138 Angola
69 Oman	139 Niger
70 Iran (Islamic Republic of)	

Source: own elaboration with data from the Global Innovation Index

It is worth mentioning that in the current global innovation index table, there are countries that no longer appear in the ranking due to their setbacks in innovation after the pandemic. Such is the case of Yemen, as well as our country, which fell seven places. Other countries also fell, and each of them will take the time necessary to recover their economies to pre-pandemic levels and use innovation as a very effective strategy.

Theoretical framework

Innovation is creating something new, modifying, distinguishing, producing a good or providing a service in a different way from the competition. Innovation is the beginning of competitive distinctions; it is an excellent ally and one leads to the other. (Moncada, 2019). Now, for;

For Haro et al (2017), innovation is a creation, a successful change or a process that needs to be improved in a product or service. Inventions and changes are not always successful at first and will require adjustments and improvements.

However, for Garcia (2021), innovation is adding value to a product or service, improving a process, which allows for optimisation of the result and, in turn, becomes a business strategy that allows us to face economic adversity. The emergence of new trends leads us to be competitive. Doing things differently from our main competitors. (Burgos & Rojo, 2018).

However, for this research, innovation in many companies was an essential requirement in order to continue operating and not close their doors permanently.

[This research is organised into an abstract, introduction, methodology, results and conclusion.

Methodology

This research has a cross-sectional design with a quantitative approach. The objective of this research was to analyse the importance and use of innovation by managers and owners of micro and small enterprises. It is supported by the research question:

Why analyse the importance of innovation by managers and entrepreneurs of micro and small enterprises (MSEs) in León, Guanajuato, Mexico? For the quantitative analysis, a data collection instrument was applied by the entire RELAYN network in Mexico and Latin America in 2024. In the case of León, Guanajuato, Mexico, they were administered by students from the León Technological University Campus I and Campus II, in the economic-administrative area. A total of 465 surveys were administered and 429 were validated correctly.

This research project has a cross-sectional design, with a quantitative approach, and is exploratory, descriptive and correlational in nature. A simple random probability sample was taken of MSMEs in León, Guanajuato, with between 2 and 50 employees, seeking a 95% confidence level, with a 5% margin of error and an estimated probability of $p= 0.5$ or 50%. A total of 451 surveys were administered. Using a survey-type measurement instrument, it was administered to the directors and owners of this type of business by students from the universities that are part of the Relayn network.

The research questions that were asked are as follows:

1. Development or payment to innovate my production or distribution processes,
2. Development or payment to innovate the products or services i offer,
3. Development or payment to innovate the way i sell my product or service,
4. Development or payment to innovate the way I organise the company
5. I attend fairs, courses, conferences or other business-related activities.

Results

The answers to the research questions are presented below.

We begin with the first research question shown in the following table.

Box 2

Table 2

Should I develop or pay to innovate my production or distribution processes?

Description	Number	Percentage
Strongly agree	190	44%
Agree	155	36%
Disagree	6	1%
Strongly disagree	5	1%
Indifferent	73	18%
	429	100%

Source: Own Creation

In the table above, 80% of MIPES managers responded that they strongly agree with investing in innovation in their production processes. This was necessary after the COVID-19 pandemic, as the companies that survived used innovation as a survival strategy and utilised technology in their production and distribution processes.

The results of question number two are shown in the following table.

Box 3

Table 3

Should I develop or pay to innovate the products or services I offer?

Description	Number	Percentage
Strongly agree	200	47%
Agree	137	32%
Disagree	9	2%
Strongly disagree	4	1%
Indifferent	79	18%
	429	100%

Source: Own Creation

In the table above, 79% of the executives and entrepreneurs of the companies analysed responded that they strongly agree with investing in their products or services to innovate and be at the forefront of innovation. One of the most important investments is in the product or service offered, in order to provide a competitive advantage over the main competitors and to have frequent customers who keep the business going and growing.

The results of question number three are shown in the following table

Box 4**Table 4**

Should I invest in development or pay to innovate the way I sell my product or service (design, packaging, promotion, pricing, etc.)?

Description	Number	Percentage
Strongly agree	250	58%
Agree	137	32%
Disagree	1	01%
Strongly disagree	3	1%
Indifferent	38	9%
	429	100%

Source: Own Creation

The table above shows that entrepreneurs developed or paid to innovate in the way they offer and sell their product or service, i.e., investing in its design, packaging, promotion, and pricing. This question had the highest percentage (90%), indicating that managers considered this aspect of innovation to be very important. This question had the highest percentage, showing us that the entrepreneurs in the analysis developed the way they make their sales. This phenomenon occurred in most businesses after the pandemic, as they found themselves needing to use social media, online sales, and home delivery services. For entrepreneurs who use these innovation tools, it will be very easy to survive for many years, while those who do not will be at risk of disappearing.

The results for question number four are shown in the following table.

Box 5**Table 5**

Development or payment to innovate the way I organise my company?

Description	Number	Percentage
Strongly agree	230	54%
Agree	116	27%
Disagree	13	3%
Strongly disagree	6	1%
Indifferent	64	15%
	429	100%

Source: Own Creation

The table above shows that 81% of entrepreneurs developed or innovated the way they organise their businesses in terms of staffing and how they manage, run and organise their companies. This is one of the most important questions that owners and managers of micro and small enterprises must consider. After the pandemic, both internal and external changes and variables will have an impact on the company, but to a greater extent, the administrative and management success of this type of business will depend on internal factors and the organisation of the company.

The answer to question number five is given below.

Box 6**Table 6**

I attend trade fairs, courses, conferences and other business-related activities.

Description	Number	Percentage
Strongly agree	218	51%
Agree	112	26%
Disagree	18	4%
Strongly disagree	22	5%
Indifferent	59	14%
	429	100%

Source: Own Creation

The table above shows that 77% agree that they invested in attending trade fairs, conferences or business innovation activities. This question represents the lowest percentage of the five questions analysed, which gives us an area of opportunity for managers and owners to invest in attending events that provide them with new ideas to improve their product or service. Currently, there are chambers and organisations that schedule trade fairs and conferences for different business sectors, with the aim of supporting the development and sustainability of MIPES companies in León, Guanajuato, Mexico.

Conclusions

Other analyses and studies precede this article in 2021, 2022 and 2023, analyses were carried out against the global innovation index to measure and compare the progress or setbacks suffered by the country, and now, four years after the first study, Mexico has fallen seven places from 51st to 58th in the global ranking.

Undoubtedly, innovation is a necessary and urgent tool within MSMEs in Mexico, the state and the city of León, and the following comment is supported by research question number three: development or payment to innovate the way I sell my product or service (design, packaging, promotion, pricing, etc.)? With the highest percentage of responses from the 429 entrepreneurs surveyed in the city of León Guanajuato, the way products and services are marketed after the COVID pandemic is undoubtedly no longer the same. Sales through social media, apps, the internet, and home delivery have innovated the way marketing is done throughout the country, and León, Guanajuato, is no exception.

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Contribution of the authors

The first author contributed to the development of the article in terms of the results and conclusions, and the second author contributed to the state of the art and methodology of the article. Both authors contributed to the preparation of this research article.

Availability of data and materials

The data obtained as results are made available to anyone who requests them and are available to any researcher from other universities who requests them by email.

Funding

To carry out this research, the Technological University of León contributed by allocating time in hours for the completion of this research article, which is extremely important for raising awareness among entrepreneurs, the government, and public and private companies to invest in innovation in the country and in companies.

Acknowledgements

Our sincere recognition and gratitude to the University of León UTL for its support in terms of the time allocated to carry out this article. Many thanks for all the support provided, especially to the research department. Thank you very much.

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Participatory and solidary management for the implementation of a dried armored catfish fillet plant in fishing cooperatives of the municipality of Centro, Tabasco, Mexico

Gestión participativa y solidaria para la implementación de la secadora de filete de bagre armado en cooperativas pesqueras del municipio de Centro, Tabasco, México

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SECIHTI classification:

Area: Humanities and Behavioral Sciences

Field: Pedagogy

Discipline: Organization and planning of education

Subdiscipline: Organization and management of educational institutions

doi <https://doi.org/10.35429/JBS.2025.11.27.3.1.12>

History of the article:

Received: July 25, 2025

Accepted: November 10, 2025

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Abstract

The article designs a participatory and solidarity-based management proposal to implement an armored catfish fillet dryer in cooperatives in the municipality of Centro, Tabasco, Mexico. Using a mixed-methods approach, it integrates surveys, interviews, observation, and SWOT analysis to diagnose gaps in governance, infrastructure, and market information. The model is grounded in the Social and Solidarity Economy and in commons governance principles, and it is operationalized in four phases: participatory diagnosis, stakeholder validation, collaborative formulation, and implementation with shared monitoring. Recommendations include sanitary standardization and traceability, as well as commercial linkages with fair pricing and the inclusion of women and youth, under cooperative identity and principles. The hypothesis is partially validated: the model improves organizational cohesion, operational efficiency, and socioeconomic conditions, and contributes to Sustainable Development Goals 8, 12, and 14, while strengthening local capacities in a sustainable manner.

Resumen

El artículo diseña una propuesta de gestión participativa y solidaria para implementar una secadora de filete de bagre armado en cooperativas del municipio de Centro, Tabasco, México. Con un enfoque mixto, integra encuestas, entrevistas, observación y análisis FODA para diagnosticar brechas en gobernanza, infraestructura e información de mercado. El modelo se basa en la Economía Social y Solidaria y en principios de gobernanza de las comunidades, y se opera en cuatro fases: diagnóstico participativo, validación con actores, formulación colaborativa e implementación con monitoreo compartido. Se recomiendan la estandarización sanitaria y la trazabilidad, así como encadenamientos comerciales con precios justos e inclusión de mujeres y jóvenes, bajo identidad y principios cooperativos. La hipótesis se valida parcialmente: el modelo mejora la cohesión organizativa, la eficiencia operativa y las condiciones socioeconómicas, y contribuye a los Objetivos de Desarrollo Sostenible 8, 12 y 14, fortaleciendo capacidades locales de manera sostenible.



Fisheries management, Community participation, Food processing



Gestión de la pesca, Participación comunitaria, Procesamiento de alimentos

Area: Development of strategic leading-edge technologies and open innovation for social transformation

Citation: Rivera-Rodríguez, María, Sepúlveda-Quiroz, César Antonio, Hernández-Martínez, Maria del Carmen and González-Izquierdo, Karina. [2025]. Participatory and solidary management for the implementation of a dried armored catfish fillet plant in fishing cooperatives of the municipality of Centro, Tabasco, Mexico. Journal of Business and SMEs. 11[27]1-12: e31127112



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]-in the contribution to the scientific, technological and innovation Peer Review Process through the training of Human Resources for the continuity in the Critical Analysis of International Research.



Introduction

The purpose of this article is to design a participatory and solidarity-based management proposal based on the principles of the solidarity economy, which will enable the effective integration of fishing cooperatives in the municipality of Centro, Tabasco, into the processes of operation, administration and distribution of products derived from armoured catfish (*Pterygoplichthys spp.*). This proposal arises in response to a series of structural problems that directly affect the internal cohesion, sustainability and competitiveness of these organisations (Kliksberg, B, 1999).

Firstly, a weak organisational structure is identified, characterised by a lack of clarity in roles, responsibilities and communication channels between members. This fragility limits active participation in decision-making and reduces the sense of belonging and collective commitment. Studies have shown that in public organisations, formal hierarchies and the absence of informal communication networks impair information flows and internal collaboration, creating barriers to participatory processes.

Secondly, there is a lack of participatory management mechanisms structured according to the principles of the social and solidarity economy, such as cooperation, reciprocity and equity. In the absence of these values, internal dynamics tend to become fragmented, individualistic and unsustainable. For example, in the context of social economy enterprises, the principles of reciprocity, solidarity and cooperation are fundamental to sustaining lasting organisational links and avoiding the atomisation of actors (Alfa Publicaciones, 2022). Finally, there is a lack of systematised administrative and operational processes, which leads to disorganisation, inefficiencies and the loss of key information for the technical and productive development of cooperatives.

In view of this context, a comprehensive solution is proposed: the implementation of an armed catfish fillet dryer managed through participation and collaboration. This alternative seeks to strengthen the organisational and operational capacities of cooperatives, improve efficiency in product transformation and generate a positive impact on the socio-economic conditions of cooperative members.

Its added value lies in the fact that it is not limited to the technical aspect of the infrastructure, but incorporates a training and organisational approach focused on internal democracy, co-responsibility and self-management. (Santiago David Muñoz Solórzano, 2022)

The hypothesis guiding this research posits that if cooperatives adopt a participatory management model based on the principles of the solidarity economy, they will be able to successfully implement a catfish drying facility that improves their organisational cohesion, operational efficiency and socio-economic conditions. To test this hypothesis, the article is structured in five sections.

The second section presents the theoretical framework, addressing key concepts such as solidarity economy, participatory management and cooperative structures. The third section analyses the current problems of cooperatives, based on the preliminary diagnosis. The fourth section develops the proposed management model, breaking down its objectives, activities and methodology. Finally, conclusions and recommendations for the practical implementation of the model are presented. This work aims to be an academic and technical contribution to the organisational transformation processes of the Barra Ciega S.C.de R.L.de C.V. fishing cooperative in the municipality of Centro, with a view to more equitable, sustainable and solidarity-based local development. The intention is to replicate it in other cooperatives. The theoretical framework underpinning the research on participatory and solidarity-based management for the implementation of the catfish fillet dryer in fishing cooperatives in the municipality of Centro Tabasco.

Social and Solidarity Economy (SSE) and cooperative identity

The SSE proposes forms of production and governance centred on people and the territory, with cooperation and sustainability. In Latin America, recent studies on the social and solidarity economy emphasise that this model promotes voluntary cooperation, collective action and democratic governance as a basis for strengthening community fabrics and territorial associative projects.

For example, they point out that the SSE focuses on local collective actions, common goods and participatory self-government. In addition, the principles of cooperative identity of the International Cooperative Alliance (ICA), such as democratic member control, economic participation, autonomy and concern for the community, provide an applicable institutional framework for community organisation.

Participatory management and governance of common goods

Participatory management reduces information asymmetries and increases local ownership. In shared resources, Ostrom's theory of the commons provides design principles (defined boundaries, local rules, monitoring, graduated sanctions, conflict resolution and nested arrangements) to sustain self-managed organisations that share common equipment (such as a dryer).

Participatory Action Research (PAR) and collective learning promote cycles of diagnosis-action-reflection with local actors, accelerating the appropriation of processes (filleting and drying) and legitimising organisational and technical adjustments.

Guidelines for small-scale fisheries and value chains.

The FAO recommends an ecosystem approach with community participation in governance and market access, which supports solidarity value chains and the involvement of cooperatives in post-harvest and processing. Safety, quality and standardisation for dried fishery products.

Economic sustainability depends on safety and quality. The Code of Practice for Fish and Fishery Products (FAO/Codex) and the HACCP Guide for Fish (FDA) establish guidelines for drying: temperature/time control, water activity and hygienic practices (2024). In Mexico, regulations for the use of fishery resources are set by the National Commission for Sustainable Fisheries and Aquaculture (CONAPESCA) based on the General Law on Sustainable Fisheries and Aquaculture and the National Fisheries Charter. In this regard, there are no guidelines on the spiny catfish (*Pterygoplichthys pardalis*), as it is an introduced species and fishing is permitted. On the other hand, there is also no federal fisheries management or exploitation plan.

Ecological context of the spiny catfish and productive integration

The armoured catfish (*Pterygoplichthys spp.*), introduced in Mexico, was first recorded in the Balsas River basin, particularly in the El Infiernillo dam (Michoacán-Guerrero), from where its population expanded to other basins in the southeast, affecting local ecosystems and fisheries. Likewise, its integration into value chains—for example, as a source of protein/hydrolysates—allows an ecological liability to be converted into an economic input with potential social and environmental benefits. Alignment with the Sustainable Development Goals (SDGs). The project is aligned with the 2030 Agenda: SDG 8 (decent work), SDG 12 (responsible consumption and production) and SDG 14 (life below water). (UN, 2015)

Development:

Participatory management model: concept and structure

A participatory management model is an organisational framework that encourages the active involvement of different actors in decision-making, planning, implementation and evaluation of actions. It differs from other models in terms of values such as co-responsibility, horizontality, internal democracy, transparency and collective trust. We present the *Tree of Participation* as an inclusive model of participatory decision-making that seeks to empower marginalised groups, promote equity in participation and ensure democratic processes within organisations.

This type of model recognises the knowledge and experience of the organisation's members, valuing their ability to contribute to the achievement of common goals. Thus, not only are technical and administrative processes optimised, but organisational links, a sense of belonging and collective commitment are also strengthened.

Participatory management is particularly relevant in the context of the Social and Solidarity Economy (SSE), where organisations—such as fishing cooperatives—seek not only productive efficiency, but also equity, sustainability, and community well-being.

For this reason, the model proposed in this article is structured taking into account both functional components and criteria of social inclusion and solidarity.

The participatory management model for the implementation of a catfish fillet dryer in the cooperatives of the municipality of Centro, Tabasco, will be based on the following pillars:

The participatory management model for the implementation of a catfish fillet dryer in the cooperatives of the municipality of Centro, Tabasco, will be based on the following pillars:

Participatory organisational diagnosis:

Internal assessment of capacities, processes and organisational culture.

Consultation and validation with key actors:

Involvement of partners, community leaders and institutional actors.

Collaborative formulation:

Design of the model with clear processes, role allocation, communication channels and control mechanisms.

Implementation and shared monitoring:

Implementation of the model with continuous evaluation and feedback from all actors.

The proposed model's approach integrates elements of strategic planning, operational management, human talent management and social sustainability, as observed in the selected reference frameworks.

Comparison of participatory management models

Comparative table of various participatory management models and their relevance in Social and Solidarity Economy (SSE) contexts.

Box 1

Table 1

Comparison of participatory management models

Management model	Central focus	Key components	Social participation	Applicability in ESS
Huertas Tannia et al. (2020)	Based on the interaction between processes, human resources, and technology.	Strategy, execution, organisational culture and horizontal structure.	Recommend involving key stakeholders in the design and implementation.	Media: values participation and strategy, useful if adapted to solidarity principles.
Intriago (2014)	Definition and comprehensive management of eight functional processes within an organisation.	Strategic, operational, human resources, maintenance, financial management, etc.	Limited; focused on internal functional processes.	Low: focuses on operational efficiency rather than solidarity values.
Cabezas (2010)	Participatory process for formulating models with a social, political and organisational focus.	Stages: prospecting, negotiation, formulation and review of the model with key stakeholders.	High participation: social actors, politicians, technical experts, community.	High: includes community participation and multi-stakeholder dialogue.
Mondragón Corporation (2012)	Cooperative model focused on democratic participation, sustainability, and shared responsibility.	Internal democracy, worker participation, collective ownership, solidarity networks.	High participation of members and workers in decision-making.	Very high: designed by and for social and solidarity economy organisations.

Source: Own Elaboration

Methodology

The methodology of this research is oriented towards the design of a participatory and solidarity-based management proposal for the implementation of a catfish fillet dryer in fishing cooperatives in the municipality of Centro, Tabasco. Specifying that the pilot test will be carried out in the Barra Ciega S. C. DE R.L. DE C.V. fishing cooperative. Given the applied and contextual approach, a mixed methodology with a qualitative predominance was chosen, which allows for the integration of both organisational analysis and the active participation of key actors in the design of the model.

Type of study:

The research is part of a descriptive and propositional study, as it aims to characterise the current situation of cooperatives and propose a management model. A participatory and organisational intervention approach is used, typical of the solidarity economy, which recognises the collective experience and situated knowledge of the actors involved.

Research hypothesis:

Hypothesis

If fishing cooperatives adopt a participatory management model based on the principles of the solidarity economy, then they will be able to successfully implement an armoured catfish dryer that improves their organisational cohesion, operational efficiency and socio-economic conditions.

