



Research article

Structural analysis of the future of the coffee industry in the Amazonas region using a MICMAC approach

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ABSTRACT

Currently there are problems in improving the competitiveness of the coffee industry in Amazonas, in this context the present research seeks to analyze the future behavior of the coffee industry through a structural analysis with MICMAC. For this purpose, 14 coffee guilds of Amazonas were interviewed, followed by an external and internal evaluation and a structural analysis with MICMAC. Subsequently, future events were analyzed and validated by experts. MICMAC identified in the short term the importance of local and regional governments supporting the coffee associations in order to achieve their objectives, such as increasing organic coffee production and expanding the coffee frontier; in the medium term, a coffee research center should be created; and in the long term, studies on the different microclimates should be carried out in order to achieve a high price and international demand. The motricity and dependency study contributed to the generation of eight probable events, of which five events are likely to occur by 2030 and a desirable scenario is the ideal.

1. Introduction

Currently, coffee cultivation is in the second position as one of the most important products worldwide. In Peru, coffee is the crop with the largest cultivated area of 345 thousand hectares [1], becoming the livelihood of more than 25 million coffee-growing families (Peruvian Chamber of Coffee and Cocoa, 2017). In 2016, parchment coffee was the country's main harvested crop, with a value of

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10.2% of the total harvested area [2]. For October 2019, among traditional products, coffee was the first agricultural product with the highest exports, with US\$89.3 million. However, in 2019, the exported agricultural volume decreased by 25.4% due to lower coffee sales to the United States of America, Germany and Belgium [3]. In 2022, a production of 352,812 tons was recorded, which represents 3% less than in 2021 and 5% less than in 2020 [1].

According to the National Action Plan for Peruvian Coffee PNA-Café, problems that impact the coffee value chain have been evaluated, which has led to the planning of objectives that refer not only to the agrarian issue but also to an approach that includes issues of quality management, environment, financing, positioning with respect to brand and commercial, as well as institutional development [4].

Products focused on biotrade with functioning value chains are one of the indicators for strengthening the value chain of the Concerted Regional Plan of the Amazon region. However, this indicator has not yet been used in Amazonas. Given the importance of using biological diversity in biotrade value chains, its use is proposed.

In view of this, it has been demonstrated that strategic planning for the future is one of the tools that helps to increase improvements in the commercialization of coffee cultivation, and through actions developed on an ongoing basis, the objectives established by the various coffee companies and guilds in the region are projected to be achieved in the future [5].

As a means for future studies, a tool used is MICMAC, which manages to reveal the influence and dependence of a variable with respect to all the others by examining all the interactions in the system. These interactions are analyzed in two dimensions: "impact" and "time" [6].

The MICMAC process takes a cross-impact matrix as input to identify the main variables that will play an important role in the future development of the system [7], which are the product of matrix analysis and their multiplication [8,9]. The MICMAC solution algorithm is achieved until a stable order of the impact factors is achieved [10,11]. In MICMAC, the importance of a variable is evaluated by the number and intensity of its relationships, and the variables strongly connected to the system are called "driving forces", which will be the ones affecting the whole system, and their future direction requires more attention [12,13].

In this context, it was determined that for this research it is essential to use this MICMAC prospective tool to analyze the possible future developments that may arise within the coffee industry in the Amazon region, as well as to determine the variables that intervene to improve efficiency in order to increase coffee crop yields and the income of producers. Giving place to the interested organisms to pay attention to the production of coffee and the efficiency decisions that is a key indicator to alleviate poverty and food security, finally of those variables that are obtained to carry out their respective validation for a greater reliability of the instruments applied to the investigation [14].

It is important from the result of the obtained variables that they go through a validation method. The Dephi methodology is a validation technique through the consensus of expert opinion, refining and improving strategies based on a planned problem, a method that offers great potential in a context of limited resources in which it is necessary to apply an approach that presents a structuring to solve certain complex problems through expert judgment and is often used in future forecasts in the drafting of strategies [15,16].

Currently the Amazon region does not have a prospective study on the coffee industry, which is why it is important to analyze the competitiveness diamond of nations by Michel Porter, an analysis of Strengths, Opportunities, Weaknesses and Threats of the coffee industry to finally perform a structural analysis through a MICMAC approach, to select strategic variables of importance to improve the competitiveness of the coffee guilds in the future, the same that should be validated by experts for greater reliability.

2. Literature review

2.1. Analysis of the coffee environment

Coffee occupies the second place among the most widely traded agricultural products at a global level in terms of quantity, being an element of great relevance, at the level of crude oil, being the most valuable agricultural product in world history. Every day, more than 2250 million cups of coffee are consumed worldwide [17].

Peruvian coffee is recognized as one of the main export products and plays an important economic and social role in the country. According to Palomino et al. [18], coffee is the main agricultural product exported from Peru. Globally, coffee production is divided into four varieties: Arabica or Arabica, Robusta, Liberica and Excelsa but the Arabica and Robusta varieties account for 98% of global coffee consumption, while the remaining two have marginal consumption and are considered of lower quality [19].

Coffee is widely consumed around the world and its trade is constant, due to its quality and reputation in international markets; is one of Peru's main export products and its value is directly related to cup quality, which is influenced by post-harvest treatments, especially drying, as mentioned by Guevara-Sánchez et al. [20]. Specialty coffees, which meet high cup quality standards (>84 points), are increasingly in demand in the global market, according to Tolessa et al. [21]. This allows Peru to offer its coffee to markets in the Andean Community, Mercosur, Europe, Asia and the United States, taking advantage of its quality potential and comparing cup quality, as indicated by Ramos et al. [22].

In recent years, coffee cultivation in Peru has experienced a decline in bean production due to the crisis caused by the outbreak of the disease known as roya in 2013, which affected most coffee plantations and revealed the lack of adequate training on the part of many producers to cope with it [23].

Coffee quality is a crucial factor for accessing better markets, but to achieve such quality, medium-sized producers often face difficulty in accessing adequate equipment, as noted by Rosas-Echevarría et al. [24]. In addition, organic coffee production, backed by certifications, is of great importance worldwide and currently accounts for 8% of the global market, according to Canet et al. [25].

In Peru, coffee production takes place in 11 regions, covering 67 provinces and 338 rural districts [26]. Among these regions,

Amazonas ranks fourth in importance as a coffee growing area in the country [1] and in third place according to Reyna [27] and the provinces with the highest coffee production are Utcubamba, Luya and Rodríguez de Mendoza, as noted by Torres & Siche [28]. However, further studies are needed to determine this position. Key external factors include political, economic, social, technological and ecological forces (PESTE) [29].

2.2. Porter's competitiveness diamond

Porter's diamond of competitiveness of nations proposes competitive advantages and organizational strategies. For an organization to be competitive, it must be framed in four points: factor conditions, demand conditions, related support and auxiliary sectors, strategy, structure and rivalry between companies [30].

2.3. Strengths, weaknesses, opportunities, opportunities and threats analysis

This acronym comes from the acronym SWOT (strengths, weaknesses, opportunities, threats). SWOT analysis is a tool that provides a picture of the current situation of the object of study (person, company or organization, etc.), thus providing an accurate diagnosis that allows decisions to be made in accordance with the objectives and policies formulated. The relevance of using a SWOT analysis matrix is that it enables us to search for and methodologically analyze all the variables involved in the area to be studied, in order to have more and better information when making decisions [31,32].

2.4. Uses of desirable scenario building tools

One of the tools that contribute to the construction of desired futures is strategic foresight, which seeks to build the desired future [33]. It is important to know that strategic planning and foresight are complementary to build future scenarios of the organizations under study, characterized by a complementary relationship. The results obtained from the strategic plan lead to the use of foresight, in which a current diagnosis of the organization's situation is made based on past experiences and is able to guide them to a better future [34].

2.5. MICMAC method

The Cross-Impact Matrix (CIM) was conceived by Gordon and Helmer in 1966 and later simplified by Vester in 1976. Although widely used for decades, this method could only assess the direct impacts of interactions between variables. In the 1970s, Michael Godet attempted to improve this methodology by developing the MICMAC method (Multiplication of Cross-Impact Matrices Applied to Classification), which sought to address the shortcomings of the original CIM approach. For the generation of the cross matrix MICMAC can use information analyzed in PESTEL, Porter's forces and SWOT [9].

The method is based on an impact matrix (IM) that works on matrix multiplication [35,36]. The entries of the main diagonal of the MICMAC matrix are filled with 0 because there is no direct impact of an impact factor on itself. Considering the indirect impact, the MI raised to the power "n" results in a matrix containing the number of indirect impacts with the chain length "n". The multiplication process is repeated until the stabilized value of influence and dependence of the variables is obtained. The main diagonals of all subsequent matrices may not be 0 because there may be indirect impacts of an impact factor on itself [37].

Finally, variables were ranked according to their influence value (known as Active Sum (AS)) and dependence values (known as Passive Sum (PS)), where these values refer to the sum of their row entries and the sum of their column entries, respectively [38]. The higher the row/column sum was, the higher the ranking of the corresponding variable was. The ranking could change as the power of the matrix increased (the longer the chains of indirect impacts). The ranking stabilized after a certain number of multiplication steps. Each variable was assigned to a unique position on the graph according to its AS and PS values to interpret the results according to four quadrants: I: Linking variables, II: Independent variables; III: Autonomous variables and IV: Dependent variables [36] and according to their position according to Castellano [39].

2.6. Use of MICMAC in the coffee industry

At the international level, studies such as those of Ñañez et al. [40], in their prospective study for 2030 for the Biocafé cooperative, established timely strategies for the sustainability and competitiveness of this organization, using MICMAC software to identify strategies in an ideal scenario such as cooperativism in action, allowing the cooperative to be a leader from production to export, adapting to the needs of the consumer through technological innovation.

On the other hand, in the prospective analysis on the impact of export coffee production on the future of Tarrazú (Costa Rica), the prospective focused on the possible futures for the economic, political and social progress of Tarrazú; marking the continuity and evaluating improvements that should be applied to generate greater development of the area [41].

National research in Peru [42] proposed a strategic coffee plan, concluding that "... to achieve sustainable development, Peruvian coffee must have regulatory and support frameworks that promote the organization of producers, as well as access to state-of-the-art technology for the entire value chain. In this sense, the strengthening of the National Coffee Council, as the representative entity of Peruvian production, will serve as the basis for promoting the development of coffee through the implementation and follow-up of the current proposed strategic plan, with the aim of consolidating Peru as one of the three main coffee producing countries in the world by

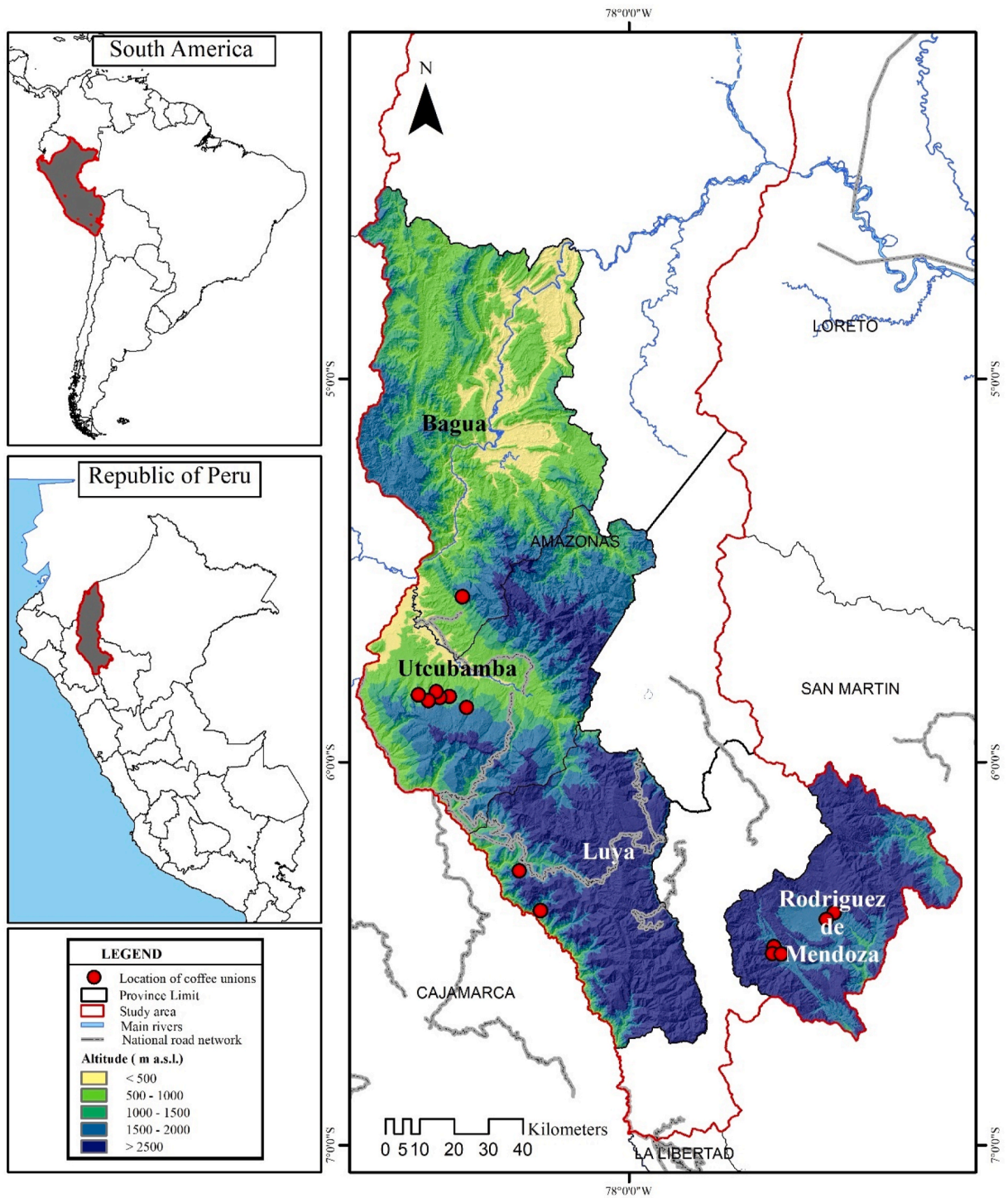


Fig. 1. Location of origin of the coffee growers' associations.

the year 2023".