Research variables

Independent variable

Adoption of a participatory management model based on the solidarity economy.

Indicators: level of democratic participation of members, existence of mechanisms for shared responsibility and collective decision-making, practices of cooperation, equity and solidarity.

Dependent variables

- **Organisational cohesion:** clarity of roles and functions, internal communication, level of commitment.
- **Operational efficiency:** proper use of the dryer, production protocols, reduction of losses.
- **Socio-economic conditions:** average income, access to markets, participation of women and young people, perception of community benefits.

Techniques and instruments:

The following techniques were used to meet the specific objectives:

Structured surveys aimed at members and cooperative leaders, in order to identify their experience, participation in productive projects and perception of internal management.

Semi-structured interviews with cooperative leaders, members and the president of the Federation of Fishing, Aquaculture and Permit Holders Cooperatives of Tabasco, S. C. DE R. L. DE C.V., focused on identifying capacities, needs and coordination dynamics.

Direct observation through technical visits to the cooperatives' facilities to gather information on infrastructure, operational processes and working conditions.

SWOT matrices to analyse in a participatory manner the strengths, weaknesses, opportunities and threats faced by cooperatives in the implementation of a fillet dryer.

Universe and sample

The study universe consists of fishing cooperatives registered in the municipality of Centro, Tabasco. A non-probabilistic intentional sample was selected from those cooperatives with an interest and potential to operate catfish processing infrastructure. The units of analysis are the cooperative members, the boards of directors, related institutional actors, and internal organisational and production processes.

Methodological process

The research was carried out in three phases:

1.- Technical-productive organisational diagnosis:

Information gathering through surveys, interviews, and observation.

Assessment of strengths and weaknesses, which we present through the SWOT matrix.

Box 2

Table 2

SWOT MATRIX – Participatory Management for the Armado Catfish Filleting Plant

Strengths (F)	Weaknesses (W)	Opportunities (O)	Threats (A)	FO (F+O) strategies	Directors' and Officers' Liability Insurance
F1. High level of fishing experience (69% >10 years)	D1. Lack of adequate infrastructure (only 7% have a filleting area)	O1. Potential of armoured catfish as a value-added resource (dried fillet)	A1. Price volatility and low profit margins on crude oil	FO1. Implement a filleting plant based on experience and active participation of partners.	DO1. Manage basic equipment: COOLERS, knives, filleting machines. Launch solidarity microloans. stainless steel tables and utensils
F2. High willingness to participate (~90%)	D2. Low awareness of safety standards and standardised processing	O2. Technical training available (27% demand for training)	A2. Health and legal risks of processing at home	FO2. Community technical school on safety and quality in armoured catfish processing	DO2. Establish training pathways with technical support in HACCP and traceability.

F3. Internal democratic governance (minutes, committees)	D3. Lack of standardisation in internal roles and functions	O3. Possibility of institutional partnerships and access to funding	A3. Dependence on individual leadership and lack of succession plans	FO3. Use governance mechanisms to establish framework agreement with purchasers	DO3. Create organisational succession plans and emergency funds with community participation.
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Source: Own Elaboration

2.- Analysis of actors and social relations:

Identify key actors, their interests/capabilities, and map the critical points of the armadillo catfish chain to align agreements, reduce conflicts, and guide cooperation under participatory management.

Identification of key actors.

- a. Cooperatives and fishing bases (presidents, councils, members—women and young people).
 - b. Government and regulators: Tabasco State Secretariat of Tourism and Economic Development
 - c. Education and research (TecNM/ITVH, UJAT, technology centres, extension workers).
 - d. Territorial mapping.
- Catch areas and landing/collection points.
 - Existing/planned infrastructure: filleting/drying, cold storage, safe water, energy.
 - Transport routes (times/distances) and cold chain nodes.
 - Markets and buyers (local, regional, institutional).
 - Risks: health, flooding, power cuts, pollution.

3.- Design of the management proposal:

Drafting of the model based on the principles of the solidarity economy.

Incorporation of guidelines for participation, equitable distribution and sustainability. This methodology responds to the need to articulate applied research with organisational strengthening from a democratic, inclusive and solidarity-based perspective, which is key to the transformation processes in the cooperative fishing sector.

Results

Organisational and technical-productive diagnosis

a. Governance and transparency

- Presidents: Most reported that there are active councils and committees and that minutes are taken at meetings. Decision-making by majority vote and cooperative principles is promoted.
- Members: Although they recognise the existence of formal structures, some mentioned that decisions are made by a few or that they are not aware of the details of the minutes.
- Conclusion: There is a gap between the formal structure and the experience of internal democracy, which points to the need to strengthen accountability mechanisms.

b. Participation in decisions

- Presidents: They ensure that members have a voice and that co-responsibility is promoted.
- Members: Only 37% indicated that they participate in 'all' or 'most' decisions.
- Conclusion: There is a need to establish real spaces for effective participation, beyond the formality of meetings.

c. Production and infrastructure

- Presidents: Only a minority (7%) reported having adequate spaces for filleting.
- Members: Processing is mainly carried out at home, without sanitary conditions.
- Conclusion: Shared infrastructure, such as collection and processing centres with safety standards, needs to be implemented.

d. Market and prices

- Presidents: They express interest in processing catfish and accessing new markets.
- Partners: They receive low prices for raw fish (\approx £10/kg), and some prefer to discard it due to lack of outlets.
- Conclusion: There is untapped potential in armadillo catfish. The proposal for a dryer could add value and generate more stable marketing channels.

e. Finance and plan management

- Chairpersons: Report quarterly follow-ups to the work plan.
- Members: Some report a lack of communication about progress or results.
- Conclusion: Weaknesses are identified in the feedback of results and transparency in the execution of the plan.

Box 3

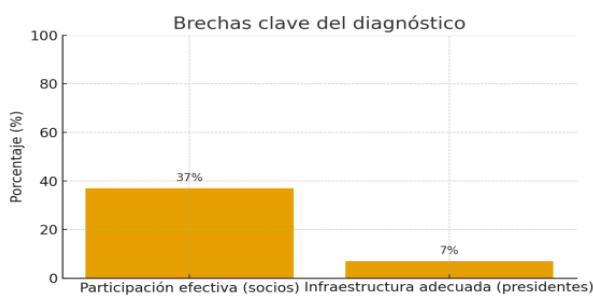


Figure 1

Key gaps in the diagnosis (effective participation and availability of adequate infrastructure).

Source: Own Elaboration

4. Analysis of actors and social relations

- Key actors identified: cooperatives, development institutions (INAES, SEDAFOP), universities (TecNM, UJAT), local merchants, technical partners (FEDECOTAB).
- Mapping and sociogram: Revealed strong alliances between cooperatives and academics, but tensions with private intermediaries and a lack of coordination with health authorities.

- Validation in workshops: Confirmed the importance of creating spaces for inter-institutional coordination and generational renewal.

5. Design of the participatory management proposal

a. Key strategies

- DO2: Design technical training routes for health standards.
- FA1: Establish agreements with buyers to ensure fair prices.
- DA2: Create regulatory compliance pathways with technical support.

b. Proposed model

- Democratic and supportive participation and collaboration.
- Equitable distribution of benefits.
- Participatory monitoring with indicators of cohesion, efficiency, and socioeconomic improvements.
- Active inclusion of women and young people.
- Links with academic and government institutions.

6. Hypothesis validation

Based on the data collected and the analysis, the hypothesis is partially validated:

‘If fishing cooperatives adopt a participatory management model based on the principles of the solidarity economy, then they will be able to successfully implement an armoured catfish dryer that improves their organisational cohesion, operational efficiency and socio-economic conditions.’

Empirical evidence:

- High level of willingness to participate.
- Deficiencies that can be addressed through training, infrastructure, and partnerships.

The empirical results largely confirm this hypothesis. The following variables show significant progress:

- Organisational cohesion: High democratic governance and clarity in collective decision-making.
- Operational efficiency: Willingness to improve infrastructure and establish community processing centres.
- Socio-economic conditions: Identification of collective benefits, inclusion of women and young people, and market potential.

Box 4



Figure 2

Results that verify the research hypothesis

Source: Own elaboration

7. Display of Relevant Results

Below is a comparison between the responses of cooperative presidents and fisher members in relation to governance, participation, infrastructure, market and finance. This comparison allows us to identify gaps, similarities and opportunities to strengthen the participatory model:

Box 5

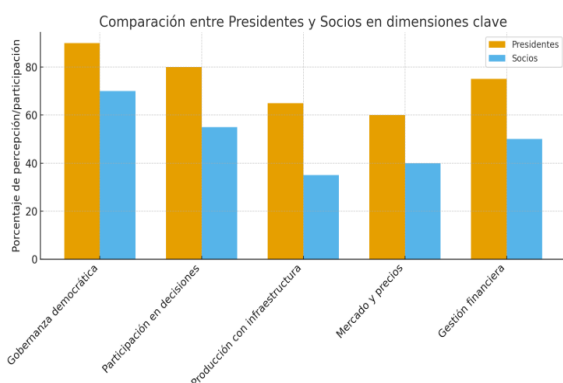


Figure 3

Comparison of perceptions between presidents and cooperative members

Source: Own Elaboration

Conclusions

Collaborative work between cooperatives, educational institutions and public governance, within the framework of the Social and Solidarity Economy (SSE), demonstrated its capacity to promote the sustainable use of armoured catfish in the municipality of Centro, Tabasco. The combination of strategic alliances and training processes strengthened production, value-added processing (e.g., prototypes of dehydrated armadillo catfish fillets for pet treats and meat products) and formal marketing, with positive effects on income, employment and organisational cohesion of cooperatives. Environmentally, productive use contributed to reducing discards and showed signs of containing overpopulation in critical areas.

However, gaps remain between the formal structure and the experience of internal democracy, as well as infrastructure limitations (processing and safety spaces) and information asymmetries in the market and prices. These areas for improvement can be addressed by consolidating participatory governance mechanisms, standardising health processes, enabling collection and processing centres, and strengthening commercial linkages.

Possibilities for improvement (specific actions):

Sanitary standardisation and traceability: implement POE/BPM, batch records and labelling, with technical support.

Commercial linkages: purchase agreements, **collective branding**, local quality seals and stable channels.

Management and marketing: training in **costing**, **price/kg** setting, customer segmentation and contracts.

Socio-environmental monitoring: quarterly indicators (kg used, waste, price/kg, jobs, social perception, discard reports).

Inclusion and governance: targets for the participation of **women and young people** in committees; periodic accountability.

Technological scaling: progress in the **drying plant** and complementary equipment (packaging, refrigeration, storage).

Suggested monitoring indicators (every 3–6 months): kg/months utilised; % wastage; kg of dehydrated fillets; price/kg; number of sales channels; net income per member; number of working days; percentage of attendance at meetings and participation of women and young people.

The implementation of the participatory management model reveals key areas for strengthening within the fishing cooperatives of the municipality of Centro, Tabasco. These include the need to clarify organisational functions, promote horizontal communication and establish formal mechanisms for shared decision-making. The appropriation of the model by community actors is an evolving process that can be optimised through continuous training, deliberative dialogue and structural adjustments.

Economic opportunities and improved implementation of the armoured catfish fillet dryer: The productive use of armoured catfish—a highly available invasive species—represents a strategic opportunity to generate added value and diversify the local economy. The implementation of the fillet dryer, if accompanied by processes of health standardisation, traceability and fair trade chains, can translate into concrete benefits: increased income, job creation and reduced fish waste. Strengthening partnerships between cooperatives, academia and government is key to ensuring its technical, economic and social viability.

Improvements in participatory and collaborative management by fishermen in the fishing communities of Centro, Tabasco: The adoption of a participatory and collaborative approach has begun to transform the internal dynamics of cooperatives by promoting shared responsibility, transparency, collective planning and joint work between different actors. This collaborative nature is essential because it promotes horizontal dialogue, the building of agreements and mutual learning between fishermen, community leaders and partner institutions. While challenges remain—such as the limited participation of women and young people and the lack of access to market information—the model has proven useful in strengthening the sense of belonging, organisational cohesion and collective action.

Its consolidation will depend on shared monitoring processes, constant feedback, and inclusive, adaptive governance based on the active cooperation of all members.

Annexes

Box 6

Table 3

Interview with fishermen from the cooperative

Question	Answer options
In what year was the cooperative formally established?	<input type="checkbox"/> Before 2000 <input type="checkbox"/> Between 2001 and 2010 <input type="checkbox"/> Between 2011 and 2020 <input type="checkbox"/> After 2020
What were the main reasons behind its creation?	<input type="checkbox"/> Financial need <input type="checkbox"/> Fishermen's union <input type="checkbox"/> Access to government programmes <input type="checkbox"/> Other:
Are you familiar with the articles of incorporation and their contents?	<input type="checkbox"/> Yes, everyone knows it <input type="checkbox"/> Some people know it <input type="checkbox"/> No one knows it <input type="checkbox"/> There is no memorandum of association
Do you have official documentation supporting your legal and organisational existence?	<input type="checkbox"/> Yes <input type="checkbox"/> No
How is the cooperative currently organised in terms of its members?	<input type="checkbox"/> Mostly men <input type="checkbox"/> Mostly women <input type="checkbox"/> Balanced
How is the cooperative structured?	<input type="checkbox"/> Board of directors and committees <input type="checkbox"/> Only a chairperson <input type="checkbox"/> No clear structure <input type="checkbox"/> Don't know / No response
Have you defined the roles and responsibilities of each member in writing?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Partially
Is there an internal operating manual or operational guidelines?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Partially
Are the roles of chairperson and secretary clearly defined for meetings?	<input type="checkbox"/> Yes, they are well defined <input type="checkbox"/> They are defined, but not applied <input type="checkbox"/> They are not defined <input type="checkbox"/> Not applicable
Where are meetings usually held?	<input type="checkbox"/> Cooperative office <input type="checkbox"/> Member's home <input type="checkbox"/> Public place or community centre <input type="checkbox"/> Other:
Who coordinates or moderates the meetings?	<input type="checkbox"/> Chairperson <input type="checkbox"/> Secretary <input type="checkbox"/> Both <input type="checkbox"/> Other:
What kind of expenses does the cooperative have?	<input type="checkbox"/> Operating expenses <input type="checkbox"/> Administrative expenses <input type="checkbox"/> Both <input type="checkbox"/> I don't know
Who covers those expenses?	<input type="checkbox"/> The cooperative itself <input type="checkbox"/> Each member contributes <input type="checkbox"/> Government or other external support <input type="checkbox"/> Not covered
Do you have a defined role and responsibilities for each member?	<input type="checkbox"/> Yes <input type="checkbox"/> No
Is there an accountant who keeps track of the finances?	<input type="checkbox"/> Yes <input type="checkbox"/> No
If you have a meter, how much does it charge and who pays?	<input type="checkbox"/> No charge <input type="checkbox"/> Monthly fee <input type="checkbox"/> Charge per event <input type="checkbox"/> The cooperative pays <input type="checkbox"/> Another member pays
How often do you hold formal meetings?	<input type="checkbox"/> Once a week <input type="checkbox"/> Once a month <input type="checkbox"/> Every three months <input type="checkbox"/> Only when there are urgent matters
How many members regularly attend meetings?	<input type="checkbox"/> All members <input type="checkbox"/> More than half <input type="checkbox"/> Less than half <input type="checkbox"/> Very few
Who participates most actively in meetings?	<input type="checkbox"/> Men <input type="checkbox"/> Women <input type="checkbox"/> Both equally
Are minutes taken at each meeting recording the decisions made?	<input type="checkbox"/> Always <input type="checkbox"/> Sometimes <input type="checkbox"/> Never

Source: Own elaboration

Box 7**Table 4**

Survey for interview with presidents (cooperatives)

Question	Answer options
How often do you hold formal meetings with the cooperative's members?	<input type="checkbox"/> Weekly <input type="checkbox"/> Fortnightly <input type="checkbox"/> Monthly <input type="checkbox"/> Only when there is an urgent need <input type="checkbox"/> Rarely
What is your role during cooperative meetings?	<input type="checkbox"/> I actively coordinate and moderate <input type="checkbox"/> I only direct the main points <input type="checkbox"/> I delegate leadership to another member <input type="checkbox"/> I do not participate directly in leadership
What strategies do you use to encourage active participation from all members?	<input type="checkbox"/> Use participatory dynamics <input type="checkbox"/> Encourage open dialogue <input type="checkbox"/> Assign speaking turns <input type="checkbox"/> Do not use specific strategies
How do you ensure that decisions are made fairly and impartially?	<input type="checkbox"/> By democratic vote <input type="checkbox"/> By consensus <input type="checkbox"/> I consult with leaders beforehand <input type="checkbox"/> I decide according to my own criteria
What mechanisms do you employ to ensure respect and order during meetings?	<input type="checkbox"/> Clear rules that are enforced <input type="checkbox"/> Verbal warnings <input type="checkbox"/> Support from the secretary or spokesperson <input type="checkbox"/> No formal mechanism
Do you personally inform members about the agreements reached?	<input type="checkbox"/> Yes, at the end of each meeting <input type="checkbox"/> Through shared minutes <input type="checkbox"/> Verbally at the next meeting <input type="checkbox"/> Not always formally reported
How do you ensure that relevant information reaches all members of the cooperative?	<input type="checkbox"/> Through printed or digital minutes <input type="checkbox"/> Through the internal communication group <input type="checkbox"/> Through informational meetings <input type="checkbox"/> No defined means
Are the documents and minutes available to all members who request them?	<input type="checkbox"/> Yes, at all times <input type="checkbox"/> Only with authorisation <input type="checkbox"/> Depends on the type of document <input type="checkbox"/> Access is not permitted
Do you consider that you fulfil all the duties assigned to you in accordance with the cooperative's internal regulations?	<input type="checkbox"/> Yes, completely <input type="checkbox"/> Mostly <input type="checkbox"/> Only the main functions <input type="checkbox"/> I am still unfamiliar with some functions
What steps do you take to ensure that the annual work plan is fulfilled?	<input type="checkbox"/> I monitor progress continuously <input type="checkbox"/> I review progress every quarter <input type="checkbox"/> I leave that task to someone else <input type="checkbox"/> There is no defined annual plan
How do you follow up on the agreements reached in the sessions?	<input type="checkbox"/> I monitor compliance <input type="checkbox"/> I only check for complaints <input type="checkbox"/> It is the secretary's job <input type="checkbox"/> There is no systematic follow-up
How do you represent the cooperative before external institutions?	<input type="checkbox"/> Through negotiations and meetings <input type="checkbox"/> Only when there are official calls for proposals <input type="checkbox"/> Another member performs this task <input type="checkbox"/> We have not had external representation
Have you promoted alliances with other cooperatives or institutions?	<input type="checkbox"/> Yes, with positive results <input type="checkbox"/> I have tried, but without success <input type="checkbox"/> I do not consider it a priority <input type="checkbox"/> I have not done so

Source: Own elaboration

Disclosures**Conflict of interest**

The authors declare that they have no conflicts of interest. They have no known competing financial interests or personal relationships that could have influenced the article reported in this paper.

Contribution of the authors

Rivera-Rodríguez, Maria: Identification of information sources, data classification, document structure.

Sepúlveda-Quiroz, Cesar Antonio: Support for fishing and aquaculture information. Field visits, interviews and surveys of fishermen.

Hernández-Martínez, Maria del Carmen: Development of the quantitative research instrument, application of the research instrument to fishermen from the Barra Ciega cooperative in the central municipality. She also contributed to the analysis of the data and results.

Karina-González Izquierdo: Application of the research instrument, logbook, analysis of results.

Availability of data and materials

All data used for the analysis and development of the article are available from the corresponding author upon request.

Funding

This work is part of a project funded by the National Technological Institute of Mexico. Call for Scientific Research, Technological Development and Innovation Projects 2025, code 23197.25-P.