Years later, Egas et al. [43] implemented a strategic plan for coffee in Peru, concluding that "long-term objectives should be oriented to the generation of jobs, achieving sales value, and its profitability. In addition, they highlight that among the main strategies to be implemented: positioning Peruvian Coffee in international markets, investing in research and development, certifying the organic coffee production chain internationally, among others."

Becerra et al. (44b) developed a strategic plan for the coffee industry in the Cusco region, to achieve the development of Cusco

Table 1
Interviews with coffee growers' associations in the Amazon region.

N°	Name of Coffee Growers Guild	Province	District	Legal representative
1	Café Monteverde S.A.C.	Rodríguez de	San Nicolás	Zevallos Majino Rafael
2	Cooperativa Agraria Rodríguez De Mendoza	Mendoza		Bocanegra Cepeda Ramiro Alex
3	Cooperativa Agraria Y De Servicios Múltiples La Flor Del Café De Rodríguez De Mendoza Ltda.			Peláez Muñoz Manolo
4	Asociación De Productores Agropecuarios Valle Verde De Rodríguez De Mendoza			Zevallos Majino Rafael
5	Cooperativa Agraria Cafetalera Alta Montaña		Huambo	Grandes Muñoz Eder
6	Cooperativa Agraria y Forestal del Valle de Huayabamba LTDA		Rodríguez De Mendoza	Francisco Peláez Muñoz
7	Cooperativa Agraria Cafetalera Bagua Grande Limitada	Utcubamba	Utcubamba	Mendoza Cienfuegos Edgar Jesús
8	Cooperativa Agraria Central De Productores Agropecuarios Del Amazonas – CEPROAA		Cajaruro	Díaz Sánchez Cily Yudixa
9	Cooperativa Agraria Ecológica Cafetalera De Lonya Grande-CECAFE		Lonya Grande	Sánchez Olivos Jose Elmer
10	Cooperativa De Servicios Múltiples Juan Marco El Palto-JUMARP			Zumarán Carranza Rodolfo
11	Cooperativa Agraria Cafetalera Valle Alto Ltda.			Fernández Campos Jheny Darlit
12	Cooperativa Agraria Cafetalera Laguna De Los Cóndores	Luya	Providencia	Sánchez Bustamante Eber Mercedes
13	Cooperativa Agraria Cafetalera Ocumal		Ocumal	Huamán Reynoso Pepe Luis
14	Cooperativa Agraria APROCAM	Bagua	Bagua	Zulueta Vásquez Mario

coffee growing, establishing a series of strategies to locate niches by increasing cooperation and participation in the markets to which its exports are directed, as well as in the markets of the Cusco region. To this end, they proposed "improving the quality of coffee using international standards and seals of guarantee, as well as investing in research, training and modern machinery. Finally, it was necessary to create strategic alliances between coffee producers in order to establish solid organizations and negotiating power with vendors and clients.

Similarly, Berrocal et al. [45] proposed strategies for the coffee industry in Junín and included disseminating their product in the international market by participating in fairs, contests, business rounds, making strategic alliances with specialty coffee certifiers and finally implementing savings education to generate research in technologies through the construction of the Coffee Institute. "These strategies were aimed at recovering national leadership in coffee production for the Junín region."

With respect to studies of prospective strategic plans at the national level, Castellano [39] carried out a prospective strategic plan for the Jayanca agroexport company in Chiclayo, applying a Michel Godet model using MICMAC software, which made it possible to propose a series of guidelines for positioning and growth in order to improve its competitiveness through a future scenario, which were validated by means of a Delphi methodology.

2.7. Delphi method

The main purpose of the Delphi method is to reach a general consensus or convergence of ideas on a specific topic, especially when evidence is sparse or controversial. Its fundamental elements include anonymity to prevent the influence of particular opinions, iteration that allows for changes in participants' perspectives, controlled feedback of individual and aggregate responses, and the use of statistical analysis to provide a measure that summarizes the degree of agreement [46].

3. Material and methods

3.1. Declaration of ethics

The informed consent of the participants was verbal. This process not only complied with established ethical regulations and respect for the autonomy of each participant. They were provided with a detailed and understandable explanation about the purpose of the study, the procedures involved and the benefits, as well as their rights as participants. We ensured that each participant fully understood this information, offering them the opportunity to ask questions and clarify doubts before expressing their consent.

This study was carried out in accordance with the standards of the Ethics Committee of the Toribio Rodríguez de Mendoza National University, for the collection of information from the coffee growing unions of the Amazonas region, approved with the identification number CIEI-N°0045 dated November 6, 2023. Furthermore, before administering the questionnaires, participants were informed of the objectives of the research and were assured that the confidentiality of their personal data would be respected.

3.2. Study location

This research was carried out with the participation of 15 representatives of coffee growers' associations from the Amazon region,