Acknowledgements

We would like to thank the Federation of Fishing and Aquaculture Cooperatives and Licensees of Tabasco, the Ministry of Tourism and Economic Development (Government of the State of Tabasco) and the National Technological Institute of Mexico, Villahermosa Campus. Thank you to each of you for your effort and dedication in making this research possible. We would also like to thank Ecorfan magazine for its support of the Villahermosa Technological Institute.

Rivera-Rodríguez, María, Sepúlveda-Quiroz, César Antonio, Hernández-Martínez, María del Carmen and González-Izquierdo, Karina. [2025]. Participatory and solidary management for the implementation of a dried armored catfish fillet plant in fishing cooperatives of the municipality of Centro, Tabasco, Mexico. Journal of Business and SMEs. 11[27]1-12: e31127112
<https://doi.org/10.35429/JBS.2025.11.27.3.1.12>

Abbreviations

ACI/ICA	Alianza Cooperativa Internacional / International Cooperative Alliance.
BPM	Good Manufacturing Practices.
Codex	Codex Alimentarius (FAO/WHO code/guidelines).
ESS	Social and Solidarity Economy.
FAO	Food and Agriculture Organisation.
SWOT	Strengths, Weaknesses, Opportunities, Threats
FDA	Food and Drug Administration (USA).
HACCP	Hazard Analysis and Critical Control Points.
IAP	Participatory Action Research.
NODESS	Nodes for the Promotion of the Social and Solidarity Economy.
SDGs	Sustainable Development Goals.
UN	United Nations
SOPs	Standard Operating Procedures.

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Diagnostic study of digital skills based on the DigComp 2.2 framework in a union of cooperatives in the state of Puebla, México

Estudio diagnóstico de competencias digitales basado en el marco DigComp 2.2 en una unión de cooperativas del estado de Puebla, México

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SECIHTI CONAHCYT:

Area: Engineering
 Field: Technological sciences
 Discipline: Computer technology
 Subdiscipline: Computer aided teaching

<https://doi.org/10.35429/JBS.2025.11.27.4.1.16>

History of the article:

Received: June 11, 2025

Accepted: November 10, 2025

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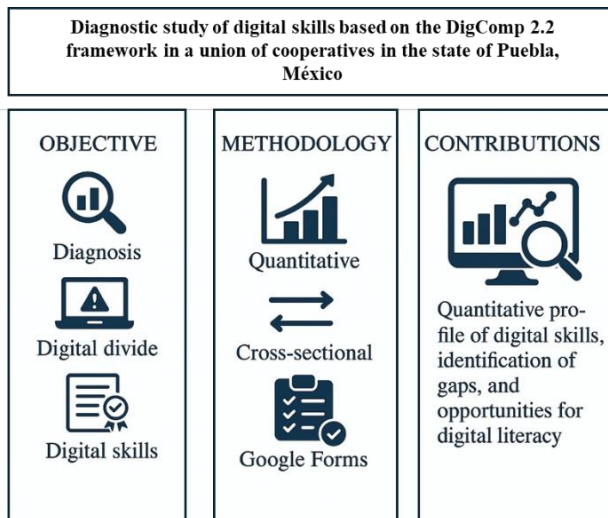


Abstract

The digital divide poses a central challenge to inclusion and development in the Social and Solidarity Economy (SSE), particularly impacting social cooperatives by limiting their access, innovation, and participation in the digital environment. Structural factors such as educational inequality, lack of infrastructure, and a lack of digital skills perpetuate this problem, especially in Mexico and Latin America. In response, this study diagnoses the level of digital skills in a cooperative union in Puebla, Mexico, using the DigComp 2.2 framework. The objective is to identify gaps in these skills to inform strategies that promote technological adoption, productivity, and greater integration into the digital ecosystem. The results provide a quantitative basis for designing and implementing targeted actions to reduce the digital divide in the cooperative sector, facilitating its sustainable development.

Resumen

Las brechas digitales constituyen un reto central para la inclusión y el desarrollo en la Economía Social y Solidaria (ESS), impactando especialmente a cooperativas sociales al limitar su acceso, innovación y participación en el entorno digital. Factores estructurales como la desigualdad educativa, la falta de infraestructura y la carencia de competencias digitales perpetúan este problema, sobre todo en México y Latinoamérica. Frente a ello, el presente estudio diagnostica el nivel de competencias digitales en una unión de cooperativas en Puebla, México, empleando el marco DigComp 2.2. El objetivo es identificar las brechas en estas competencias para fundamentar estrategias que impulsen la apropiación tecnológica, la productividad y una mayor integración al ecosistema digital. Los resultados brindan una base cuantitativa para diseñar e implementar acciones focalizadas que permitan reducir la brecha digital en el sector cooperativo, facilitando su desarrollo sostenible.



Digital skills, digital literacy, cooperatives, DigComp 2.2



Competencias digitales, alfabetización digital, cooperativas, DigComp 2.2

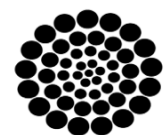
Area: Advocacy and attention to national problems

Citation: Alonso-Calpeño, Mariela Juana & Pérez-Jiménez, Carlos [2025]. Diagnostic study of digital skills based on the DigComp 2.2 framework in a union of cooperatives in the state of Puebla, México. Journal of Business and SMEs. 11[27]1-16: e41127116



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]- in the contribution to the scientific, technological and innovation **Peer Review Process** through the training of Human Resources for the continuity in the Critical Analysis of International Research.



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Introduction

Digital divides, understood as lack of internet access, limited affordability of services, and lack of digital skills, pose a significant challenge to equitable development and social inclusion. These gaps represent an obstacle to social and economic progress, as they lead to the marginalisation of large sectors of the population and a loss of productivity, efficiency and competitiveness in businesses, regions and nations (Koike, 2024). The groups most affected are rural communities, people living in poverty, and workers in the social and solidarity economy (SSE), who are left behind in an increasingly digitised and competitive environment (Morales, 2020; Sánchez-Zárate, 2025).

In these organisations, digital divides pose a critical threat, as they hinder their inclusion in the digital ecosystem and limit both their capacity for innovation and the fulfilment of their community values and objectives. The persistence of these gaps contributes to deepening inequality and weakens the transformative impact of the SSE on poverty reduction and improving quality of life, by hindering access to health services, education, decent employment and citizen participation (Olarte, 2017).

For digital transformation to take place in cooperatives linked to the SSE, it is necessary to develop digital skills and comprehensive, contextualised and critical training processes that enable both technical and social barriers to be overcome, thereby generating real digital inclusion (Camalle et al., 2025). This implies not only access to technology, but also its appropriation and effective use (Espinoza et al., 2023).

Digital literacy involves the skills necessary to participate autonomously and critically in the digital society and benefit from the opportunities it offers. It also involves the ability to obtain, manage, integrate, communicate, evaluate and create information using digital technologies to access employment, decent work and entrepreneurship (UNESCO, 2018, as cited in Dalio et al., 2023). To ensure universal accessibility to digital tools and services, the development of digital skills must be guided by universal design principles that promote equity and usability (Karelis et al., 2025).

Various reference frameworks have been developed to classify digital competencies and facilitate the identification of skill requirements for both citizens and economic sectors. Among these, the European Digital Competence Framework for Citizens (DigComp 2.2) stands out. This framework provides assessment criteria and application examples for the design of policies and training programmes tailored to specific needs (Vuorikari et al., 2022).

This paper presents the results of the application of a diagnostic tool based on the DigComp 2.2 framework to a union of cooperatives in the state of Puebla, Mexico. The main objective was to identify gaps in the digital competence domain of its members, in order to inform the formulation of digital literacy strategies.

The relevance of this study lies in obtaining statistical data that will allow for a comparative measurement between the before and after of this intervention, as well as enabling future evaluation of whether its members have successfully appropriated technology to increase productivity and their participation in the digital ecosystem.

This article is structured in four sections: contextualisation of the problem; theoretical and conceptual framework; methodology applied; presentation of results and critical discussion; and, finally, conclusions with recommendations for future research.

1. Contextualisation of the problem

The causes of the digital divide are complex and structural, ranging from educational and socio-economic inequality, lack of infrastructure, lack of knowledge of inclusive technological models and solutions, to lack of funding and institutional support (Dalio et al., 2023).

In recent years, the development of digital skills has become an essential component of social, educational and labour inclusion, as well as for the fulfilment of the Sustainable Development Goals (SDGs). In this context, the study conducted by Koike (2024) presents a detailed overview of the level of digital skills in Mexico, according to the definitions and criteria established by the International Telecommunication Union (ITU).

The study classifies digital skills into three main categories: basic skills, standard skills, and advanced skills. These categories are determined on the basis of specific activities ranging from the basic use of digital tools to computer programming.

At the national level, the results for 2022 show that 38.2% of the population had no digital skills, 31.3% had basic skills, 24.6% had standard skills and only 6.4% had advanced skills. This picture reflects a situation that must be addressed, as between 40 and 45 million people lack digital skills, limiting their participation in increasingly technology-mediated environments.

The study also identifies significant regional disparities. The state of Chiapas had the highest percentage of the population without digital skills (55.7%), while Mexico City had the lowest (24.6%). These gaps are accentuated in isolated and marginalised rural areas, where lack of connectivity, low affordability of services and limited availability of technological equipment hinder the development of such skills. In addition, states such as Guanajuato, Michoacán, Nayarit, Puebla, Tabasco, Veracruz and Zacatecas have high percentages of the population without digital skills.

In the particular case of the state of Puebla, the study reports that 40.6% of the population lacks digital skills, 27.1% has basic skills, 21.5% has standard skills, and only 6.3% has advanced skills.

On the other hand, the analysis of the Digital Development Index (DDI) -which considers the infrastructure dimensions of Information and Communication Technologies (ICT), ICT adoption, affordability, ICT use in economic activities, and internet use – shows that Mexico City obtained the highest value (2.52), while Chiapas achieved the lowest (-3.36). In this indicator, Puebla recorded a value of -0.41, below the national average.

Taken together, these results reveal a wide digital and technological appropriation gap in Mexico, particularly in the most vulnerable sectors and in regions with less infrastructure. This situation represents a challenge for digital inclusion and for the equitable use of ICT towards sustainable development and the reduction of social inequalities.

2. Theoretical context

2.1 Social and solidarity economy

The social and solidarity economy (SSE) refers to a group of organisations (cooperatives, mutual societies, associations, social enterprises) that prioritise the satisfaction of social needs and collective well-being over profit, promoting equity, inclusion and sustainability. Countries such as France, Spain and Brazil have promoted the digital transformation of the SSE, facilitating its access to markets and strengthening its resilience to crises such as the one suffered in the COVID-19 pandemic (Villalba-Eguiluz & Arcos-Alonso, 2025; Gallego-Bono & Tapia-Baranda, 2021). The central purpose of the SSE is to create an economic system that promotes social justice, reduces socio-economic gaps and encourages community participation in economic and social development. It also seeks to integrate social and ecological aspects into productive and consumption activities (Saiz-Álvarez and Palma-Ruiz, 2019).

Among the main challenges to driving the digital transformation of the SSE are limitations in resources and training, especially in rural areas and indigenous communities. Digitalisation can facilitate social inclusion, improve management and expand the scope of solidarity projects, but it requires specific policies, institutional strengthening and technological capabilities in communities to take advantage of these tools (Sotomayor et al., 2021, Solaz et al., 2025).

2.2 The European Digital Competence Framework for Citizens (DigComp 2.2)

The European Digital Competence Framework for Citizens (DigComp 2.2) is a key reference for digital literacy in Europe and internationally, providing a structured framework for assessing and developing citizens' digital competences in a context of accelerated digital transformation.

This framework addresses five main areas (Vuorikari et al., 2022):

1. **Information and digital literacy:** the ability to identify, locate, retrieve, store, organise and analyse digital information, as well as to assess its relevance and reliability.

2. **Online communication and collaboration:** the ability to communicate, collaborate, interact and participate in virtual networks and teams, using appropriate means, tones and behaviours.
3. **Digital content creation:** the ability to create, configure, expand and edit digital content, understanding the principles and rules that govern it.
4. **Network security:** ability to protect devices, people, personal data, content and the digital environment, using technologies in a safe and sustainable manner.
5. **Problem solving:** ability to identify and solve technical problems, as well as to explore new ways of leveraging digital technologies.

DigComp 2.2 stands out for its cross-cutting approach, its constant updating in line with new technologies and its applicability to different citizen profiles, not only to educational or work contexts. Its flexible and technologically neutral structure allows for adaptation to different contexts and needs, avoiding rapid obsolescence and facilitating international comparison (Bartolomé et al., 2022).

The use of a framework such as DigComp is essential to ensure consistency, comparability and quality in the assessment and development of digital competences, as it allows for the identification of gaps, the design of relevant training interventions and the certification of competences in a transparent and recognised manner. Furthermore, it facilitates adaptation to technological and social changes, promoting inclusion and active digital citizenship (Barboutidis & Stiakakis, 2023; Van Audenhove et al., 2024).

Several studies have documented the application of DigComp in digital literacy processes, demonstrating its usefulness (Bartolomé et al., 2022; Chaw and Tang, 2023; Laguado et al., 2024; Nguyen et al., 2024; Spyropoulou et al., 2024), and supporting them by providing clear criteria, international comparability, and guidance for the design of training programmes.

3. Methodology

This study is characterised as quantitative, cross-sectional and descriptive, aimed at diagnosing the level of digital competences among members of a union of cooperatives within the Social and Solidarity Economy. The instrument used was a structured survey with a total of 50 questions. The first part collected sociodemographic data (gender, age, educational level, economic activity). The rest addressed digital competences classified according to the DigComp 2.2 framework (Vuorikari et al., 2022).

To measure achievement levels, Likert scales were used, adapted according to the nature of each competence. Thus, in some sections, five levels were used (always, often, sometimes, rarely, never), while in others, three-option scales were used, such as (totally, partially, I do not use them), (totally, partially, I do not know) or similar. This strategy is based on the flexibility recommended in the literature for collecting self-reports in diagnostic studies on digital competences (Laguado, et al., 2025).

The survey was validated through a pilot test with 15 people outside the target population, allowing areas for improvement in the wording of the questions to be identified before the final application. The sample consisted of 63 people selected randomly and voluntarily from among the 80 active members of the cooperative union, corresponding to a 78.7% participation rate.

All participants gave their informed consent, guaranteeing anonymity and ethical protection of data, in accordance with guidelines for social and educational research (Hernández et al., 2014). The information was collected electronically using Google Forms, and the results were compiled in a spreadsheet for subsequent descriptive analysis in accordance with the recommended procedures for studies of this type (Laguado et al., 2025).

4. Results

The results of the diagnosis carried out to assess the level of digital competences among the members of a union of cooperatives within the SSE are presented below. The presentation of the data is organised in a first section with the analysis of the sociodemographic profile of the participants, followed by the five areas of the DigComp 2.2 framework.

Finally, their perception of the impact of technology on the growth of their businesses is included. The results are visualised using descriptive graphs that identify levels of proficiency and areas requiring improvement, thus facilitating a clear and useful interpretation for strategic decision-making.

Figure 1 shows the count and percentage of participants by age range. It can be seen that the age range with the highest percentage is between 36 and 45 years old.

Figure 2 shows the age distribution of respondents grouped by gender. The graph shows a clear predominance of females in all age groups surveyed.

The age group with the highest female participation is 36 to 45 years old, followed by 46 to 55 and 26 to 35 years old. Male representation is significantly lower in all ranges, and the category "Prefer not to say" appears only in the 36 to 45 age group, with a single case.

Box 1

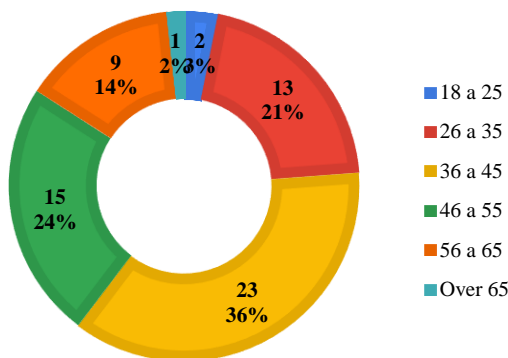


Figure 1
Count and percentage of the age range of respondents
Own Elaboration.

Box 2

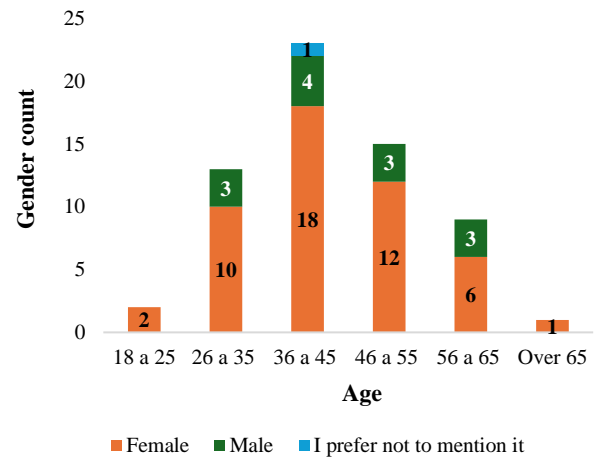


Figure 2
Age distribution of respondents grouped by age and gender
Own Elaboration

Figure 3 shows the age and gender breakdown grouped by level of education. It can be seen that most of the members have a university degree, totalling 29 in all, with women predominating. Among those surveyed, only one person has no academic qualifications and is female.

Figure 4 shows that the predominant economic activity carried out by respondents is the manufacture and sale of products.

Figure 4 shows that the predominant economic activity among respondents is "Manufacturing and selling products" with 23 responses (37%), followed by "Producers" with 21 responses (33%). The activity with the fewest responses was "Intermediary," representing 8%.

Box 3

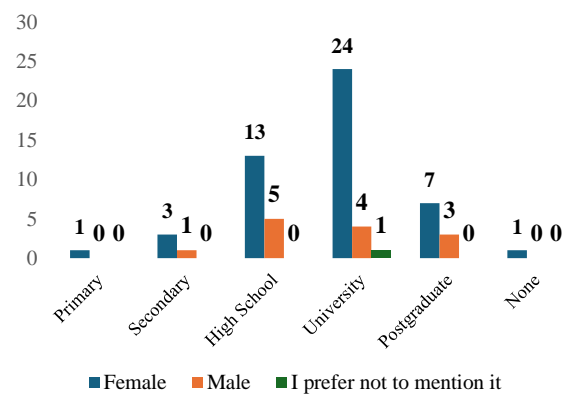


Figure 3
Data grouped by educational attainment and gender
Own Elaboration

Box 4

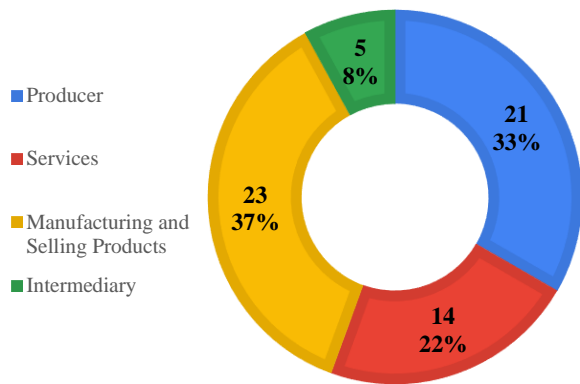


Figure 4
Economic activity of respondents.
Own Elaboration

Figures 5 to 7 show the responses to the eight questions focused on diagnosing the first category of the DigComp 2.2 framework (Information and Data Search).

Figure 5 shows the results of the responses to question 1: “How often do you use web browsers such as Google Chrome, Mozilla Firefox or Safari to find information related to your business?”

It can be observed that 66.6% of respondents mention using browsers daily and frequently, and only one of the respondents (1.58%) mentions not using them.

Figure 6 summarises the responses to questions 2 to 7.

- *Question 2.* “Knows how to improve search results by using advanced search features (e.g., specifying the exact phrase).”
- *Question 3.* “Knows how to use advanced search operators (such as AND, OR, NOT) to improve search results.”
- *Question 4.* “You know how to find the author or source of information to verify the credibility of information you have previously found.”
- *Question 5.* “You are able to download a document from the web, save it to a specific location, and rename it.”
- *Question 6.* “Knows how to download databases from data repositories and use

that information to generate statistics that support decision-making for their business.”

- *Question 7.* “Knows how to collect data through digital surveys to learn more about the market or competition in order to compile statistics and establish action plans.”

Box 5

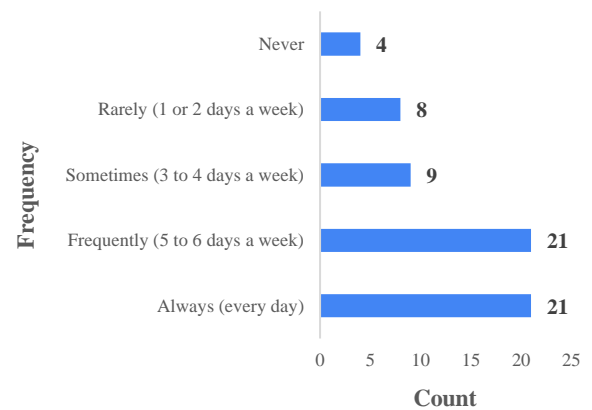


Figure 5
Answers to question 1
Own Elaboration.

Box 6

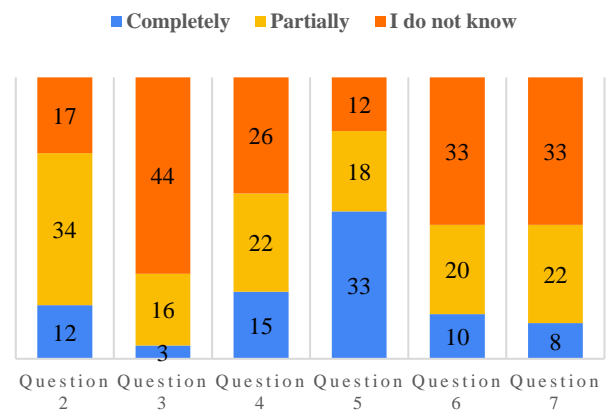


Figure 6
Answers To Questions 2 To 7
Own Elaboration.

It can be seen that for *Questions 2 and 3*, the percentages for the option ‘Completely’ are low (19% and 5%, respectively), while ‘I don’t know’ reaches up to 44% in *Question 3*. This indicates that a significant proportion of the group is not proficient in the use of Boolean operators or advanced search engine tools, which limits their efficiency in locating relevant information.

Regarding *Question 4*, 23.8% responded 'Totally' and 34.9% 'Partially,' indicating an average level of competence in assessing the credibility of the information found. This result is relevant, as source verification is key to combating misinformation and making informed decisions.

The responses to *Question 5*, related to downloading and managing documents, show the highest percentage of 'Totally' responses (52.4%), suggesting that this skill is more established in the group. This may reflect a practical familiarity with everyday digital tasks, although not necessarily with critical or analytical skills.

The responses to *Questions 6 and 7*, which address the use of databases and digital surveys to generate statistics, show the highest percentages of 'I don't know' (52.4% in both). This reveals a significant lack of analytical skills applied to the professional or business context, which limits the group's ability to use strategic information in decision-making.

Figure 7 shows the results for *Question 8*. "Do you use the artificial intelligence tools of browsers such as Google, Edge, or Firefox to find more comprehensive answers to your questions?"

Box 7

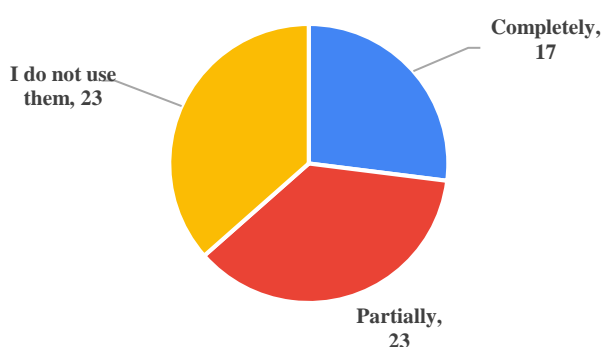


Figure 7

Answers to question 8

Own Elaboration

It is observed that only 17 of the respondents (27%) mention using them, which indicates that there is a significant proportion that does not yet take advantage of the benefits of Artificial Intelligence tools integrated into search engines.

The results of the respondents' answers to the eight questions focused on the second category of the DigComp 2.2 framework (Communication and Collaboration) are shown in Figures 8 to 11.

Figure 8 shows the responses to *Question 9*: "Do you use social media to stay in touch with other people and expand your network of potential customers?" It is observed that 23 people, representing 36.5% of those surveyed, contact potential customers daily, indicating an understanding of the advantages that social networks offer to strengthen their market share.

Box 8

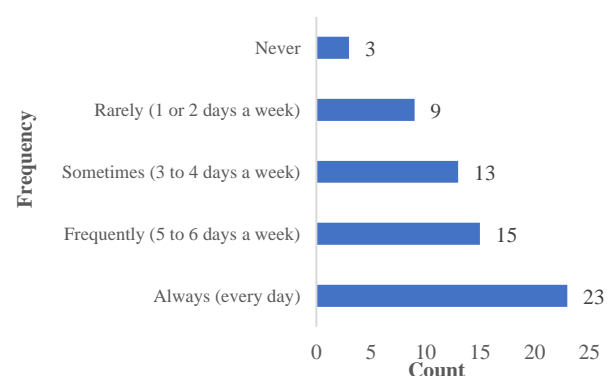


Figure 8

Answers to question 9

Own Elaboration.

Figure 9 shows the results of the responses to *Question 10*: "The social networks you use are (you may choose more than one)." It can be seen that the most widely used is WhatsApp, as only one of the respondents mentioned that they do not use it. The least used is Snapchat.

Box 9

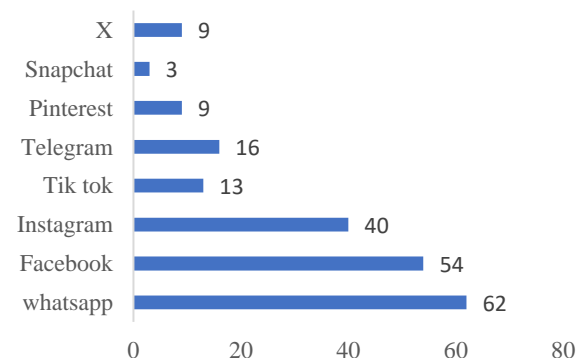


Figure 9

Answers to question 10

Own Elaboration

Figure 10 summarises the results of the responses to *Question 11*. "Do you use email to send information to other people about your business or to expand your sales network?" It can be seen that 39.7% of respondents rarely use it and only 6.3% say they always use it.

Box 10

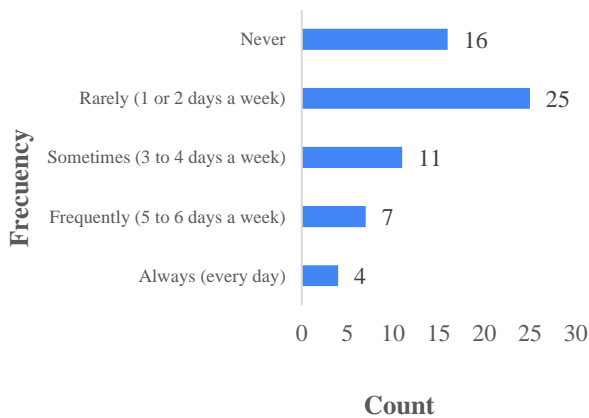


Figure 10

Answers to question 11

Own Elaboration

Figure 11 summarises the results for questions 12 to 16.

- *Question 12*. "You know how to use videoconferencing platforms to participate as an attendee in various professional or personal events."
- *Question 13*. "You know how to use videoconferencing platforms to moderate, record, or present information to a group of people with whom you can promote your product."
- *Question 14*. "You know how to protect your privacy and personal data when communicating with others through social media."
- *Question 15*. "Knows how to direct files that arrive in their email to spam to stop receiving unwanted messages."
- *Question 16*. "Knows how to use platforms to create blogs, wikis, or personal pages to generate collaboration on research or discussion of specific topics that can highlight the benefits of their products or services."

It can be seen that the results for *Question 12* show a balance between the responses 'Totally' (26) and "Partially" (29), with only 8 people who 'Do not know' this skill.

This indicates that the majority of the group has experience as participants in virtual events, which represents a consolidated competence in basic digital environments.

With regard to *Question 13*, although 27 people answered 'Partially,' only 16 answered 'Completely,' and 20 indicated 'I don't know.' This suggests that the group has difficulty playing active roles as moderators or presenters, which limits their digital leadership and professional promotion capabilities.

Responses to *Question 14* reveal that 31 people 'Don't know' how to protect their privacy on social media, compared to only 10 who 'Totally' do. This finding is concerning, as privacy management is essential for digital security and online risk prevention.

With regard to *Question 15*, although 28 people answered 'Partially,' a significant proportion (23) 'Do not know' how to redirect emails to spam. This indicates the need to develop intermediate competence in the use of email tools.

Question 16 received the highest number of "Don't know" responses (43), which shows a low level of familiarity with blogs, wikis, or personal pages as means of collaboration and dissemination. This lack of knowledge limits the group's potential to participate in digital communities, generate collaborative content, and position their products or ideas in virtual environments.

Box 11

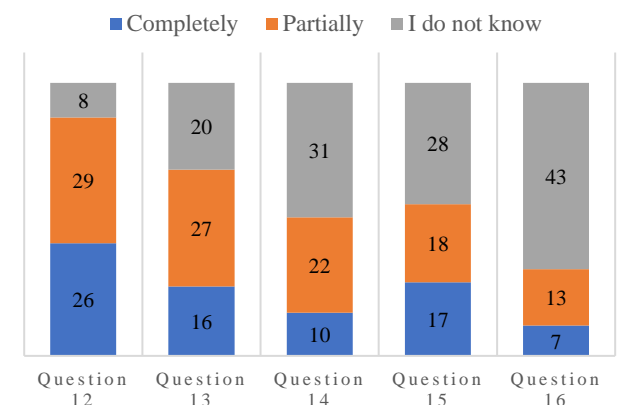


Figure 11

Answers to questions 12 to 16

Own Elaboration

The results of the respondents' answers to the nine questions focused on the third category of the DigComp 2.2 framework (Digital Content Creation) are shown in Figures 12 and 13.

Figure 12 shows the responses to questions 17 to 21.

- *Question 17.* “Knows how to use office software (e.g. Word) to generate digital documents with images, information tables, graphs or audio.”
- *Question 18.* “Knows how to use a spreadsheet (e.g. Excel) to keep track of purchases, sales, suppliers, profits and losses, among other things.”
- *Question 19.* “Knows how to use tools that implement artificial intelligence to create presentations, audio files or graphics that can be sent to customers.”
- *Question 20.* “You know how to use your mobile phone to create digital content such as audio or video.”
- *Question 21.* “You know how to create infographics and posters that combine information, statistics and images using software available on your computer to advertise your products or services.”

Box 12

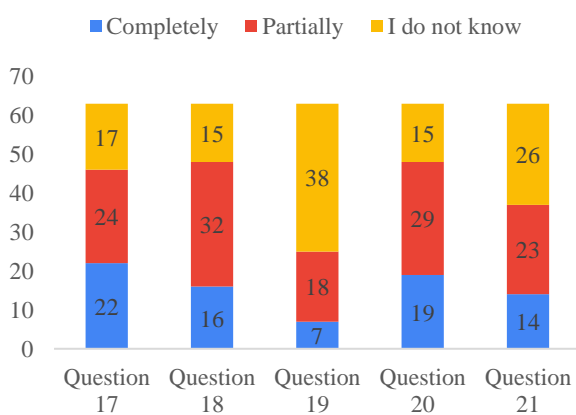


Figure 12

Answers to questions 17 to 21.

Own Elaboration

The results of *Questions 17 and 18* show a balanced distribution between ‘Totally’ and ‘Partially’ responses, with low percentages for ‘I don't know.’ This indicates that most of the group has the operational skills to generate documents and manage financial information using Word and Excel, which represents a solid foundation in functional digital skills.

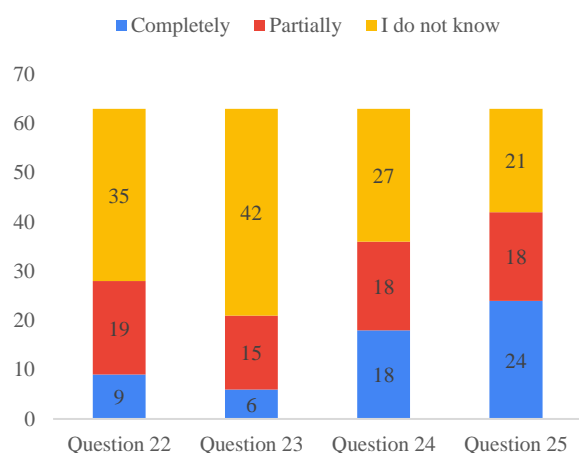
The results of *Question 19* show the highest number of ‘Don't know’ responses (38), with only 7 people responding ‘Totally’. This result highlights a significant gap in the use of emerging technologies for content creation, which limits the use of innovative solutions in productive contexts.

As for the results of *Question 20*, 19 people responded ‘Totally’ and 29 ‘Partially,’ suggesting a growing familiarity with the use of mobile phones as a digital production tool.

The results of *Question 21* show a considerable proportion of ‘I don't know’ responses (26), indicating that many participants are not proficient in the use of software to create infographics or advertising posters. This shortcoming may affect the group's ability to effectively communicate their ideas, products, or services visually.

Figure 13 summarises the responses to questions 22 to 25.

- *Question 22.* “You know how to edit videos to make them shorter or longer or to improve their quality.”
- *Question 23.* “You know how to edit audio files to make them shorter or longer or to improve their quality.”
- *Question 24.* “Knows that digital content, goods and services may be protected by intellectual property rights (e.g. trademarks, copyright, designs, patents) and understands the implications.”
- *Question 25.* “Knows that when generating digital content and taking information, images, audio or video from other sources, they must always give the appropriate credit to avoid plagiarism.”

Box 13**Figure 13**

Answers to questions 22 to 25.

Own Elaboration

The responses to *Questions 22 and 23* indicate a low level of familiarity with audiovisual editing tools, which limits the group's ability to improve the quality of their digital content and adapt it to different formats or audiences.

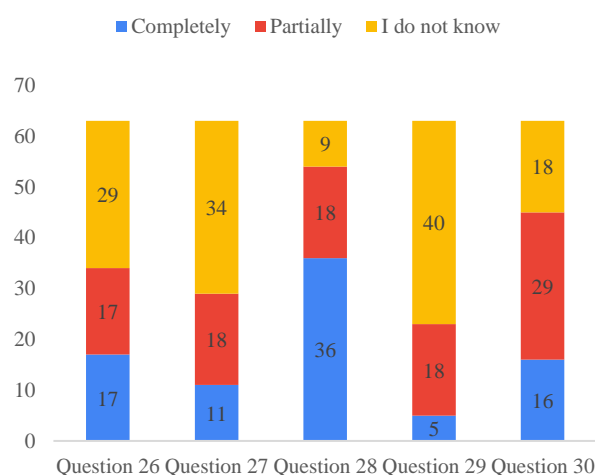
In *Question 24*, although 18 people answered "Totally," 27 indicated "I don't know." This result suggests that a significant portion of the group is unclear about the legal implications of copyright, trademarks, or patents in the digital environment, which represents a risk in the ethical management of content. However, in contrast, in the responses to *Question 25*, 24 people answered "Totally" and only 21 answered "I don't know." This reflects greater awareness of the need to credit the sources used, which is a positive indicator in terms of digital responsibility and information ethics.

The results of the respondents' answers to the 10 questions focused on the fourth category of the DigComp 2.2 framework (Network Safety) are shown in Figures 14 and 15.

Figure 14 shows the answers to questions 26 to 30.

- *Question 26*. “You know how to install antivirus software on your computer.”
- *Question 27*. “You know how to install antivirus software on your mobile phone.”

- *Question 28*. “You know that you should create passwords that include numbers, letters, and special characters to prevent them from being easily hacked.”
- *Question 29*. “You know how to configure your computer to enable the firewall.”
- *Question 30*. “When installing a new application on your mobile phone, you check the messages it displays to see what data it is granting access to and, based on that, you decide whether or not to install it.”

Box 14**Figure 14**

Answers to questions 26 to 30

Own Elaboration

The results of the responses to *Questions 26 and 27* regarding the installation of antivirus software on computers and mobile phones, respectively, show that only 17 and 11 people responded ‘Absolutely,’ while 29 and 34 indicated ‘I don't know.’ This highlights a gap in basic knowledge of malware protection, especially on mobile devices, which poses a risk to the integrity of personal and professional information.

The results of the responses to *Question 28* suggest partial awareness of the importance of digital credential security, but also an area for improvement towards more conscious and preventive practices.

As for the responses to *Question 29*, related to firewall enablement, 40 people indicated that they were ‘Unfamiliar’ with this feature, while only 5 responded ‘Totally’. This reflects a significant lack of proactive configuration of perimeter defence measures on computer equipment.

In *Question 30*, 46% belong to the Partially category, suggesting that although respondents take security aspects into account when installing software on their mobile devices, they can still improve their practices in this regard.

Figure 15 summarises the responses to questions 31 to 35.

Box 15

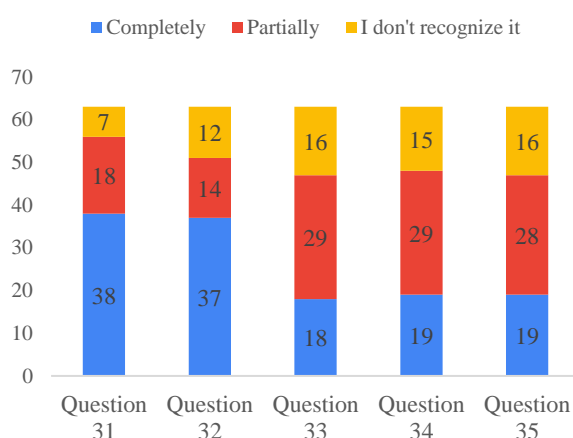


Figure 15

Answers to questions 31 to 35.

Own Elaboration

- *Question 31*. “Consider the importance of only providing biometric data (such as your fingerprint or facial recognition) to institutions that need to confirm your identity, and not to any application that requests it.”
- *Question 32*. “Consider the importance of not connecting to public Wi-Fi networks to carry out financial transactions or online banking.”
- *Question 33*. “Know how to identify suspicious emails that attempt to obtain sensitive information (e.g., personal data, bank details) or that ask you to click on a link that could download malicious software or take you to fake websites.”

- *Question 34*. “You are able to identify a fraudulent event through a message or phone call, so you do not provide any information that could affect your assets, personal data or family.”
- *Question 35*. “Identifies the energy-saving advantages of the devices and services you use, for example, by changing the quality settings of video streaming services, using Wi-Fi instead of mobile data when at home, closing applications, optimising email attachments.”

With regard to *Questions 31 and 32*, the responses indicate that the group has a solid understanding of the risks of sharing biometric data and conducting transactions on public networks, reflecting a preventive attitude towards digital threats.

The results for *Questions 33 and 34* suggest that, although there is a certain level of awareness about fraudulent emails and calls, there is still room for improvement in accurately identifying threats and making secure decisions. The responses to *Question 35* show that the group is beginning to recognise the importance of optimising the use of technological resources, although this is not yet established as a common practice.

Finally, the results of the respondents' answers to the 10 questions focused on the fifth category of the DigComp 2.2 framework (Problem solving) are shown in Figures 16 and 17.

Figure 16 shows the responses to questions 36 to 39.