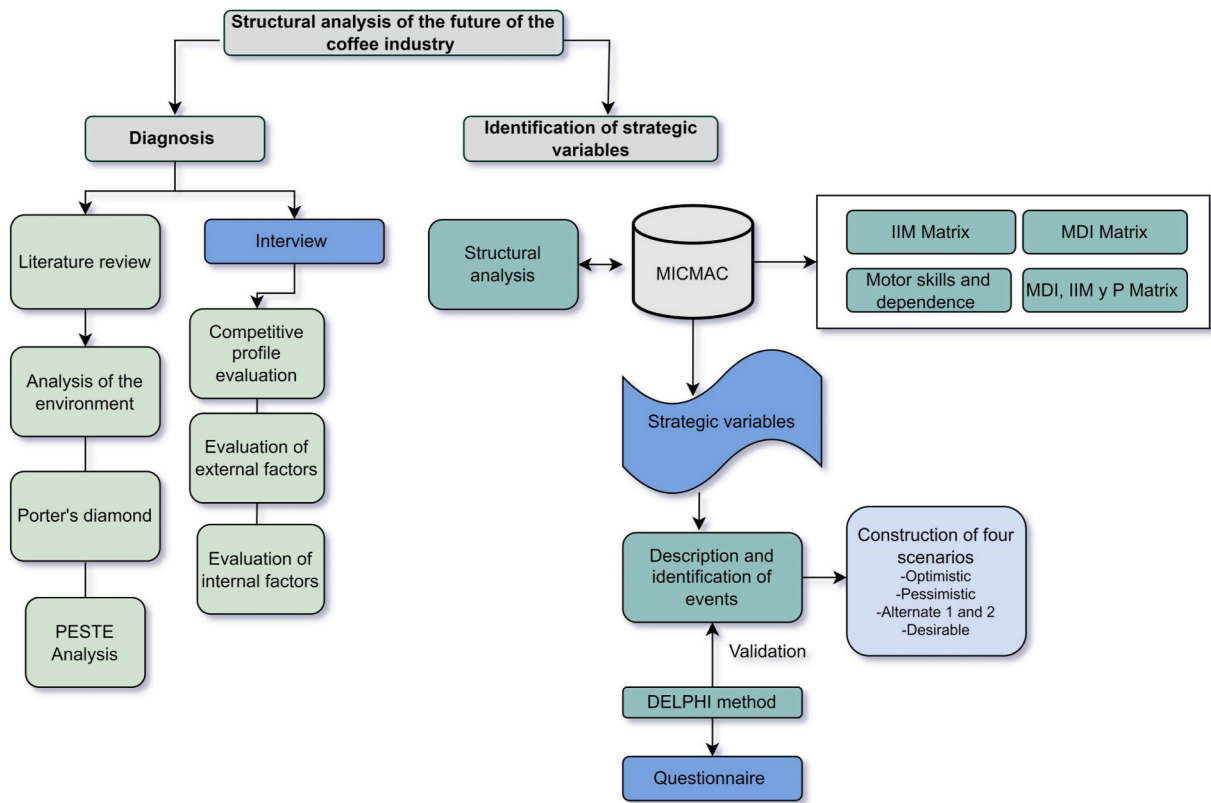


Fig. 2. Methodological flowchart.

with the participation of nine districts of origin (Fig. 1).

The population consisted of 28 representatives of coffee associations and cooperatives from the Amazon region, which are made up of groups of more than 50 coffee growers. The sample was identified through the formula described by Bustamante [47] for finite populations, which consisted of 14 representatives of coffee guilds (general managers of each guild) of the Amazon region. The sampling was carried out according to selection criteria by inclusion determined by those provinces of the Amazon region that are representative of coffee production, such as Rodriguez de Mendoza, Utcubamba, Luya and Bagua, which exceed annual production by more than 2500 tons.

According to the inclusion and exclusion criteria, 14 coffee guilds were selected to form part of the study (Table 1).

The study was conducted in a descriptive and propositional research design, considering that through the use of techniques and procedures it allowed us to analyze and propose guidelines to solve the problems that may arise. In this study there were no treatments or manipulated variables and it was conducted under the following methodology (Fig. 2).

3.2.1. Diagnosis of the environment of the coffee industry in the Amazon region

A literature review was carried out to gather information on the analysis of the environment of the coffee industry to be included in Porter's diamond and for the PESTE analysis [29].

An interview was conducted in 2022 as a data collection technique to obtain qualitative information. The interview was conducted with each of the representatives of the coffee guilds of agrarian cooperatives and associations of the Amazonas region in the coffee growing sector. The main topics of dialogue were the situation of the coffee value chain from production, post-harvest, the current state of coffee commercialization and target markets. The interviews were conducted virtually using the virtual tool Google Meet with a maximum duration of 1 h. With the information from the interview, the competitive profile and the evaluation of external and internal factors described by D'Alessio [29] were determined.

3.2.2. Identification of strategic variables

The information gathered was organized into a matrix for structural analysis with the construction of the weighting matrix using the MICMAC program to determine the short-term variables (MDI Matrix), medium-term variables (IIM Matrix), long-term variables (MDI, IIM and P Matrix) and key variables (Motor skills and dependence).

Through the construction of the matrix of weights in the MICMAC program, the processing was carried out, which was based on the influences and dependencies of the variables to select and establish which are the most important key variables.

The method is based on an impact matrix (IM) that works on matrix multiplication [[35,36]]. The entries of the main diagonal of

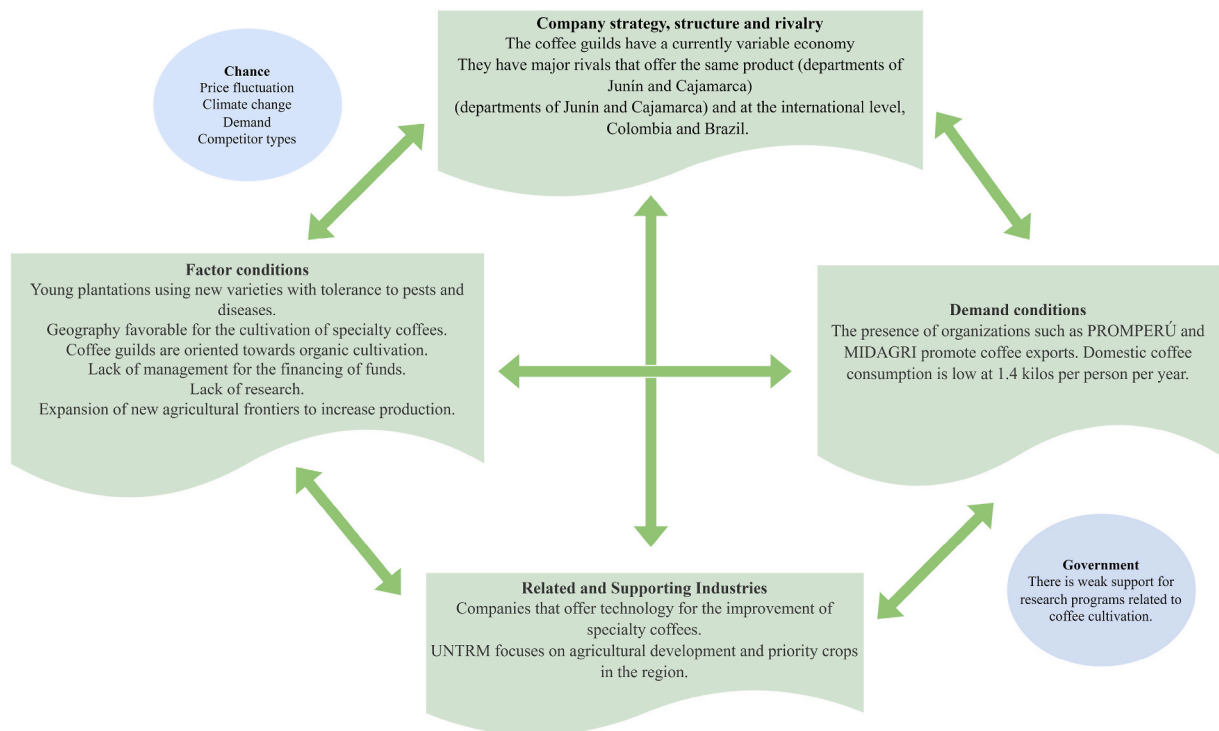


Fig. 3. Diamond of competitiveness of nations by Michel Porter.

the MICMAC matrix are filled with 0 because there is no direct impact of an impact factor on itself. Considering the indirect impact, the MI raised to the power "n" results in a matrix containing the number of indirect impacts with chain length "n". The multiplication process is repeated until the stabilized value of influence and dependence of the variables is obtained. The main diagonals of all subsequent matrices may not be 0 because there may be indirect impacts of an impact factor on itself [37].

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3.2.3. Description of events and validation

The description of probable events to 2030 was carried out and validated through the application of a questionnaire judged by 5 experts using the Delphi technique. The questionnaire was structured with a scoring scale between 0% and 100%. Achieving the identification of probable events in 2030.

3.2.4. Scenario construction

With the results obtained, the future scenarios for 2030 were drawn up, considering the construction of an optimistic and pessimistic scenario. For this purpose, it was important to generate a map with the Peter Schwartz axes with the information of the strategic variables obtained, whose construction determines the four possible scenarios where each of the ideas is located depending on the approach of each of the scenarios and variables evaluated [48].

3.3. Data analysis

For the prospective analysis, scales established by the MICMAC software were taken into account, where the values of Strong = 3, Moderate = 2, Weak = 1, Null = 1, Potential = P [49] were established.

Subsequently, the description of events and prospective strategies began with a questionnaire weighted from 1 to 100% and was applied to the experts. The results were statistically processed using R software version 4.3.2. For the identification of strategic variables and key actors, the MICMAC and MACTOR forecasting software was used.

Table 2
Exports - Destination countries January–December 2022.

N°	COUNTRY DESTINATION	OB VALUE (US\$)	WEIGHT (QQ)	AVERAGE PRICE (US\$/QQ)
1	United States	283,686,860.77	1,188,445.89	238.70
2	Germany	258,252,664.83	1,089,770.15	236.98
3	Belgium	155,529,281.27	653,068.32	238.15
4	Colombia	76,534,020.98	499,779.76	153.14
5	Sweden	59,095,394.79	269,687.41	219.13
6	Canada	55,792,494.41	237,429.43	234.99
7	Italy	47,272,418.53	193,911.30	243.78
8	United Kingdom	46,828,658.20	194,010.02	241.37
9	Netherlands	42,158,567.65	163,348.01	258.09
10	South Korea	35,806,466.91	147,569.78	242.64
11	France	33,411,881.80	143,010.14	233.63
12	Japan	31,654,490.25	121,892.76	259.69
13	Spain	16,636,774.85	79,476.59	209.33
14	Australia	11,554,412.19	44,698.08	258.50
15	Mexico	7,197,232.78	32,852.20	219.08
16	Portugal	5,594,532.95	23,225.28	240.88
17	Jordan	5,423,316.00	21,450.00	252.84
18	Russian Federation	5,298,406.47	23,251.24	227.88
19	Finland	4,473,647.45	18,203.00	245.76
20	Ireland	4,390,342.10	18,700.61	234.77
21	New Zealand	4,275,348.55	17,396.72	245.76
22	Norway	4,264,001.36	17,014.03	250.62
23	China	3,969,415.17	15,426.39	257.31
24	Malaysia	3,931,459.00	13,610.87	288.85
25	Ecuador	3,068,162.71	16,969.13	180.81
26	Vietnam	3,031,578.00	12,639.46	239.85
27	Greece	2,767,882.85	11,233.48	246.40
28	Denmark	2,583,196.81	10,347.67	249.64
29	Costa Rica	2,004,166.00	14,896.41	134.54
30	Argentina	1,630,575.65	5792.61	281.49
31	Chile	1,452,814.77	6271.74	231.64
32	Taiwan	1,383,124.34	4575.08	302.32
33	Poland	1,381,929.00	5849.57	236.24
34	United Arab Emirates	1,352,782.45	4986.70	271.28
35	Panama	1,304,406.00	5613.20	232.38
36	Latvia	1,134,041.00	4719.11	240.31
37	Switzerland	1,069,874.71	4269.54	250.58
38	Saudi Arabia	910,534.00	2797.50	325.48
39	Estonia	793,587.78	3390.00	234.10
40	Hong Kong	715,920.82	2851.63	251.06
41	South Africa	688,080.98	2947.50	233.45
42	Antarctica	493,428.00	2062.50	239.24
43	Singapore	484,761.93	1969.89	246.09
44	Ukraine	407,550.00	1665.00	244.77
45	Turkey	349,090.65	1237.50	282.09
46	Israel	345,541.00	1282.50	269.43
47	India	138,623.85	1125.00	123.22
48	Lithuania	114,930.00	412.50	278.62
49	Iceland	111,818.45	434.78	257.18
50	Uruguay	61,892.00	217.50	284.56
51	Bulgaria	25,244.00	16.18	1560.09
52	Austria	14,085.00	18.00	782.50
Total general		1,232,851,712.01	5,357,819.67	230.10

Source: SUNAT-VERITRADE

4. Results and discussion

4.1. Analysis of the competitiveness diamond of nations by Michel Porter

In the competitiveness diamond of nations planned by Porter, the competitiveness of nations was related to the production of coffee from Amazonas (Fig. 3).

Factor conditions: Peru has geographical characteristics for coffee production. The Amazonas region has different altitudinal levels and different microclimates, which allows for the diversification of the plantation of different varieties of coffee. In addition, the Amazonas region has large areas to expand the agricultural frontier.

Demand conditions: Coffee consumption worldwide has a growing tendency, so there is an increasing demand for more and more production. Peruvian coffee is one of the country's most exported products, accounting for 1.4% of total exports [50]. The demand for

Table 3
Exports by company january–december 2022.

Company	Fob Value (US\$)	Weight (Qq)	Average Price (US\$/Qq)
Perales Huancaruna S.A.C.	227,111,108.53	953,864.00	238.10
Olam Agro Perú S.A.C.	105,199,131.32	473,350.02	222.24
Comercio Amazonia S.A.	103,832,282.87	430,892.99	240.97
Ed&F Man Volcafe Peru S.A.	67,592,272.86	255,259.46	264.80
Compañía Internacional Del Cafe Sociedad Anónima Cerrada	56,884,890.62	244,206.37	232.94
H.V.C.Exportaciones Sac	45,830,470.93	181,478.35	252.54
Coop. De Servicios Múltiples Cenfrocafe Peru	29,336,789.35	131,344.61	223.36
Negrisa S.A.C.	26,449,467.53	110,514.98	239.33
Coop. Agraria Cafetalera Alto Mayo	26,301,621.43	122,353.72	214.96
Cooperativa Agraria Norandino Ltda.-Coop.Norandino	20,829,405.13	91,326.41	228.08
Expoimp Beviperu Eirl	18,599,483.53	113,547.15	163.80
Exportadora Romex S.A.	17,184,369.49	72,021.74	238.60
Cafe Monteverde Eirl	16,422,716.10	68,900.27	238.35
Pronatur S.A.C.	16,036,262.18	75,915.80	211.24
M & V Rivas E.I.R.L.	14,906,409.53	70,368.93	211.83
Rainforest Trading S.A.C.	13,681,105.59	56,447.20	242.37
Valley Coffee Trading S.A.C.	13,193,651.92	55,875.98	236.12
Cooperativa De Servicios Múltiples Sol&Cafe Ltda.	12,448,762.24	51,985.41	239.47
Cooperativa Agraria Rodriguez De Mendoza	12,165,802.23	49,397.25	246.29
Finca Churupampa Peru S.A.C.	12,124,479.28	47,365.67	255.98
Cooperativa Agraria Cafetalera "La Prosperidad" De Chirinos	11,671,034.30	48,866.87	238.83

Peruvian coffee is divided into the export group (95%) and domestic consumption (5%) [43].