- *Question 36*. “Knows how to identify and solve a camera and/or microphone problem in an online meeting.”
- *Question 37*. “Knows how to find solutions on the Internet when faced with a technical problem.”
- *Question 38*. “Knows how and when to use machine translation solutions (e.g., Google Translate) and simultaneous interpretation applications (e.g., iTranslate) to gain a rough understanding of a document or conversation.”

- *Question 39.* “Knows how to use digital technologies to help turn their idea into action (e.g., mastering video making to start a channel for sharing recipes).”

Box 16

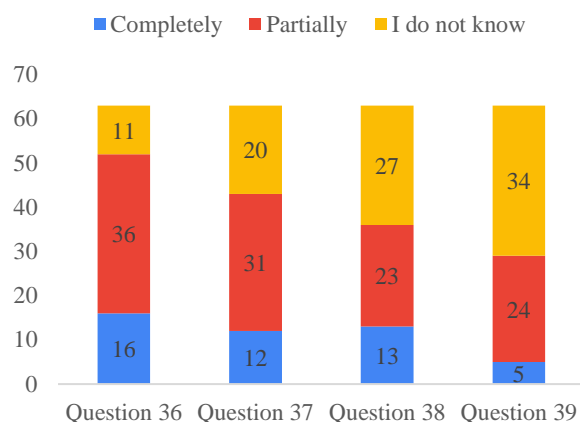


Figure 16

Answers to questions 36 to 39

Own Elaboration

The results of *Question 36* suggest an opportunity for improvement in the technical autonomy of respondents during online collaborative environments, as the majority of the group has a basic understanding of how to resolve camera or microphone issues in virtual meetings, but has not yet fully mastered these skills.

The results of *Question 37* show signs of a positive trend towards self-management of problems through internet searches, but the level of mastery is still limited, which could affect the efficiency of digital incident resolution.

The results of *Question 38* show that a significant proportion of the group does not use or is unaware of the potential of tools such as Google Translate or iTranslate, which could limit access to multilingual information and participation in global digital environments.

Regarding *Question 39*, the results show evidence of a lack of digital entrepreneurship skills and strategic use of platforms to turn ideas into concrete projects, such as content channels or personal initiatives.

The results for the responses to *Question 40*: "You are able to reflect on your level of knowledge, make plans and take steps to improve it in order to boost your business," are shown in Figure 17.

This graph shows that 42.9% of participants answered 'Partially,' indicating that a relative majority recognise the importance of reflecting on their knowledge and are in the process of taking steps to improve. This is a group that could benefit from training support strategies.

Box 17

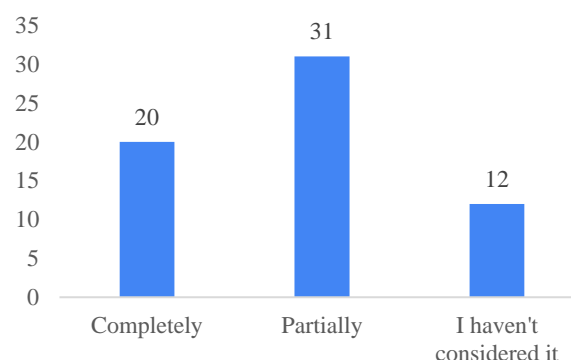


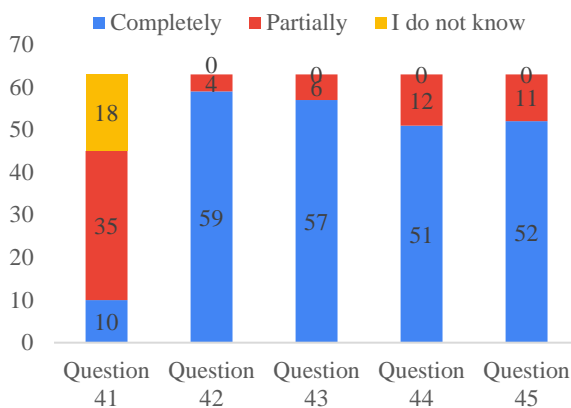
Figure 17

Answers to questions 40

Own Elaboration

The responses to questions 41 to 45 are summarised in Figure 18.

- *Question 41.* “You know how to access educational and skills certification platforms, or standards applicable to goods and services, among others.”
- *Question 42.* “You are willing to continue learning, training and keeping yourself informed in order to find ways to grow your business.”
- *Question 43.* “You are aware that digital tools can be used to help identify your own learning interests and set personal goals in life.”
- *Question 44.* “You take the initiative to ask to be taught how to use an application (e.g. how to book a doctor's appointment online) rather than delegating the task to someone else.”
- *Question 45.* “You are willing to help others improve their digital skills, building on their strengths and mitigating their weaknesses.”

Box 18**Figure 18**

Answers to questions 41 to 45.

Own Elaboration

The responses to *Question 41* indicate that a relative majority recognise the value of online platforms for skills certification and regulatory updates, although there is still a group that requires guidance to access these resources. With regard to *Questions 42 and 43*, the results show a deep-rooted culture of continuing education, self-assessment and personal goal setting using digital tools.

With regard to the responses to *Question 44*, the results highlight the group's autonomy and self-management in the acquisition of practical digital skills.

Finally, the responses to *Question 45* reflect a high sense of responsibility and community, in line with the objective of the ESS.

Conclusions

The joint analysis of the sociodemographic data (Figures 1 to 4) and the results by areas of digital competence (Questions 2 to 45) allows us to establish a detailed profile of the social group evaluated, as well as to identify strengths, gaps and opportunities for improvement within the framework of the DigComp 2.2 model.

The predominance of the 36-45 age group (Figure 1), together with the high representation of women in all age ranges (Figure 2), configures a profile of participants in the active productive stage, with the potential to apply digital competences in work and commercial contexts.

This profile is reinforced by the predominant educational level (Figure 3), where 29 people have university education, which correlates positively with the results obtained in areas such as:

- *Digital communication and collaboration:* Functional proficiency was observed in the use of videoconferencing as assistants (Question 12) and intermediate proficiency in advanced functions such as moderation or recording (Question 13), which is consistent with the educational level and economic activity of the group.
 - *Digital content creation:* Basic office automation skills (Questions 17 and 18) are well established, while the use of artificial intelligence tools (Question 19) and collaborative platforms (Question 16) shows gaps, suggesting a need for specialised training to take advantage of emerging technologies.
- However, despite the level of education, weaknesses were identified in critical areas such as:
- Installation of antivirus software and firewall configuration (Questions 26 to 29), where responses indicating lack of knowledge predominate, especially on mobile devices.
 - Protection of personal data and privacy (Questions 14 and 30), with intermediate results that require reinforcement in secure practices.
 - Digital sustainability (Question 35), where there is evidence of an emerging awareness of energy saving, but it is not yet consolidated as a common practice.

These gaps are significant considering that the predominant economic activity is the manufacture and sale of products (Figure 4), which involves the constant use of digital devices and the need to protect sensitive information.

The results of questions 40 to 45 show a highly favourable attitude towards autonomous learning, continuous improvement and collaboration:

- 59% are willing to continue training to boost their business (Question 42).
- More than 50% take the initiative to learn new applications (Question 44) and help others improve their digital skills (Question 45).
- Although access to educational platforms still has room for improvement (Question 41), the commitment to personal and community development is evident.

This set of findings suggests that the evaluated group has a solid foundation for progressing toward higher levels of digital competence, provided that contextualized, differentiated training strategies focused on real-world applicability to their economic activities are implemented, as suggested by Koike (2024) and Laguado et al. (2025).

Currently, ICT-related companies, as well as those in the communications sector, are leading the digitization process. This dynamic represents a significant opportunity for other sectors to increase their competitiveness and efficiency by incorporating advanced digital technologies, as is the case for organizations belonging to the social and solidarity economy (SSE) (Rodríguez-Pedro, 2025). In this sense, as a future line of work, the design of a differentiated digital literacy campaign is proposed, based on a holistic and systemic approach (Mohamad et al., 2025, which provides participants in later phases with the necessary skills to adopt technologies and apply them in processes aimed at their digital transformation (Montaudon-Tomas et al., 2020, Rodríguez-Pedro, 2025).

Conflict of interest

The authors declare no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article reported in this article.

Author contribution

Alonso-Calpeño, Mariela Juana: Contributed the idea for the project, was responsible for contacting the cooperative union and establishing the link for the development of the project. She also determined the framework on which the diagnosis would be carried out, collaborated in the design and application of the data collection and analysis instrument, and contributed to the writing of the article.

Pérez-Jiménez, Carlos: Collaborated in liaising with the cooperative union. Designed the data collection instrument under the selected competency framework, collaborated in conducting the pilot test, and collaborated in administering the survey and analysing the data. He also collaborated in writing and reviewing the article.

Availability of data and materials

Data on this type of study are unavailable or very scarce. That is why this diagnostic study had to be conducted.

Funding

The research did not receive funding.

Acknowledgements

To the members of the Union of Cooperatives and their leaders for allowing us access to conduct this study.

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Antecedents

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
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
Market study on craft beer consumption in southern Tamaulipas

Estudio de mercado sobre el consumo de cerveza artesanal en el sur de Tamaulipas

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Classification SECIHTI:

Area: Social Sciences

Field: Administration and business

Discipline: Business and accounting

Subdiscipline: Marketing and market research

 <https://doi.org/10.35429/JBS.2025.11.27.5.1.9>

History of the article:

Received: September 11, 2025

Accepted: December 10, 2025

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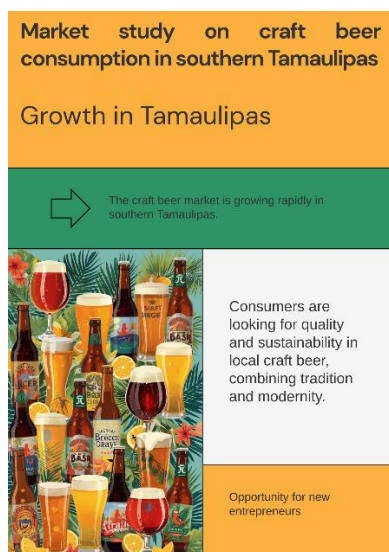


Abstract

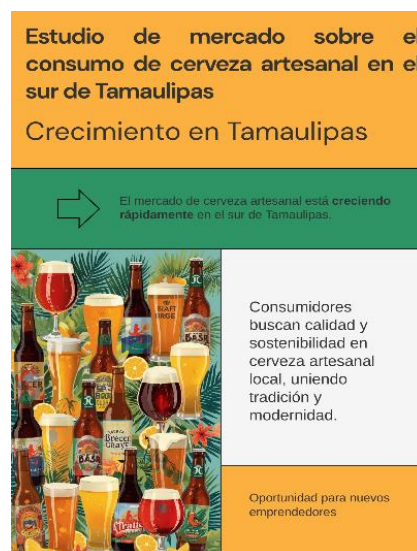
The craft beer market in southern Tamaulipas shows significant growth potential, driven by middle- and high-income consumers with higher education and a preference for premium products. This study analyzes supply and demand conditions, identifying opportunities and challenges for the positioning of a new craft brewery project. Data was collected through surveys and direct observation in supermarkets and local breweries. Results reveal that consumers value flavor, quality, and sustainability, with willingness to pay between 2.5-3.6 USD per bottle. The findings provide strategic insights into business planning and market entry.

Resumen

El mercado de la cerveza artesanal en el sur de Tamaulipas presenta un crecimiento significativo, impulsado por consumidores de ingresos medios y altos, con educación superior y preferencia por productos premium. Este estudio analiza las condiciones de oferta y demanda, identificando oportunidades y desafíos para el posicionamiento de un nuevo proyecto cervecero. Los datos se obtuvieron mediante encuestas y observación directa en supermercados y cervecerías locales. Los resultados muestran que los consumidores valoran el sabor, la calidad y la sostenibilidad, con disposición a pagar entre 45-65 MXN por botella. Los hallazgos ofrecen información estratégica para la planeación de negocios y la entrada al mercado.



Craft beer, Strategic insights, Business plan



Cerveza artesanal, Información estratégica, Plan de negocios

Area: Strengthening the scientific community

Citation: Díaz-Flores, Jorge, Soto-Hernández, Ana María and Florencia-Castillo, Irma Beatriz. [2025]. Market study on craft beer consumption in southern Tamaulipas. Journal of Business and SMEs. 11[27]1-9: e51127109



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]- in the contribution to the scientific, technological and innovation **Peer Review Process** through the training of Human Resources for the continuity in the Critical Analysis of International Research.



Introduction

The objective of this study is to comprehensively analyze the profile, consumption habits, preferences, and attitudes of craft beer consumers in southern Tamaulipas, to generate strategic information that supports decision-making in brewing projects in the region. This study is based on the application of a structured questionnaire designed to provide a comprehensive view of the craft beer market in southern Tamaulipas and it was administered via social media.

The first section presents the relevance of Mexico's brewing industry within the global context, highlighting its role as the fourth largest producer and the leading exporter worldwide. It explains its economic impact on GDP and employment, as well as the concentration of production in certain states and leading companies. Finally, it points out the emerging growth of the craft beer segment, which, although still marginal, contributes to innovation and regional development opportunities.

The following section describes the features of the research methodology and design, including the structure of the questionnaire applied. The instrument was divided into five sections: Demographic Data, Consumption Habits, Product Preferences, Behaviors and Attitudes, and Final Comments, allowing for a comprehensive analysis of consumer behavior.

The results section shows the demographic characteristics of the respondents and the findings for the questions asked.

1. Background

The brewing industry is one of the most dynamic sectors worldwide and in Mexico, with significant economic impact and influence on consumption patterns. In 2022, global beer production reached 1,890 million hectoliters, with nearly half concentrated in five countries: China, the United States, Brazil, Mexico, and Germany (Martínez, 2023).

Global beer consumption increased by 2.9% compared to the previous year, equivalent to more than 303 billion bottles of 633 ml, driven by post-COVID-19 recovery (Kirin Brewery Company, 2023).

China remained the largest consumer, while Mexico ranked fourth in production and first in exports, with USD 5.95 billion in sales abroad, mainly to the United States, which absorbs 78.6% of Mexican beer imports (OEC, n.d.).

The importance of the Mexican brewing industry is reflected in its 1.5% contribution to national GDP and the generation of approximately 700,000 direct and indirect jobs (INEGI, 2017). Its value chain involves farmers, packaging manufacturers, brewmasters, and distributors, strengthening key sectors such as agriculture and logistics. Production is concentrated in Zacatecas, Coahuila, and Nuevo León, which together account for more than half of national output.

The market is dominated by Grupo Modelo and Heineken Mexico, with production capacities exceeding 120 million hectoliters annually (El Financiero, 2023; Alfa Editores, 2018). Domestic consumption has shown steady growth, with an average annual expenditure of USD\$182.87 per person in 2021 and per capita consumption rising from 56 to 68 liters between 2010 and 2019 (Storecheck, n.d.).

Within this panorama, Mexican craft beer represents an emerging yet marginal segment, accounting for only 0.84% of total beer sales in the country. According to the Brewers Association (n.d.), craft beer must meet three criteria: production below seven million hectoliters, independent ownership, and exclusive malt-based brewing. In Mexico, there are approximately 1,500 independent breweries, averaging 7.2 employees, of whom 33% are women and 16% are single mothers (Amarilio-Castillo, 2021).

Craft beer production reached 303,337 hl in 2021, with Jalisco, Baja California, and Nuevo León leading. The most produced styles include Bitters, IPAs, and Double IPAs (19.35%), followed by light ales, pale ales, lagers, and amber beers (Amarilio-Castillo, 2021). The market reached USD 125 million in 2023 and is projected to grow at 7.1% annually until 2032, reaching USD 232.86 million (Informes Expertos, n.d.).

In the northeastern region of Mexico, several local producers stand out for their contribution to the diversity and quality of the craft beer market:

Article

- Nuevo León hosts well-known breweries such as *Albur*, *Propaganda Brewing*, *Ocho Reales*, *Cervecería Duarte*, and *Boca Negra*, among others (Girón, 2023).
- Tamaulipas is home to breweries including *Robleoro Brewing Co*, *Caserío*, *El Milagro de los OVNI*s, *Cerveza Cuarto de Milla*, and *Heroica* (González, 2022).
- Coahuila has a strong presence with breweries such as *Aeon*, *Barbaroja*, *Clásica*, *Huérfana*, and *Primitivo*, among others (IBUS, 2019).

These breweries significantly enrich the regional beer landscape, offering variety, innovation, and distinctive flavors that strengthen the identity of northeastern Mexico's craft beer industry. Specifically, Southern Tamaulipas—comprising Tampico, Ciudad Madero, and Altamira—provides a unique environment for the development of craft beer. With a metropolitan population of over 773,285 inhabitants (Data México, 2020), the region combines urban density with strong cultural traditions of social gatherings and gastronomy. Its humid subtropical climate, characterized by high temperatures and humidity for most of the year, influences consumption patterns, favoring refreshing beer styles and lighter presentations. The presence of a port economy and industrial activity also contributes to a diverse consumer base with medium- to high-income segments, creating opportunities for premium products such as craft beer (POSTA).

To complement this context, a field visit was conducted to two recognized establishments in Tampico. The fieldwork identified a wide variety of brands and styles of beer available, both national and international, reflecting the diversity of consumer preferences and the positioning of craft beer alongside imported premium options. The variants are shown in Table 1, which summarizes the assortment found in Walmart and HEB supermarkets.

This context highlights the duality of the Mexican brewing industry: on one hand, a consolidated and globally competitive sector; on the other, an expanding craft segment that, although minor, contributes diversity, innovation, and regional development opportunities.

Box 1**Table 1**

Variety of beer in supermarkets

Walmart Brand	Price (USD)	HEB Brand	Price (USD)
Minerva	2.22	Goblin	5.66
Tropper	3.00	Erdinger	5.11
BelHaven Black	3.33	Bombardier	5.66
Grolsch	3.28	HB	6.05
Delirium	6.77	Youngs	5.66
Tsingtao	3.39	Eagle Banana	5.66
Lefmans	4.89	San Peters	5.66
Sapporo Light	3.83	Duff	2.39
Brewdog	4.55	Tropper	5.83
Samuel Adams	3.61	Tsingtao	3.28
Calavera	3.16	Sapporo	4.66
Finisima	3.28	Asahi	3.5
Ticus	2.78	Perro del mar	3.28
Paulaner	5.77	Baja Brewing	4.66
Erdinger	5.11	Minerva	3.5
Jabali	2.11	Lagerita	3.28
HB	3.66	Rrey	3.11
Flensburger	4.66	Nacional	2.28
Tempus	2.22	Finisima	2.89
Allende	3.33	Allende	2.5
Baja brewing	3.00	Colimita	2.22
		Principia	3
		Regio	2.33

Source: Owned

2. Methodology

This research is non-experimental in design, following a cross-sectional and descriptive approach, according to Hernández Sampieri & Mendoza Torres (2018). A transversal perspective was adopted, since cross-sectional designs collect data at a single point in time, with the purpose of describing variables and analyzing their incidence and interrelation at a given moment.

In accordance with market research standards, research was conducted on the current status of the availability and sale of craft beer through secondary sources (Coursera, 2023). A questionnaire (UNADM) was designed as a tool to collect information from primary sources through fieldwork with a non-probabilistic sample (Morales Pérez, De la Torre Romero, & Aguerrebere Salido, 2003).

The study population consisted of residents of Tampico, Ciudad Madero, and Altamira, all part of the metropolitan area of Southern Tamaulipas. People aged 20 years and older were included as the units of analysis. The distribution of the population aged 20 years or older is presented in Table 2 (Data México, 2020).