There are 239 Peruvian coffee exporting companies, where the company Perales Huancaruna S.A.C. obtained a higher export, 953,864 quintals at a price of US\$238 per quintal from January to December 2022. Placing it as the company with the highest production and supply. At the national level, reports from January to December 2022 indicate that exports were to the United States and Germany with an FOB value of \$ 283,686,860.77 and \$ 258,252,664.83 respectively, with a total of 1188445.89 quintals for the United States and 1089770.15 quintals for Germany, achieving a sale of \$ 238.70 \$/QQ and \$ 236.98 \$/QQ for both the United States and Germany [1] (Table 2).

Related and support sectors: Due to the fact that technologies are at the forefront in the world, it is necessary to make use of them in order to compete with countries that offer the same product, which is why it should have the support of the state, institutions that contribute in the region with training and improve the coffee production chain are: The Ministry of Agriculture (MIDAGRI), PROMPERÚ, SIICEX, SENASA, INIA, PROMPEX, SUNAT, MEF, AGROBANCO, JNC, ONGS pro coffee, ADEX, SIERRA EXPORTADORA, APECAFÉ, Universities both national and private, research institutes, Peruvian Chamber of Coffee and Cocoa.

In addition, the important actors in the Amazonas region for the growth and development of the coffee sector are the companies that offer seeds for planting, fertilizers and adequate tools. As well as the presence of cooperatives and savings and loan banks for coffee growers, with financial support for the acquisition of inputs necessary for the production of coffee crops.

Strategy, structure and rivalry of the companies: With the presence of climate change the crops have suffered a decline, however, coffee has continued to improve with respect to demand over the years. In addition, with the introduced coffees it is possible to obtain specialty coffees increasing the price for the product offered, which contributes to the coffee growers having a special interest in the production of this type of coffees increasing their quality and volume of production.

It is also important to mention the main coffee exporting companies according to the SUNAT-VERITRADE report, in first place is Perales Huancaruna S.A.C., in second place is OLAM AGRO PERÚ S.A.C., in third place is Comercio Amazon S.A.C., in third place is OLAM AGRO PERÚ S.A.C., in third place is Comercio Amazonas S.A. with a participation in FOB value of \$ 227,111,108.53; \$ 105,199,131.32 and \$ 103,832,282.87 respectively, in terms of pesos in QQ the values are 953,864.00; 473,350.02; 430,892.99 with average prices of \$/QQ 238.10; \$/QQ 222.24 and \$/QQ 240.97 respectively at the national level (Table 3).

4.2. Analysis of the political, economic, social and technological environment (PESTE)

4.2.1. Political, governmental and legal forces (P)

The coffee sector in Peru operates within a structure that involves both public and private institutions, which play a crucial role in the development of this important industry. These institutions include governmental entities, nongovernmental organizations (NGOs), private companies, financial entities, cooperation agencies, and regional and local organizations. Together, they carry out various activities to promote coffee cultivation.

However, the lack of integration, coordination and collaboration between these entities has generated difficulties in achieving the objectives of establishing a solid and dynamic coffee sector. As a consequence of this lack of synergy, the sector faces challenges in terms of leadership and joint development, which limits its potential for growth and expansion.

Within the governmental forces, we have the participation of the Ministry of Agriculture, which is the governmental entity in charge of formulating and executing agricultural policies, including those related to the cultivation and production of coffee, and the National Coffee Institute (INACAFE), which has the function of promoting research, production, industrialization and

Table 4
External factors evaluation matrix EFEM.

Success factors	score	value	weighting
Opportunities			
Worldwide trend in coffee consumption	0.03	3	0.09
Production of organic coffee for select markets	0.05	4	0.2
Diversity of altitudinal zones for coffee production	0.15	3	0.45
Access to financing through competitive funds	0.06	2	0.12
Increase in coffee growing zones	0.12	2	0.24
Development of technologies to improve coffee quality	0.08	4	0.32
Creation of a coffee research center	0.08	3	0.24
Sub total	0.57		1.66
Threats			
Variability of international coffee prices	0.05	2	0.1
Climate change	0.08	3	0.24
Crop shift to alternative crops	0.06	2	0.12
Coffee rust and coffee berry borer pests and diseases	0.06	3	0.18
Increased skills and competencies	0.05	2	0.1
Age of the producer	0.07	4	0.28
Difficult access to government support	0.05	2	0.1
Failure to meet demand rejection of market	0.01	2	0.02
Sub total	0.43		1.14
Value	1.00		2.8
4. Responds very well 2. Responds average			
3. Responds well 1. Responds poorly			

commercialization of coffee in the country. In addition, the SUNAT regulates aspects related to the import and export of coffee.

On the other hand, we also have the National Coffee Council, which was established in 2002 by a resolution of the Ministry of Agriculture and is composed of the Peruvian Coffee and Cocoa Chamber, the National Coffee Board and the Ministry of Agriculture, the latter being in charge of presiding over it. It is a consultative body that lacks resources for its operation and to date has had limited participation and has not achieved outstanding results in the development of the coffee sector.

The National Coffee Board is a trade union entity that was formed in 1993 and represents 58 coffee producer organizations. Its main function is to manage projects financed by international cooperation sources and competitive funds, with the purpose of strengthening its members and promoting the development of the certified coffee chain. It also has a branch office in the Selva Central region.

The Peruvian Chamber of Coffee and Cocoa represents coffee and cocoa exporting companies, whose members are responsible for 80% of the country's coffee exports. This entity administers projects financed by competitive funds, with the objective of strengthening the coffee and cocoa chain. They also have a coffee quality laboratory where they offer training courses.

Regarding the laws that support and promote the development of the coffee sector, the following laws are in place:

Law 29972, enacted on December 22, 2012, promotes the inclusion of agrarian producers through cooperatives, which has led many producer associations to become coffee cooperatives.

4.2.2. Economic and financial forces (E)

In the last 12 years, the national production of green coffee beans has decreased by 31.3%, from 331,547 tons in 2011 to 227,750 tons in 2022. This reduction is attributed to the decrease in the area allocated to coffee cultivation in the country, which has gone from 425,000 ha in 2012 to 380,000 ha in 2022. In addition, the average yield per hectare decreased by 23%, from 780 kilos per hectare in 2011 to 600 kilos per hectare in 2022. Other factors that have contributed to this situation include the increase in production costs, the exclusion of coffee cultivation from credit programs, the lack of professionalism of some government actors, distrust among various actors, political instability, and the lack of a solid public-private institutional framework, among other challenges [51].

4.2.3. Social, cultural, and demographic forces (S)

Seventy percent of the area dedicated to this crop has some seal of sustainable production, which is equivalent to approximately 260,000 ha. Currently, there are 140,000 ha certified as organic and another 59,000 ha in the process of transition to this certification [51].

There has been a significant increase in collaboration among coffee-growing families, evidenced by the formation of 190 cooperatives and 80 associations. These coffee cooperatives are promoting agroforestry practices and the migration of coffee-growing areas to high and medium altitudes [51].

4.2.4. Technological and scientific forces (T)

The technological and scientific forces in Peruvian coffee growing are related to the application of technological advances and scientific knowledge to improve coffee production, quality and sustainability. The following are some of these forces: scientific research, genetic improvement, agricultural technologies, processing and postharvest, use of data and analysis, certifications and traceability, and knowledge transfer.