Box 2**Table 2**

Population aged 20 years or older in Tampico metropolitan area

City	Men	Women
Tampico	99,867	115,233
Madero	69,677	79,969
Altamira	85,362	89,826

Source: Owned based on (Data México, 2020)

Surveys were conducted online due to their efficiency, low cost, accuracy, and ease of participation, which also facilitated data processing and analysis (QuestionPro, n.d.). To ensure clarity and reliability of the instrument, a pilot test was administered to 10 randomly selected individuals meeting the inclusion criteria. Feedback from this stage was used to refine the questionnaire, eliminating ambiguities and improving the structure. The final questionnaire consisted of 15 items, divided into four main sections, as shown in Table 3.

Box 3**Table 3**

Questionnaire composition

Dimension	Items	Characteristics
1. Demographic	1, 2, 3, 4, 5, 6	All multiple choice
2. Consumption Habits	7, 8, 9, 10, 11, 12	All multiple choice
3. Behaviors and Attitudes	13, 14	All multiple choice
4. Final Comments	15	Open question

Source: Owned

Each dimension in Table 3 corresponds to:

1. Demographic Data. Basic information such as age, gender, and income level, allowing segmentation of responses by socio-demographic groups.
2. Consumption Habits. Frequency of craft beer consumption and common purchase locations, providing insights into consumer behavior.
3. Behaviors and Attitudes. Motivations, openness to trying new beers, influence of recommendations, and participation in beer-related events.

4. Final Comments. Open-ended question for respondents to share opinions, suggestions, and additional insights.

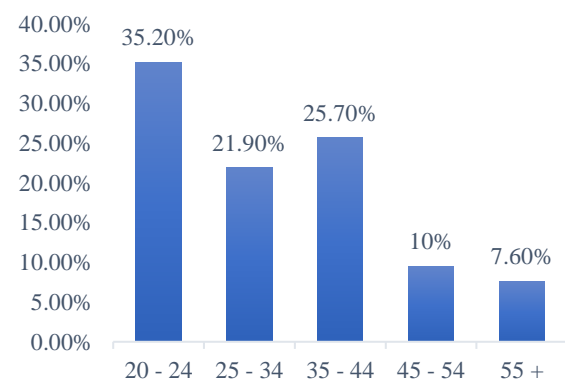
Data collection was carried out between October 2024 and February 2025 using online survey tools. Responses from 101 people were retrieved. The results were processed with Excel for statistical analysis, while qualitative responses were examined through word cloud visualization to identify recurring themes and perceptions.

3. Results

The findings are presented here according to the dimensions of the questionnaire.

3.1 Demographic data of the sample

The market study reflects a diverse consumer profile in terms of age, gender, income level, education, and occupation. Regarding age, many consumers are between 25 and 44 years old with 47.6%, followed by the group aged 20 to 24 with 35.2%. This young-adult population represents the most relevant segment for craft beer consumption, as illustrated in Figure 1.

Box 4**Figure 1**

Sample age range

Source: Owned

In terms of gender, both men and women participate in the market, with a balanced distribution across respondents. With respect to income levels, middle- and high-income segments account for the largest proportion of consumers, based on their monthly income. Figure 2 indicates the purchasing power levels.

Almost a third of those surveyed preferred not to declare their income. Each end of the income range represents one-fifth of the respondents.

Box 5

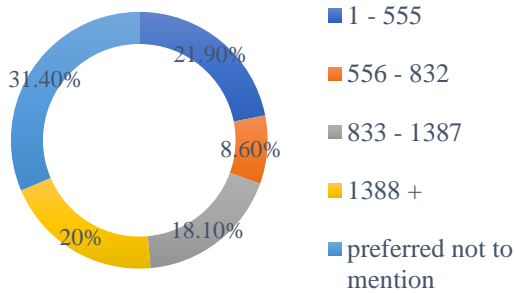


Figure 2

Monthly income levels (USD) of the sample

Source: Owned

In terms of education, most respondents reported having completed higher education or postgraduate studies (97.1%). This suggests a public with a high level of knowledge and demanding expectations regarding product quality. This characteristic is consistent with the occupational profile, where employees constitute the predominant group, reflecting economic stability and the capacity for frequent purchases.

Finally, in relation to geographical location, many consumers reside in Tampico (58%), followed by Ciudad Madero (26%), and to a lesser extent, Altamira (16%). Altamira is underrepresented in this sample, although the characteristics of its population are very different from those of the other municipalities in the metropolitan area.

3.2 Consumption habits of craft beer

The survey results reveal that craft beer consumption is generally occasional rather than habitual. 31.4% of the responses say that they never consume craft beer.

Most respondents reported consuming craft beer either *sometimes* or *monthly* (64.7%), indicating that it is perceived more as a special experience than as regular practice. As shown in Figure 3.

Box 6

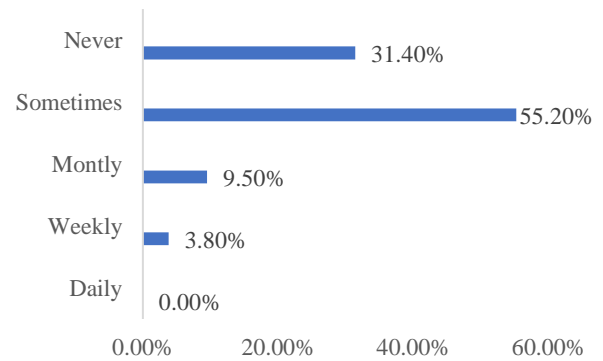


Figure 3

Craft beer intake frequency

Source: Owned

Regarding purchase locations, supermarkets and restaurants/bars were identified as the most common points of sale. However, specialized stores and online platforms also emerged as relevant alternatives, reflecting consumer interest in exploring diverse distribution channels as you can see in Figure 4.

Box 7

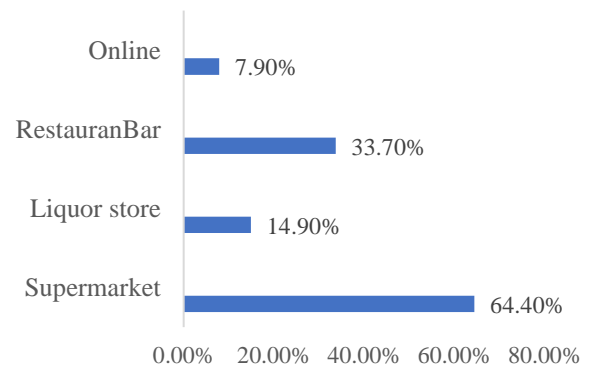
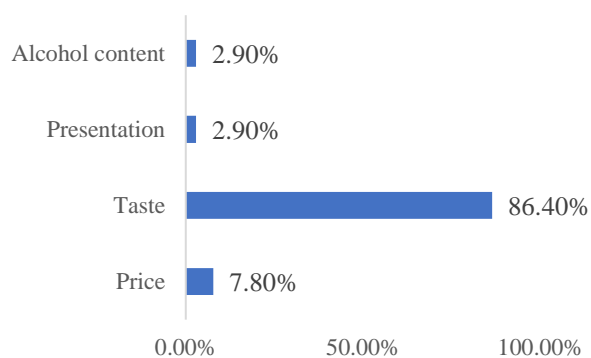


Figure 4

Craft beer purchase locations

Source: Owned

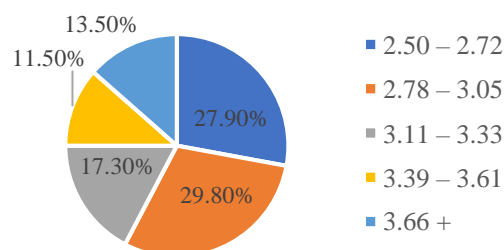
In terms of preferred packaging size, the 355 ml bottle was the most popular option (63.5%), and 33.7% prefer the 500ml one, both considered practical and sufficient for individual consumption. When asked about their favorite beer styles, respondents showed a clear preference for Amber (40.6%), Golden (34.7%), and Dark/Black (33.7%) beers. This highlights a tendency toward more robust and complex flavor profiles. The findings in Figure 5 reveal the attributes most valued in craft beer, flavor and organoleptic quality were identified by 86.4% as the main differentiators, underscoring the importance of sensory experience in consumer choice.

Box 8**Figure 5**

Attributes most valued in craft beer

Source: Owned

Finally, in relation to price sensitivity, most respondents expressed willingness to pay between 2.50 and 3.33 USD per bottle, as you can see in Figure 6. This range exceeds the typical price of commercial beers, reinforcing the perception of craft beer as a premium product.

Box 9**Figure 6**

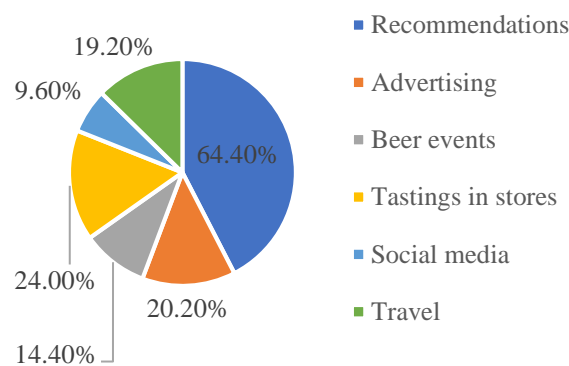
Craft beer price sensitivity (USD)

Source: Owned

3.3 Behavior and Attitudes

When people in the sample were asked about their motivation to try new craft beers, Figure 7 shows that respondents highlighted the importance of direct marketing strategies and personal recommendations.

Those factors play a significant role in influencing consumer decisions to explore new products.

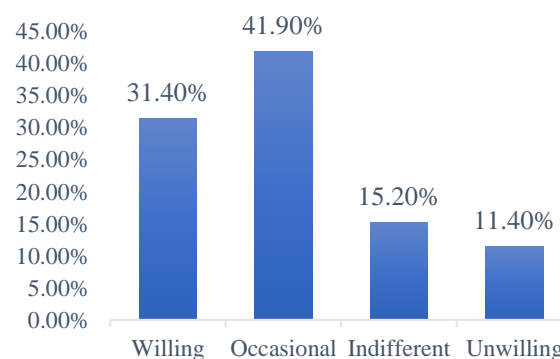
Box 10**Figure 7**

Motivation to try new craft beers

Source: Owned

Regarding participation in craft beer-related events such as festivals or tastings, only 5.7% reported attending several times a year. This finding reveals an area of opportunity for breweries and organizers to promote events more actively and increase consumer engagement.

The data in Figure 8 shows that willingness to pay a higher price for sustainable products, respondents expressed sensitivity toward beers made with local ingredients and sustainable methods.

Box 11**Figure 8**

Willingness to Pay a Premium for Craft Beer with Local and Sustainable Attributes

Source: Owned

This suggests that marketing strategies emphasizing ethical and local values could enhance consumer willingness to purchase at premium prices.

3.4 Final Comments

The open-ended question with number 15 allowed respondents to freely express their preferences and expectations. Several valuable aspects can be identified and visually summarized in Figure 9 with a word cloud that mainly highlights the tasting and quality of the craft beer.

Based on the results of the study presented, the following recommendations are made for the marketing process of craft beer and its differentiating elements.

- Marketing and promotion opportunities. Respondents emphasized the need for greater advertising and in-store demonstrations, suggesting that visibility and direct engagement could enhance consumer interest.
- Perception of authenticity. Craft beer was valued as a product distinct from industrialized options, associated with variety, originality, and richer flavors.
- Accessibility. Easy access was an important factor, indicating that distribution channels remain a key area for improvement.
- Product attributes. Specific preferences were mentioned, such as Pale Ale styles and higher alcohol content, reinforcing the importance of offering diverse options.
- Branding and design. Suggestions included the use of slogans, attractive packaging, and collectible bottles, showing that presentation and identity play a significant role in consumer appeal.
- Symbolic value. Some respondents purchase craft beer as gifts, associating it with premium quality and distinctive design.
- Overall satisfaction: Positive remarks such as *it taste better* reflect strong consumer appreciation and reinforce the perception of craft beer as a superior product.

Box 12



Figure 9

Word cloud regarding preferences and expectations

Source: Owned

4. Conclusions

This study focused on understanding consumer behavior and preferences in the craft beer market of southern Tamaulipas. Surveys revealed that consumption is generally occasional, with most respondents drinking craft beer monthly or sporadically, positioning it as a premium experience rather than a habitual practice.

Regarding consumer preferences, the research identified that Amber, Dark, and Golden styles are the most popular, with the 355 ml bottle being the preferred packaging size. Flavor and overall quality were highlighted as the main differentiators, reinforcing the importance of sensory attributes in product positioning.

In terms of purchasing behavior, supermarkets and restaurants/bars were the most common points of sale, although specialized stores and online platforms also emerged as relevant alternatives. This indicates opportunities for expanding distribution channels and strengthening market presence.

The study also revealed sensitivity toward sustainability and local values. Many consumers expressed willingness to pay a higher price for beers made with local ingredients and sustainable methods, suggesting that marketing strategies emphasizing authenticity and ethical production could increase demand.

Overall, the findings confirm that the craft beer market in southern Tamaulipas is driven by young-adult and middle- to high-income consumers with higher education levels, who value quality, innovation, and identity.

Article

These insights provide strategic opportunities for breweries to strengthen their positioning, expand consumer engagement, and promote sustainable growth in the region.

Declarations

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the research findings reported in this article on the craft beer market.

Contribution of the authors

Díaz-Flores Jorge: Contributed to the project idea, research on context analysis, writing and editing.

Soto-Hernández, Ana María: Contributed to the research method and technique on context analysis and editing.

Florencia-Castillo, Irma Beatriz: Contributed with data analysis techniques.

Availability of data and materials

The data obtained are not available.

Acknowledgements

We thank the Instituto Tecnológico de Ciudad Madero for the resources to carry out the research.

Abbreviations

GDP	Gross Domestic Product
ml	Milliliters
hl	Hectoliters

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Background

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Calli: A Proposal for an Accommodation Platform for the Huasteca Region of Hidalgo

Calli: Propuesta de una Plataforma de Alojamiento para la Huasteca Hidalguense

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Classification SECIHTI:

Area: Social Sciences
Field: Administration and business
Discipline: Bussiness and accounting
Subdiscipline: Bussiness and commerce

<https://doi.org/10.35429/JBS.2025.11.27.6.1.11>

History of the article:

Received: September 11, 2025

Accepted: December 10, 2025

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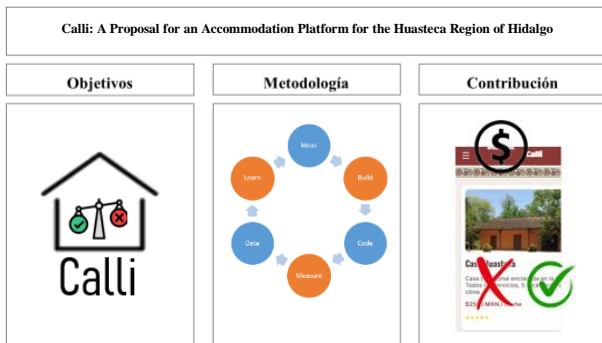


Abstract

Huejutla de Reyes, located in the Huasteca region of the state of Hidalgo, Mexico, has established itself as a leading regional cultural tourism destination and is recognized nationally. In 2024 alone, it received 350,000 visitors (Hernández, 2024). The existing accommodations are overwhelmed by demand, so this project aims to compile the various lodging options available in the region. Using the Lean Startup methodology, a Minimum Viable Product (MVP) is being developed: *Calli*, which means "house" in nahuatl, is conceived as an inclusive and secure technological solution that will allow individuals in the municipality and the region to register and promote their lodging offerings.

Resumen

Huejutla de Reyes ubicado en la huasteca del estado de Hidalgo, México; se ha consolidado como un referente de turismo cultural regional y con reconocimiento a nivel nacional. Tan solo en el año 2024 tuvo una afluencia de 350,000 visitantes (Hernández, 2024). El alojamiento establecido se ve rebasado por la demanda, por lo que este proyecto pretende recopilar las distintas ofertas de la región que ofrecen hospedaje, a través de la metodología *Lean Startup* se proyecta un PMV: *Calli*, que en náhuatl significa "casa" se concibe como una solución tecnológica, inclusiva y segura para que particulares del municipio y la región puedan registrar y promover sus ofertas de alojamiento.



Collaborative accommodation, Mobile App, Tourism Huejutla

Alojamiento colaborativo, App Móvil, Turismo Huejutla

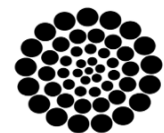
Area: Development of strategic leading-edge technologies and open innovation for social transformation

Citation: Felipe-Redondo, Ana María, Del Carmen-Morales, Yucels Anaí, Del Carmen-Morales, Heidi and Nuñez-Cárdenas, Felipe de Jesús. [2025]. Calli: A Proposal for an Accommodation Platform for the Huasteca Region of Hidalgo. Journal of Business and SMEs. 11[27]1-11: e61127111.



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Peer review under the responsibility of the Scientific Committee [<https://www.marvid.org/>]- in the contribution to the scientific, technological and innovation Peer Review Process through the training of Human Resources for the continuity in the Critical Analysis of International Research.



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Introduction

In our country, the tourism business is becoming increasingly important. According to UN Tourism, Mexico remains the sixth most visited country in the world [Ministry of Tourism, 2025].

For its part, INEGI reported that in August 2025, 7,880,311 visitors entered the country, 14.7% more than in the same month in 2024. Of this number, 3,786,226 (48.0%) were international tourists—travellers residing abroad who stayed overnight in Mexico [INEGI, 2025].

With regard to the state of Hidalgo, the State Secretary of Tourism reported that Hidalgo has received 7 million visitors so far this year, an increase of 46% compared to the beginning of the state's six-year term [Nochebuena, 2025].

The mountain and Huasteca regions of Hidalgo, made up of the municipalities of Atlapexco, Calnali, Huautla, Huazalingo, Huejutla de Reyes, Jaltocán, Lolotla, San Felipe Orizatlán, Tlanchinol, Xochiatipan, and Yahualica, offers opportunities for cultural tourism (religious, gastronomic, and ethnic) and nature tourism (ecotourism, rural, and adventure), with tourism potential based on heritage conservation, the richness of ecosystems, and traditional communities [SECTURH, 2024].

Huejutla de Reyes is a municipality nestled in the Huasteca region of the state of Hidalgo, Mexico. In recent years, it has established itself as a benchmark for regional cultural tourism and has gained national recognition. In 2024 alone, it had an influx of 350,000 visitors [Hernández, 2024]

This massive influx of visitors stems from tourists' interest in immersing themselves in and experiencing the popular culture of this municipality and others that make up the Hidalgo, Veracruz and San Luis Potosí Huasteca regions, where Huejutla is a key hub due to its road infrastructure and tourism services.

Folkloric and religious events, notably the Xantolo festival (Huasteco Day of the Dead), increase the demand for accommodation services, with most hotels located in the municipal capitals, as these are the main urban centres.

However, some accommodation options can be found within the ecotourism developments in the area, as can be seen in Table 1.

Box 1

Table 1

Temporary accommodation establishments by municipality

Municipality	Total	4*	3*	2*	1*	SC
Atlapexco	3	0	0	0	0	3
Calnali	8	0	0	0	0	8
Huautla	2	0	0	0	0	2
Huazalingo	0	0	0	0	0	0
Huejutla de Reyes	42	0	0	0	0	42
Jaltocán	0	0	0	0	0	0
Lolotla	4	0	0	0	1	3
San Felipe Orizatlán	4	0	0	0	0	4
Tlanchinol	7	0	0	1	2	4
Xochiatipan	1	0	0	0	0	1
Yahualica	0	0	0	0	0	0

Source SECTURH (2024)

The number of places is estimated at a total of 2,369, according to data from the 2023 State Tourist Information System, of which 942 (39.76%) are located in Huejutla de Reyes. As can be seen, temporary accommodation is overwhelmed by demand, so this project aims to compile the different offers in the region that provide accommodation, differentiating itself by offering a regional tourism experience, being pet-friendly, combining safety, sustainability and authentic local experiences, and centralising them through Calli, a mobile app that seeks to promote collaborative accommodation.

Calli, which means 'house' in Nahuatl, is conceived as a technological, inclusive and secure solution for individuals in the municipality and the region to register and promote their accommodation offers.

Methodology

Lean Startup is a business management methodology that aims to create a business model in an agile and secure way, shortening development cycles and establishing continuous innovation processes [Ries, 2011]. In one way or another, we have all witnessed a company with a promising future inexplicably fail. For the creator of the Lean Startup methodology, many of these companies make decisions based on the results of market research.

'There is an irresistible temptation to apply this to startups as well, but this does not work because they operate with much more uncertainty. Startups do not yet know who their consumers will be or what their products will be,' explains Eric Ries.

The Lean Startup approach promotes capital efficiency and leverages human creativity. It is based on 'validated learning,' rapid experimentation that shortens product development cycles, measures actual progress, and learns what customers really want, allowing companies to change course at the right time and avoiding the development of products that do not meet customer needs.

The methodology seeks to reduce uncertainty, given that the interest of those involved can be quickly validated, the business model can be experimented with, as well as the website and the regulatory framework of the service, through validated learning and pivoting to adjust or modify it.

Box 2

Information feedback loop create-measure-learn

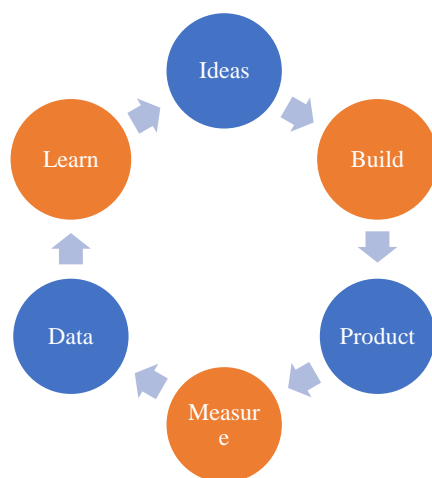


Figure 1

Basic stages of the Lean Startup method

Source: Own Elaboration

Figure 1 shows the iteration of activities proposed in the methodology, followed by a description of each one.

The Lean Startup method consists of a continuous three-step cycle: Build, Measure, and Learn. Based on ideas and needs, a Minimum Viable Product (MVP) is built to test the hypotheses proposed from the ideas. Subsequently, the customer's response is measured using indicators or metrics.

Finally, this information is used to learn from the data in order to decide whether to continue with the product, make a *pivot* (change of direction) or continue improving the current version.

In short, the aim of this methodology is to ensure that no company wastes time and money developing a solution to a non-existent problem.

Build

Based on the project's preliminary ideas and with a palpable need identified, the following hypothesis is proposed:

If the inhabitants of Huejutla have a simple, easy-to-use and secure digital platform to register and offer temporary accommodation, they will be willing to publish their spaces in order to meet part of the tourist demand and generate local income opportunities.

In order to validate the hypothesis and identify needs, two surveys were conducted, targeting potential customers—both locals who can offer accommodation (hosts) and tourists who demand accommodation. These surveys were validated using the Delphi method, which aims to structure the criteria that can measure the object of study through a communicative process involving experts [López-Gómez, 2018].

Determination of the needs of potential users (tourism)

A sample size with a finite population was determined in order to know how many units of analysis were necessary for the proposed purpose. This took into account the available resources and the minimum requirements for a reliable analysis [Fisher & Espejo, 2016].

Therefore, the formula for finite population sampling was used.

$$n = \frac{NZ^2pq}{(N-1)e^2 + Z^2pq}$$

Where:

n = sample size to be calculated

N = population size

Z = standard deviation according to the confidence level

P, Q = proportion of expected variability, 0.5

E = margin of error

From this, we obtained that:

$$n = \frac{(35000)(1.96)^2(0.5)(0.5)}{(34999)(0.05)^2 + (1.96)^2(0.5)(0.5)}$$

For a

N = 35,000

Z = 1.96 (for 95% confidence)

e = 0.05 (margin of error of 5%)

p = 0.5

q = 0.5

This determined a sample size of 380.0 units of analysis.

The survey was conducted during the Xantolo 2024 period. It was administered to individuals between the ages of 15 and 60, regardless of gender or academic degree.

The results of the survey administered to those seeking accommodation are as follows:

Box 3

Table 2

1. How often do you visit this region and for what reasons?

Reason	Frecuency
Cultural tourism	205
Nature/adventure	60
Family events	30
Temporary work	60
Other	25

Source: Own Elaboration

This result encouraged the idea of developing the PMV, given that there is sustained demand from visitors.

Box 4

Table 3

2. What type of accommodation do you usually prefer when travelling?

Type	Frecuency
Hotels	156
Hostels	60
Temporary rentals	80
Family homes	60
I have no preference	24

Source: Own Elaboration

This result shows that there is a demand from people who prefer other accommodation options besides hotels.

Box 5

Table 4

3. What factors do you consider most important when choosing accommodation?

Factor	Frecuency
Price	120
Location	150
Security	250
Opinions/Reviews	189
Services included	208
Authenticity	106
Ease of booking	117

Source: Own Elaboration

In this question, respondents selected three options they considered priorities, highlighting safety, included services, and reviews.

Box 6

Table 5

4. How confident are you when booking accommodation offered by individuals?

Confidence level	Frecuency
Very high	10
High	23
Medium	125
Low	177

Source: Own Elaboration

This result guides us to seek mechanisms through the app proposal to increase the level of trust among users. It is also expected, given that it is not a common service in the region.

Box 7

Table 6

5. Which payment methods would you prefer to use on a local accommodation platform?

Method	Frecuency
Debit/credit card	280
MercadoPago	120
Bank transfer	166
Cash payment on arrival	50
Mixed payment	144

Source: Own Elaboration

This result highlights the different payment options that should be prioritised for inclusion in the application, according to user needs.

Box 8**Table 7**

6. What features do you consider essential for a local accommodation website?

Functionality	Frecuency
Verified potos	135
Clear accommodation information	380
Filters	72
Interactive map	57
Direct chat	156
Verified host identity	96
Cancellation policies	87
Customer support	157

Source: Own Elaboration

Respondents were asked to select the three options they considered most important, identifying customer support, clear accommodation information and verified photos as the most relevant.

Box 9**Table 7**

6. What features do you consider essential for a local accommodation website?

Functionality	Frecuency
Verified photos	135
Clear accommodation information	380
Filters	72
Interactive map	57
Direct chat	156
Verified host identity	96
Cancellation policies	87
Customer support	157

Source: Own Elaboration

This result points to strengthening the information describing the services and characteristics of the accommodation, the images and customer support, as well as the choice of an entity to verify the information published.

Box 10**Table 8**

7. What kind of experiences would motivate you to choose local accommodation?

Reason	Frecuency
Gastronomy	248
Cultural activities	349
Rural or nature experiences	155
Interaction with the community	8

Source: Own Elaboration

This question also points to strengthening other additional services and can be seen as an opportunity to boost other sectors through the application, such as the gastronomic sector, local crafts, other economic activities such as embroidery, bread making, candle making, among others, as well as guided tours of communities and their customs.

Box 11**Table 9**

8. Have you used platforms such as Airbnb, Booking, or others?

Use	Frecuency
Yes	117
No	263

Source: Own Elaboration

This result indicates that most visitors are not accustomed to using a local accommodation service platform.

Box 12**Table 10**

9. If your answer is yes, how would you describe your experience?

Degree of satisfaction	Frecuency
Excellent	6
Very good	43
Good	46
Fair	15
Poor	7

Source: Own Elaboration

It is clear that if this approach is chosen, work will need to be done not only with the application but also with service providers (hosts) to change this perception in a regional approach.

Box 13**Table 11**

10. What would motivate you to use a local accommodation platform?

Reason	Frecuency
More affordable prices	275
Greater authenticity	125
Better security policies	109
More confidence in verified hosts	178
Ease of use	73

Source: Own Elaboration

Trust in verified hosts and prices stood out in this question, highlighting once again the need for a host verification entity.

Determining the needs of potential users (service providers)

To identify the needs of service providers (hosts), local people who post on social media were contacted, totalling 12 people, who account for a total of 120 places, representing 10% of the current local supply.

All of them were asked the following questions:

Box 14

Table 12

1. How willing would you be to use an app or website to offer your accommodation to tourists?

Availability	Frecuency
Very willing	2
Willing	4
Indifferent	2
Not very	2
Not at all	2

Source: Own Elaboration

It can be observed that there is moderate interest in the development of the application, although it should be noted that the age of some hosts causes a digital divide.

Box 15

Table 13

2. What features do you consider most important for the platform to have? (Select up to 3)

Features	Frecuency
Availability calendar	5
Photos and description of the accommodation	5
Selection of number of guests (adults/children) or pets	4
Payment methods	5
Chat with guests	3
Reviews and ratings	4
Booking notifications, messages	4
Promotion within the platform	2
Registration of events or cultural activities	4

Source: Own Elaboration

This question is fundamental because it lays the foundation for what local hosts consider necessary to offer their service.

Box 16

Table 14

1. Would you prefer to use the platform as a mobile application, website, or both?

Preference	Frecuency
Mobile application	0
Website	0
Both	10

Source: Own elaboration

Source: Own Elaboration

All hosts believe that offering both options for interacting with the application is best for its use.

Box 17

Table 15

1. Would you be willing to pay a commission or fee for using the platform if it generates bookings for you?

Availability	Frecuency
Yes, booking fee	3
Yes, monthly fee	8
I would not be willing	1

Source: Own Elaboration

It can be seen that 10/11 of the hosts are willing to pay for the service.

With these preliminary ideas from potential users, the PMV was designed based on the recommendations made by potential users.

Product

Based on the surveys, it was determined that the PMV should include at least:

Service

Photo gallery, accommodation details, availability calendar, reservations in addition to the platform by email, telephone, social media, payment methods, chat, reviews and ratings, notifications, advertising space.

Administration

Host registration and validation, income statistics, advertising management, and additional tourist services (events, pottery routes, gastronomy, embroidery, local festivals, and traditional ceremonies).

The regulatory framework for the services offered: privacy policy, terms and conditions of service, and cancellations.

An app with a PWA (Progressive Web App) approach, in order to offer both a web and mobile version in the prototype.

A verification entity that provides certainty about the information shared (photos, identity and security of the provider and the spaces).

The colour palette features the typical and characteristic colours of local crafts, which give the region its identity.

Figure 1 shows the initial interface of the application.

Box 18



Figure 1

Calli initial interface

Measure:

It was in Xantolo in 2025 that the application was once again presented to a group of tourists for their opinions:

Considering a finite population of 380 units of analysis, a calculation was made with a 5% error and a 95% confidence level.

$$n = \frac{NZ^2pq}{(N-1)e^2 + Z^2pq}$$

Where:

n = Sample size to be calculated

N = 380 units of analysis.

Z = Standard deviation according to the confidence level

P, Q = The proportion of expected variability, 0.5

E = Margin of error

From this, it was found that:

$$n = \frac{(380)(1.96)^2(0.5)(0.5)}{(379)(0.05)^2 + (1.96)^2(0.5)(0.5)}$$

For a

N = 380

Z = 1.96 (for 95% confidence)

e = 0.05 (margin of error of 5%)

p = 0.5

q = 0.5

This determined a sample size of 191.0 units of analysis.

However, due to logistical limitations, non-probabilistic convenience sampling was chosen [Hernandez Sampieri, Fernandez Collado, & Baptista Lucio, *Research Methodology*, 2007], adjusting to 50 units of analysis.

$$E = Z \sqrt{\frac{p}{q} * \frac{N-n}{N-1}}$$

Replacing

N = 380

n = 50

Z = 1.96

p = 0.5

q = 0.5

Source: Own Elaboration

This sample size offers a margin of error of approximately 12%, which is considered adequate for exploratory studies and technological design proposals aimed at investigating general trends rather than precise population parameters [Hernandez Sampieri & Mendoza Torres, *Research Methodology: Qualitative, Quantitative and Mixed Methods*, 2023].

Therefore, a sample of 50 tourists was surveyed on their use of the application.

With regard to the hosts, the entire population was surveyed, i.e. 12.

Learning

During the testing phase, efforts were made to keep the time short (no more than 5 minutes) to test the functionality, usability and design of the application for both tourists or potential users and hosts.

With regard to functionality, the following were evaluated: registration and login, search and filtering of results (calendar, room type, type of occupants), reservations, payment methods and cancellations, reviews and ratings, and updating availability.

With regard to usability, criteria such as ease of use, intuitive navigation flow to complete a task, clarity of text and images, and app feedback were evaluated.

With regard to design, colour harmony, readability and visual hierarchy were observed.

Tasks were set according to the participation profile:

Tourists or potential users were asked to: search for accommodation using filters, view photos, check prices, make reservations and receive confirmation, post reviews, and use the app offline.

Those offering a service (hosts) were asked to:

Register accommodation, upload photos, mark availability, check statistics, and accept or reject reservations.

A verification role was also defined in order to give visibility to the information displayed by hosts, with the aim of offering security and certainty of the information, after verification.

A short survey was administered to both groups, which included the following questions:

With regard to functionality, they were asked:

Box 18

Table 16

The application functions correctly and enables me to perform my tasks without errors.

Criterion	Tourists	Hosts
Strongly agree	7	2
Agree	26	5
Neither agree nor disagree	10	3
Disagree	4	1
Strongly disagree	3	1

Source: Own Elaboration

With regard to usability, they were questioned.:

Box 19

Table 17

I find it easy to use the app and find what I need.

Criterion	Tourists	Hosts
Strongly agree	6	3
Agree	22	5
Neither agree nor disagree	11	2
Disagree	6	1
Strongly disagree	5	1

Source: Own Elaboration

In pursuit of efficiency, questions were raised about:

Box 20

Table 18

I can complete tasks (search/book/publish/manage) quickly.

Criterion	Tourists	Hosts
Strongly agree	9	3
Agree	24	6
Neither agree nor disagree	10	2
Disagree	5	1
Strongly disagree	2	0

Source: Own Elaboration

With regard to visual design, he asked himself:

Box 21

Table 19

The visual design makes the application easy to use

Criterion	Tourists	Hosts
Strongly agree	5	3
Agree	21	5
Neither agree nor disagree	16	2
Disagree	4	1
Strongly disagree	4	1

Source: Own Elaboration

In order to gain an overall view of perception, the following question was asked:

Box 22

Table 20

Overall, I am satisfied with my experience using this application

Criterion	Tourists	Hosts
Strongly agree	8	3
Agree	27	6
Neither agree nor disagree	12	2
Disagree	3	1
Strongly disagree	0	0

Source: Own Elaboration

Results

These results give us an overview of the palpable need where hotel capacity is exceeded, which is why there is a proposal for Calli, a digital platform that, through a network of hosts, offers an inclusive, practical, and secure technological solution so that individuals in the municipality and the region can register their accommodation offers throughout the year, considering that the demands of users of accommodation services have also changed [Calza Quishpe, 2025] and are looking for options to choose freely. This is where *Calli* comes in.

However, we must also be aware that there will be a very large sector of the population that is not yet ready to make use of these proposals [Leite Farias, Alexandre Silva, & De Azevedo Barbosa, 2019].

New travellers – millennials – seek experiences and spaces with connections. This promotes a healthy local economy and benefits businesses that derive from tourism. Millennials plan their trips using mobile devices and attach importance to comments on social media, giving rise to the collaborative economy [Fonseca Saldaña & Estela Estela, 2020].

One aspect to bear in mind is the regulatory framework for these service providers of this form of accommodation, which has revolutionised the sector, so the implementation of administrative controls is an issue that needs to be addressed [López Sánchez, 2021].

Conclusions

It is important to mention that, based on a regional need in the economic and social environments within the Huasteca region of Hidalgo, the feasibility of developing a platform that brings together and transforms an economy, in this case the hotel industry, has resulted in the *Calli* platform. According to the data collected in the surveys that support this application, This can be scaled up to other economic aspects, such as the gastronomic, tourism and craft sectors, all of which lead to a complete experience through the platform that focuses on the search for spaces not only for accommodation, but also for adventure, culture and regional gastronomy.

According to these results, and although international accommodation platforms already exist, this business model brings together people who can provide accommodation services according to their means with those who are looking for places to stay in an easy, safe and, why not, more economical way.

The development of the Calli Platform seeks, in the first instance, to create a digital space that promotes the efficient, effective, safe and economical use of spaces, whether rooms, flats or houses, that are available for occupation during certain periods of time by tourists, mainly in times of high demand, thus providing a new option that allows for the maximum occupancy of these spaces, which until now have not been considered for this purpose.

Definitely, in order to lend or use this type of accommodation here in the region, a paradigm shift is required to access these services.

Currently, there is another trend of innovation in accommodation through home swapping, i.e. free home exchanges for individuals and their families. The idea is to exchange homes so that everyone can enjoy and get to know the best of the other place. It is an equitable cultural exchange open to all [Suarez Ramírez, 2017]. So the challenge of using the platform involves not only a technological intervention, but also a change in the way these services are appropriated.

Conflict of interest

The authors declare that they have no conflict of interest. They have no known competing financial interests or personal relationships that could have appeared to influence the article.

Contribution of the authors

Felipe Redondo, Ana María: Contributed the research idea, project leader for the application.

Del Carmen Morales, Yucels Anaí: Contributed to the design of the data collection instrument for hosts and the analysis of this data.

Del Carmen Morales, Heidi: Contributed to the design of the data collection instrument for potential customers and the analysis of this data.

Núñez Cárdenas, Felipe de Jesús: Contributed to the design of the data collection instrument and its analysis; also coordinated the data collection with his students.

Availability of data and materials

The collected data are available for consultation upon request to the corresponding author.

Funding

This research did not receive any funding.

Acknowledgements

Special thanks to the students who participated in this research.

TSU Montserrath Álvarez Hernández

TSU Gelacio Hernández Bautista

7th semester students of the Bachelor's Degree in Administration at the ESH of the UAEH.

Abbreviations

PMV	Minimum Viable Product		
PWA	Progressive Web App		
UTHH	Huasteca Hidalguense Technological University		
UAEH	Hidalgo	State	Autonomous University
ESH	Huejutla	Higher	Education Institution

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Analysis of generic and specific competencies of Industry 4.0 in Engineering students from the Laguna region



Análisis de las competencias genéricas y específicas de la Industria 4.0 en estudiantes de Ingeniería de la región Lagunera

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Classification SECIHTI:

Area: Social Sciences

Field: Business and Management

Discipline: Management and Administration

Subdiscipline: Business Administration

 <https://doi.org/10.35429/JBS.2025.11.27.7.1.7>

History of the article:

Received: September 11, 2025

Accepted: December 10, 2025

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Abstract

The challenges faced by university graduates when entering the labor market require concrete, short-term actions. This study examined the generic and specific competencies associated with Industry 4.0, promoted by the World Economic Forum, for university students in the Laguna region. A total of 262 engineering students were surveyed, and a PLS-SEM model was estimated with evaluation of reliability, validity, and predictive relevance. The participating engineering programs are: Computer Systems, Environmental Technology, Logistics, Electrical Systems, Business Management, Agrobiotechnology, Industrial Engineering, Advanced Manufacturing, Agronomy, Food Science, and Administration. The results indicate positive effects of generic and specific competencies on engineering students at universities in the Laguna region. The model explains 72.1% of the variance in the dependent variable: Industry 4.0. The research hypotheses are accepted with a highly significant result. And a Q2 of 0.403, registering a moderate to high predictive power.