Table 5
Internal factors encountered within the coffee unions.

Success factors	score	value	weighting
Strengths			
Human group of the cooperative	0.12	4	0.48
Production of organic coffee	0.08	4	
High international quotation and demand	0.08	4	0.32
Worldwide image in the fulfillment of contracts	0.09	3	0.27
Cooperatives with good infrastructure	0.09	4	0.36
Organic coffee certification	0.09	4	0.36
Good environmental practices	0.05	3	0.15
Trained personnel	0.05	4	0.2
Commitment of the personnel working in the institution	0.05	3	0.15
Sub total	0.7		2.29
Weaknesses			
Lack of personnel for technical assistance in the field	0.07	1	0.07
Lack of government support	0.06	1	0.06
Low level of research	0.09	1	0.09
Expansion of the coffee frontier	0.08	1	0.08
Sub total	0.3		0.3
Value	1		2.59
4. Responds very well 2. Responds average 3. Responds well 1. Responds poorly			

4.2.5. Ecological and environmental forces (E)

The manager of the National Coffee Board (JNC), Lorenzo Castillo, indicates that the entire coffee industry in Peru is facing the need to adapt to climate change, including low, medium and high areas [51a].

According to data from the World Agroforestry Center (ICRAF), it is predicted that by the year 2030, approximately 40% of the area dedicated to the cultivation of Arabica coffee in Peru, in regions below 1000 m above sea level, will lose its suitability for cultivation. The areas most affected by this situation are San Martín, Junín, Huánuco, Amazonas and La Convención (Cusco) [51a].

Among the reasons that have led to the reduction in the area dedicated to coffee cultivation in Peru are the aging of 70% of coffee trees (more than 20 years old), the substitution of coffee areas for other more profitable crops such as cocoa, citrus and papaya, and illicit crops. The limited access of producers to innovation and agricultural technical assistance is also noted [51a].

In addition, the yellow rust plague affected 26% of Peru's current coffee production, estimated at 380,000 ha, and generated losses of more than 330 million soles for small producers in 12 coffee-growing regions [52b].

4.3. Evaluation of key success factors

The study of external factors, the competitive profile and the evaluation of internal factors were carried out, and the following matrices and their respective evaluation are presented below.

4.3.1. External factors evaluation matrix (EFEM)

Of the total number of factors identified as opportunities, two were assigned a score of 2, which means that they respond in an average manner; 3 factors were assigned a score of 3, showing that they are factors that are responding adequately to the opportunity; and 2 factors were assigned a score of 4, which means that they are responding very well to the opportunities (Table 4).

Likewise, 8 threats were identified, where out of 5 factors obtained a rating of 2 that corresponds to an average response, which indicates that there are points to work on for the improvement of the coffee guilds. On the other hand, 2 factors were assigned a score of 3, indicating that they respond well, and one factor was assigned a score of 4. Of the 15 factors found as opportunities and threats, a total weighted value of 2.80 can be obtained. This value indicates that the coffee sector is above average, which means that the coffee guilds are responding excellently to the opportunities generated and that there is good management of threats. The strategies of the guilds allow the exploitation of the opportunities, minimizing the effect of external threats (Table 4). Contrary situations were presented in the diagnoses made by Becerra [44], who reported weights of 2.00 and 2.58, respectively, for the case of the coffee situation in Cusco and Colombia, demonstrating that they are not adequately capitalizing on opportunities and lack of management of threats.

4.3.2. Internal factors evaluation matrix (IFEM)

For the industry of the coffee guilds of the Amazon region, 13 determinants of success were identified, which were distributed into 9 strengths and 4 weaknesses. The weighted value obtained is 2.59, indicating that the coffee guilds are taking good advantage of the strengths and managing to neutralize the weaknesses (Table 5). The weighting reported is similar to that reported by the strategic plan of the coffee industry of the province of La Mar - Ayacucho with 2.50. The weighting obtained in the research indicates that at present, the majority of coffee guilds are taking advantage of the strengths in a good way. This is justified by the high international demand for the product and the presence of consumers who demand high levels of quality, placing it in fourth place nationally with a growth of +7.6%, with 53,941 tons in production within the top 5 [1].

Within the threats, we find an increase in competencies and weaknesses and a lack of government support. Similar situations were

Table 6
Matrix of influences and dependencies of variables MICMAC.

To rate horizontally the level of influence of a variable on the others and vertically the level of dependence of a variable on the others.

	Human group in the guild	Organic coffee production	High price and international demand	Corporate image	Guilds with good infrastructure	Organic coffee certification	Good environmental practices	Trained personnel	Staff commitment	Weaknesses	Technical assistance in the field	Lack of government support	Low level of research	Expansion of the coffee frontier	Opportunities	Domestic coffee consumption	Entry to selected markets	Diversity of microclimates	Access to financing	Increased production	Development of technologies	Creation of a coffee research center.	Threats	Variability of international coffee prices	Climate change	Change of crop to alternative crops	Pests and diseases	Increasing skills and competencies	Producer's age	Difficult access to government support	Meeting demand	INFLUENCE	
Strengths																																	
Human group in the guild (HGG)	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Organic coffee production (OCP)	0	0	P	3	0	3	2	0	0	0	0	0	2	2	3	1	2	1	2	2	2	2	0	0	0	0	0	0	0	0	0	0	23
High price and international demand (HPID)	0	3	0	2	2	3	0	0	0	0	0	0	2	2	3	1	1	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	24
Corporate image (CI)	1	3	0	0	0	2	1	0	2	0	0	0	2	0	P	0	3	1	2	3	3	0	0	0	0	0	0	0	0	0	0	19	
Guilds with good infrastructure (GWGI)	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	0	0	1	0	0	0	0	0	10	
Organic coffee certification (OCC)	0	P	1	2	3	0	2	2	2	0	0	0	2	1	3	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	26	
Good environmental practices (GEP)	2	2	2	2	2	3	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	15	
Trained personnel (TP)	1	1	1	1	1	2	1	0	2	0	0	0	0	0	3	0	2	2	3	1	3	1	0	0	0	2	2	0	0	0	0	24	
Staff commitment (SC)	2	0	0	1	0	2	2	2	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	10	
Weaknesses																																	0
Technical assistance in the field (TAF)	2	0	0	1	0	0	0	1	1	0	0	2	0	0	0	0	1	0	2	0	0	0	0	0	0	2	0	0	1	1	1	11	
Lack of government support (LGS)	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	0	2	2	3	P	3	0	0	2	2	2	1	2	1	2	1	29	
Low level of research (LLR)	1	1	0	0	2	1	1	3	2	P	3	0	2	1	2	0	2	2	3	3	3	0	1	2	3	3	0	0	0	0	0	37	
Expansion of the coffee frontier (ECF)	0	2	2	2	2	2	1	1	1	1	2	0	0	0	1	3	2	P	2	2	2	0	0	0	1	2	0	0	3	3	32		
Opportunities																																	0
Domestic coffee consumption (DCC)	0	3	0	1	0	3	1	0	0	0	2	1	2	0	3	0	2	2	2	3	3	1	0	0	0	2	0	0	0	0	0	28	
Entry to selected markets (ESM)	0	P	3	1	2	P	3	2	1	1	0	0	3	2	0	0	2	2	2	2	2	0	0	0	0	1	0	0	3	3	30		
Diversity of microclimates (DM)	0	0	0	0	0	3	0	0	0	0	0	0	3	0	0	0	1	3	3	2	2	0	0	0	2	2	0	0	0	0	0	19	
Access to financing (AF)	0	2	3	2	3	P	2	2	1	0	3	0	3	0	1	2	0	1	3	3	3	0	0	0	0	2	0	0	0	0	0	33	
Increased production (IP)	0	3	3	0	2	3	2	0	0	0	1	0	3	2	2	3	0	0	2	3	3	0	0	0	1	2	0	0	0	0	32		
Development Technology (DT)	1	3	3	1	2	3	2	2	2	0	2	0	3	3	2	3	3	3	0	P	0	0	0	2	3	0	0	0	0	0	42		
Creation of the coffee research center (CCRC)	1	3	3	2	3	3	2	2	2	0	2	0	2	3	3	3	2	3	2	0	0	0	0	3	3	3	1	2	2	52			
Threats																																	0
Variability of international coffee prices (VICP)	0	0	2	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	1	0	0	2	2	12		
Climate change (CC)	0	0	0	0	0	0	2	0	0	0	0	2	0	0	0	2	0	0	0	0	0	0	0	3	3	0	0	1	1	1	14		
Crop change to alternative crops (CCAC)	0	1	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0	2	2	0	2	2	0	1	2	15			
Pests and diseases (PD)	0	2	0	0	0	0	1	1	1	0	0	2	1	0	0	2	0	1	0	0	0	3	0	0	0	0	0	0	0	2	16		
Increased skills and competencies (ISC)	1	2	2	1	2	2	1	2	2	0	2	2	1	2	2	1	3	2	2	3	3	0	0	0	0	0	0	0	0	0	34		
Producer's age (PA)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	P	2	3		
Difficult access to government support (DAGS)	0	0	0	0	1	0	1	0	0	0	2	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	10	
Meeting demand (MD)	0	1	0	0	0	0	0	0	0	0	2	2	0	0	3	0	0	3	2	1	1	0	0	0	0	0	0	0	2	0	16		
DEPENDENCE	12	32	25	22	27	38	29	20	19	0	3	21	18	34	0	24	35	22	34	32	41	33	0	3	8	10	22	30	4	9	21		