Resumen




Los retos que enfrenta los egresados universitarios al integrarse a un mercado laboral, exigen acciones concretas en un corto plazo. Este estudio examinó las competencias genéricas y específicas asociadas a la industria 4.0 y promovidas por el Fondo Económico Mundial a estudiantes universitarios de la región lagunera. Se encuestó a 262 estudiantes de ingeniería y se estimó un modelo PLS-SEM con evaluación de fiabilidad, validez y relevancia predictiva. Las ingenierías participantes son: Sistemas Computacionales, Tecnología Ambiental, Logística, Sistemas Eléctricos, Gestión Empresarial, Agrobiotecnología, Industrial, Manufactura Avanzada, Agronomía, Alimentos y Administración. Los resultados indican efectos positivos de las competencias genéricas y específicas en alumnos de ingeniería de universidades de la región lagunera. El modelo explica en un 72.1% la varianza de la variable dependiente: Industria 4.0. Se aceptan las hipótesis de investigación con un resultado altamente significativo. Y un Q² de 0.403, registrando un poder predictivo de moderado a alto.

EVALUATION OF GENERIC AND SPECIFIC COMPETENCIES OF INDUSTRY 4.0 IN ENGINEERING STUDENTS

Objectives	Methodology	Contribution
 <ul style="list-style-type: none"> Evaluate generic and specific competencies associated with Industry 4.0 Identify strengths and areas for improvement 	 <ul style="list-style-type: none"> Questionnaire Statistical Tests 	 <ul style="list-style-type: none"> Greater development of generic competencies Reinforcement of curricula with innovation and practice strategies

Generic Competencies, Specific Competencies, Industry 4.0

ANÁLISIS DE LAS COMPETENCIAS GENÉRICAS Y ESPECÍFICAS DE LA INDUSTRIA 4.0 EN ESTUDIANTES DE INGENIERÍA DE LA REGIÓN

Objetivos	Metodología	Contribución
 <ul style="list-style-type: none"> Evaluar las competencias genéricas y específicas Identificar fortalezas y áreas de oportunidad 	 <ul style="list-style-type: none"> PLS-SEM Cuantitativo Cuestionario de 23 ítems 	 <ul style="list-style-type: none"> Desarrollo en competencias genéricas Fortalecer los planes de estudio

Competencias Genéricas, Competencias Específicas, Industria 4.0

Area: Strengthening the scientific community

Citation: Escobar, Héctor, Cárdenas, Víctor, Araiza, María and Rodríguez, Ana. [2025]. Analysis of generic and specific competencies of Industry 4.0 in Engineering students from the Laguna region. Journal of Business and SMEs. 11[27]1-7: e71127107



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Introduction

The emergence of the Fourth Industrial Revolution, also known as Industry 4.0, has profoundly transformed production systems by integrating emerging technologies such as the Internet of Things (IoT), artificial intelligence (AI), big data, additive manufacturing, augmented reality, and cyber-physical systems. These advances have generated new demands in the labor market, requiring professionals not only to possess technical knowledge but also to develop transversal competencies that enable them to adapt to highly dynamic, digitalized, and competitive environments.

Industry 4.0 has brought about a significant shift in production systems, characterized by the digitalization and interconnectivity of industrial processes. This revolution incorporates technologies such as the Internet of Things (IoT), artificial intelligence, big data, additive manufacturing, robotics, augmented reality, and cyber-physical systems, among others, which have radically transformed the skill set required in professional contexts—particularly in the field of industrial engineering. Industry 4.0 represents a profound transformation in production systems by integrating emerging technologies such as the Internet of Things, artificial intelligence, big data, and simulation.

In this context, it is crucial for industrial engineers to develop both generic and specific competencies that allow them to adapt to new smart-manufacturing environments. Studying this topic is essential, as it ensures that future professionals acquire the necessary skills to face the technological and organizational challenges of the Fourth Industrial Revolution, thereby contributing to the competitiveness of enterprises and the nation as a whole.

In this context, universities and higher education institutions face the challenge of updating their academic programs to prepare graduates capable of meeting the demands of an increasingly automated, digital, and competitive industrial environment. In this regard, numerous studies and initiatives have emerged aiming to define the generic and specific competencies that future engineers must possess.

According to the [World Economic Forum \(2018\)](#), the key competencies required to thrive in the context of Industry 4.0 include complex problem-solving, critical thinking, creativity, emotional intelligence, decision-making, the ability to work in interdisciplinary environments, and adaptability. These skills are part of what is known as generic competencies, applicable to a wide range of professional contexts. On the other hand, studies such as those by [Prifti et al. \(2017\)](#), [Terrés et al. \(2017\)](#), and [Karre et al. \(2017\)](#) have identified specific competencies related to the mastery of technological tools, such as the use of simulation software, programming, data analysis, and computer-aided design.

Regarding digital transformation, which has become a key component of Industry 4.0, the education of future professionals requires the strengthening of both generic and specific competencies. The latter are essential for mastering tools, methodologies, and technical knowledge that enable individuals to effectively address the challenges of the current productive environment.

In this context, higher education institutions face the challenge of preparing graduates capable of responding to these demands by strengthening both generic competencies—such as critical thinking, creativity, emotional intelligence, and complex problem-solving—and specific competencies related to the mastery and application of technological tools inherent to Industry 4.0.

The purpose of this study is to examine the generic and specific competencies of university students who are about to graduate from four universities in the Laguna region. Surveys were administered across institutions in the Laguna region, providing a broad perspective on the current state of academic training in relation to the needs of the labor market.

This research aims to provide guidelines that contribute to the improvement of educational programs, promoting a comprehensive training approach that ensures the successful integration of future professionals into smart manufacturing environments.

However, the results obtained from the survey administered to senior university students across three different institutions reveal a concerning situation. When assessing the development of specific competencies, most respondents selected the option “sometimes” for all questions within this category. This response, positioned at an intermediate point on the proposed scale (“always,” “almost always,” “sometimes,” “almost never,” “never”), reflects a perceived insufficiency or inconsistency in the acquisition of these competencies during their academic training.

This finding suggests that although students may have had some exposure to the content or skills associated with specific competencies, they do not feel fully prepared to apply them consistently or effectively in a professional setting. This situation represents both a concern and a limitation in terms of competing for employment positions given the demands of Industry 4.0, which requires mastery of areas such as artificial intelligence, the Internet of Things, virtual reality, additive manufacturing, blockchain, big data, simulation, horizontal and vertical system integration, cybersecurity, cloud computing, cyber-physical systems, and machine-to-machine (M2M) communication.

The lack of acquisition of these competencies could directly affect graduates’ ability to successfully enter the labor market and to respond proactively to the technological and organizational challenges of the current industrial sector. Therefore, this issue highlights the need to review and strengthen curricular content, teaching strategies, and learning environments in higher technological education, in order to ensure training that meets the demands of the Fourth Industrial Revolution.

It is essential to adapt educational programs for future professionals to the current needs of the labor market, enabling the development of graduates capable of effectively responding to the requirements of an automated, connected, and flexible industry. Likewise, this knowledge will allow higher education institutions to implement pedagogical and curricular strategies aligned with the competencies demanded by Industry 4.0, such as data analysis, the integration of cyber-physical systems, and the ability to make decisions in complex environments.

The hypotheses proposed are as follows: H1: University students’ generic competencies have a positive and significant influence on Industry 4.0; H2: University students’ specific competencies have a positive and significant influence on Industry 4.0.

Methodology

The present study adopts a quantitative approach with a non-experimental, cross-sectional design and an explanatory scope with causal correlation. For data analysis, the software programs SMART PLS v3.02 (Ringle et al., 2015) and IBM SPSS Statistics 29 were employed. The measurement instrument consisted of 23 items and was administered to 262 university students. Based on an extensive literature review, the study focuses on validating the existence of an effect of the independent variables—employment status and employment relationship—on the dependent variable, work commitment.

Data collection was conducted through a Google Forms questionnaire, using a five-point Likert-type scale (from 1 to 5, with 5 being the highest value). Composite reliability was assessed, which is a more advanced measure that considers the individual factor loadings of each item and their associated errors.

This approach provides greater precision than Cronbach’s alpha, particularly in more sophisticated analyses such as confirmatory factor analysis (CFA) or structural equation modeling (SEM). Since greater accuracy is required and the analysis is based on a factorial model, composite reliability is considered a more appropriate reliability indicator. In addition, various analyses were performed to validate the assumptions of the model in multiple linear regression, including tests of homoscedasticity, linearity, normality, model fit, and data adequacy.

The study sample consisted of 262 students, and the internal reliability of the variables was evaluated using Cronbach’s alpha coefficient. Additionally, composite reliability was employed to validate internal consistency. The structural model was analyzed through structural equation modeling using PLS-SEM, with standardized coefficients employed to test the proposed hypotheses.

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The normality analysis (Kolmogorov–Smirnov test), as well as discriminant validity—confirmed through the Fornell–Larcker criterion—and collinearity tests ruled out multicollinearity issues. Finally, the Kaiser–Meyer–Olkin (KMO) measure and Bartlett’s test of sphericity, along with factor analysis, were conducted to validate the contribution of the items to the variance of the factors.

Results

Figure 1 presents the proposed structural model designed to analyze the relationship between generic competencies (X1), specific competencies (X2), and their influence on the dependent variable Industry 4.0 (Y). The model was estimated using the Partial Least Squares Structural Equation Modeling (PLS-SEM) method, with the objective of evaluating the contribution of these competencies to professional development oriented toward digital transformation.

Box 1

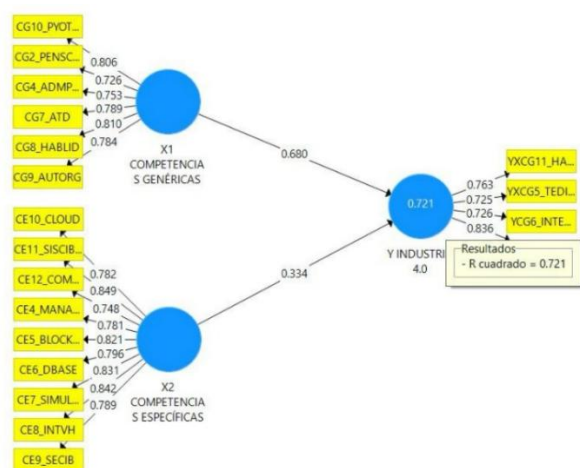


Figure 1

SmartPLS output

Source: Own Elaboration

Using Pearson’s coefficient of determination (R^2), 72.1% of the variability in students’ competency levels is explained by the two evaluated dimensions: generic competencies (X1) and specific competencies (Y1). Likewise, regarding the adjusted R^2 value (71.9%), and following Hair et al. (2021), this value is considered acceptable in social science research, as it demonstrates a significant relationship among the variables. Figure 2

Box 2

R cuadrado

Matriz	R cuadrado	R cuadrado ajustada
Y INDUSTRIA 4.0	0.721	0.719

Figure 2

 R^2 and Adjusted R^2 Values

Source: Own elaboration

Regarding the Durbin–Watson statistic (Figure 3.), a value of 1.955 was obtained, which falls within the acceptable threshold of 1.5 to 2.5, confirming the independence of residuals.

Box 3

Resumen del modelo ^b						
Error estándar de la estimación	Cambio en R cuadrado	Estadísticos de cambio			Sig. Cambio en F	Durbin-Watson
		Cambio en F	gl1	gl2		
,68585	,019	2,314	2	240	,101	1,955

ESPECIFICAS, X1_COMPETENCIAS_GENERICAS

Figure 3

Model Summary

Source: Own Elaboration

The Fisher’s F value (71.478) is statistically significant, validating the presence of meaningful variations within the analyzed sample Figure 4.

Box 4

ANOVA ^a						
Modelo		Suma de cuadrados	gl	Media cuadrática	F	Sig.
1	Regresión	31,178	2	15,589	71,478	<.001 ^b
	Residuo	52,343	240	,218		
	Total	83,522	242			

a. Variable dependiente: Y COMPETENCIAS DE INDUSTRIA RL 4.0
b. Predictores: (Constante), X2_COMPETENCIAS_ESPECIFICAS, X1_COMPETENCIAS_GENERICAS

Figure 4

ANOVA

Source: Own Elaboration

Figure 4. Regarding the analysis of variance (ANOVA), the results show a highly significant level of 0.001, indicating that at least one of the analyzed variables contributes significantly to the explanation of the model. The population sample consisted of $n = 243$ students, confirming the validity of the mean comparison among groups, since in the statistical treatment, 19 remaining data points were identified as outliers.

Article

The standardized coefficients obtained in the model indicate that the variable X1, *generic competencies* ($\beta = 0.680$; $t = 18.930$, $p = 0.000$), exhibits a strong and statistically significant effect, leading to the acceptance of the corresponding research hypothesis. This suggests that skills such as critical thinking, problem-solving, emotional intelligence, and creativity are well developed among soon-to-graduate students. In contrast, the variable X2, *specific competencies* ($\beta = 0.334$; $t = 7.554$, $p = 0.000$), shows a moderate-to-strong effect with a t -value above the critical threshold of 1.96 and highly significant values ($p < 0.05$), indicating that mastery of areas related to big data, artificial intelligence, IoT, and cyber-physical systems still requires further strengthening. Figure 5.

Box 5

	Muestra original ...	Media...	Desviación est...	Estadísticos t...	P Valores
X1 COMPETENCIAS GENÉRICAS -> Y INDUSTRIA 4.0	0.680	0.680	0.036	18.930	0.000
X2 COMPETENCIAS ESPECÍFICAS -> Y INDUSTRIA 4.0	0.334	0.336	0.044	7.554	0.000

Figure 5

Standardized Coefficients of the Model

Source: Own Elaboration

The Variance Inflation Factor (VIF) presented a value of 1.117, which, being below the threshold of 5.000, confirms the absence of multicollinearity among the model variables Figure 6.

Box 6

Estadísticos de colinealidad (VIF)

	X1 COMPET...	X2 COMPET...	Y INDUSTRIA 4.0
X1 COMPETENCIAS GENÉRICAS	1.117		
X2 COMPETENCIAS ESPECÍFICAS		1.117	
Y INDUSTRIA 4.0			

Figure 6

The Variance Inflation Factor (VIF)

Source: Own Elaboration

The histogram of standardized residuals (Figure 7) shows a normal distribution of the data, fitting the Gaussian curve and confirming a mesokurtic behavior of the model. Complementarily, the Kolmogorov–Smirnov test validates the normality of the sample ($n = 243$), confirming that the data are significantly distributed under a two-tailed asymptotic behavior

Box 7

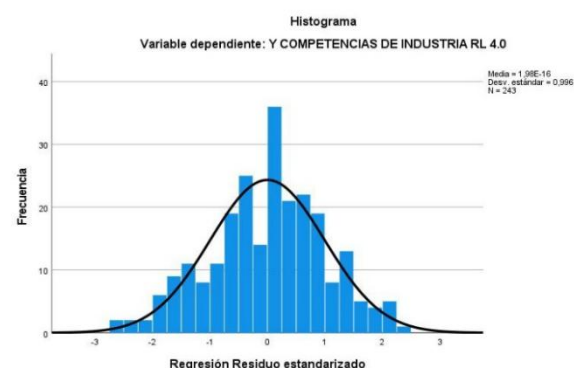


Figure 7

The histogram of standardized residuals

Source: Own Elaboration

The P–P regression plot of standardized residuals (Figure 8) demonstrates compliance with the linearity criterion, showing that the observations are distributed closely along the line of estimation, which represents an adequate model fit between generic and specific competencies.

Box 8

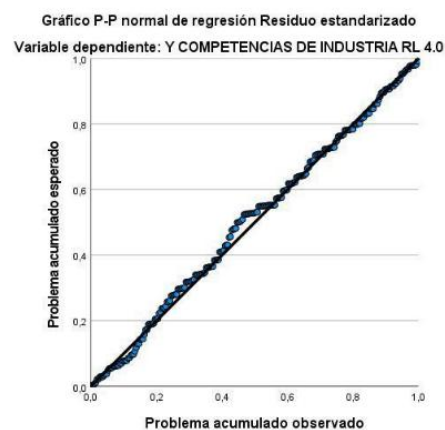


Figure 8

The P–P regression plot of standardized

Source: Own Elaboration

Finally, the results of the internal consistency reliability analysis (Figure 9) show that the instrument used was both consistent and valid: for X1 (*generic competencies*), Cronbach's alpha was 0.870; for X2 (*specific competencies*), the value was 0.932; and for the dependent variable E (*Industry 4.0*), the value was 0.763. All values exceeded the acceptable threshold of 0.70. This confirms that the items used to measure these variables are reliable and appropriate for assessing students' preparedness to face the challenges of Industry 4.0.

Box 9

	Alfa de Cronbach	rho_A	Fiabilidad compuesta	Varianza extraída media (AVE)
X1 COMPETENCIAS GENÉRICAS	0.870	0.871	0.902	0.606
X2 COMPETENCIAS ESPECÍFICAS	0.932	0.936	0.943	0.648
Y INDUSTRIA 4.0	0.763	0.783	0.848	0.584

Figure 9

Cronbach's alpha

Source: Own Elaboration

Therefore, regarding the analysis of predictive power using the Stone–Geisser Q^2 test (Figure 10), the model demonstrates predictive relevance for the specific constructs, yielding a value of 0.407. This result indicates a moderate predictive relevance ($Q^2 \geq 0.35$) within the analytical context, suggesting that the model predicts reasonably well, although not with excellent precision.

Box

Redundancia de constructo validada de forma cruzada

	SSO	SSE	$Q^2 (=1-SSE/S...$
X1 COMPETENCIAS GENÉRICAS	1476.000	1476.000	
X2 COMPETENCIAS ESPECÍFICAS	2214.000	2214.000	
Y INDUSTRIA 4.0	984.000	583.274	0.407

Figure 10Stone–Geisser Q^2 test*Source: Own Elaboration***Conclusions**

The diagnostic analysis reveals that students nearing graduation demonstrate an acceptable level of development in generic competencies, whereas specific competencies still represent a significant area for improvement. Among the most relevant findings, it was identified that 66.6% of respondents consider themselves prepared for problem-solving, reflecting a positive mastery of this generic competency. Meanwhile, 43.1% indicated that they almost always engage in analysis and decision-making, while 41.1% reported that they almost always develop planning and work organization skills. With respect to emotional intelligence, most students perceive that it is consistently fostered, which strengthens their ability to adapt to interdisciplinary environments.

On the other hand, the results for specific competencies were less favorable: 44.9% of respondents indicated that they only “sometimes” develop skills related to artificial intelligence and robotics.

Similarly, 46.1% reported that they “sometimes” work with big data and data analysis, revealing limited preparation in this area. Between 39% and 41% of the participants stated that they only “sometimes” apply skills in virtual reality, cyber-physical systems, cloud computing, and M2M communication, which demonstrates that their learning has been partial and lacks consistent practice. These results lead to the conclusion that, although students show strengths in generic competencies such as critical thinking, creativity, and problem-solving, they exhibit notable weaknesses in specific competencies directly linked to Industry 4.0. This situation represents a risk for their insertion into the labor market, as it limits their ability to interact effectively with the emerging technologies that characterize smart manufacturing environments.

Therefore, the findings confirm the need for higher education institutions to strengthen their curricula through strategies that enhance practice, innovation, and the real-world application of these technologies. The goal is to achieve a balance between generic and specific competencies and to ensure that future professionals are able to respond competitively to the challenges of the Fourth Industrial Revolution.

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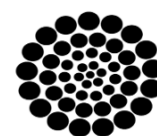
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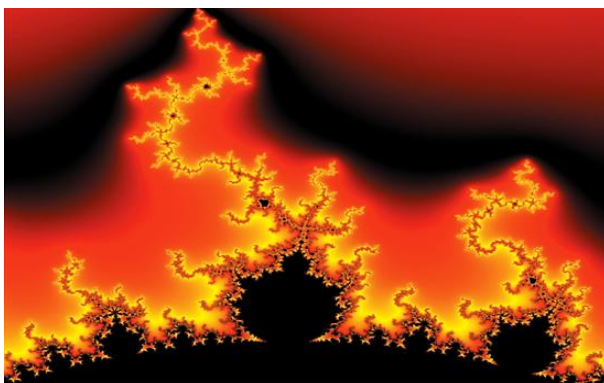


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ANN Artificial Neural Network

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