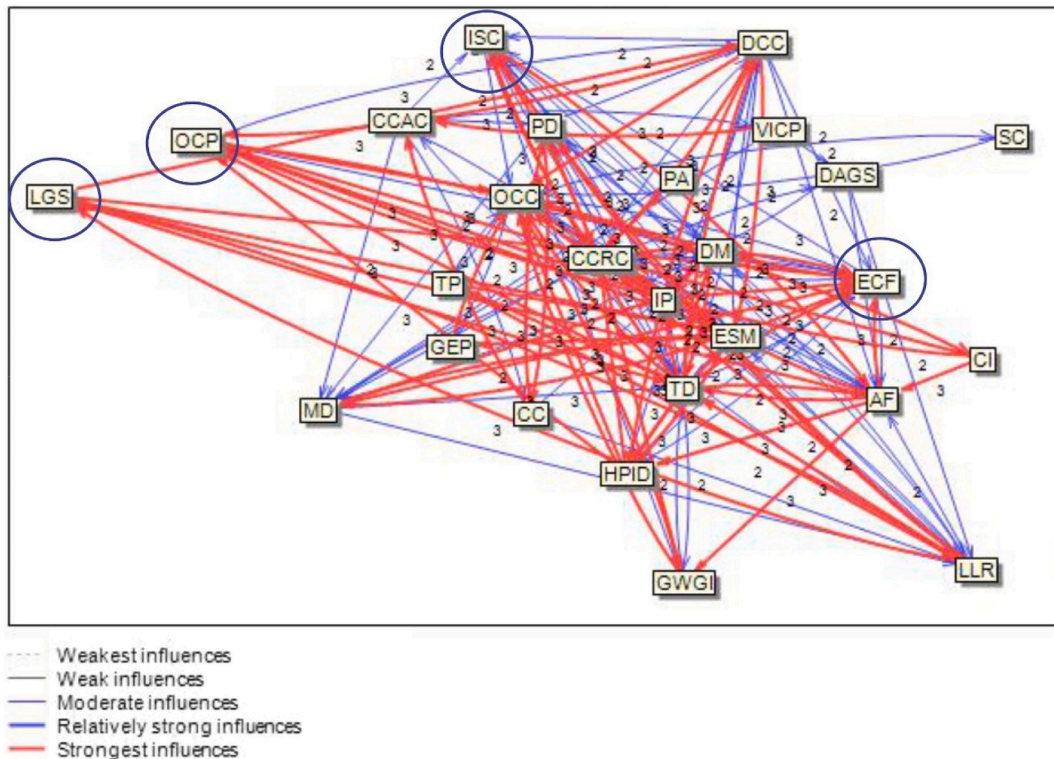


Fig. 4. Map of direct influences of relevant variables in the short term. ISC: Increased skills and competencias, OCP: Organic coffee production, LGS: Lack of government support, ECF: Expansion of the coffee frontier.

found in the strategic plan made for El Paraíso coffee in the country of Honduras [53], which demonstrates that the countries that offer specialty coffees present similar objectives, such as the positioning of their coffee quality, and act at certain key points of their weaknesses and threats.

4.4. Identification of strategic variables through structural analysis for the prospective approach

Structural analysis was carried out, in which both internal and external variables were extracted, forming a double-entry table. Each of the variables was rated according to its level of influence considering the scale proposed in the proposed methodology.

Table 6 shows that one variable obtained the highest influence score of 52 points, the creation of the coffee research center, showing that it is a potential variable and an opportunity for development. In addition, there is a dependent variable with a score of 41 with the variable development of technologies to improve the quality of coffee, showing that it is a dependent variable of many decisions or strategies that can be taken.

4.5. Matrix of direct influences (MID)

The MICMAC software identified the importance of a variable determined by the number and intensity of its relationships, and the variables strongly connected to the coffee system that affect the whole system and its future direction require more attention [12and13]. For the development of this analysis, various matrices were used; in the present research, matrices such as EFEM, IFEM, and PESTEL were used [9]. The MICMAC algorithm achieved a stable order of impact factors when raised to the sixth power [10], identifying short-, medium- and long-term variables.

The results of the MICMAC software presented in Fig. 4 as a plane of direct influences show that the coffee guilds of the Amazon region in the short term the local and regional governments should support the coffee guilds to achieve their objectives in increasing the production of organic coffee, having the expectation of improving the skills of the competencies and the expansion of the coffee frontier, all these variables are fundamental for immediate success.

4.6. Matrix of indirect influences (MII)

In Fig. 5, we can see that some variables that were not found in the previous plan have been displaced, so the software has identified new variables that are influenced by a second interaction, giving rise to the relevant variables in the medium term in which the main

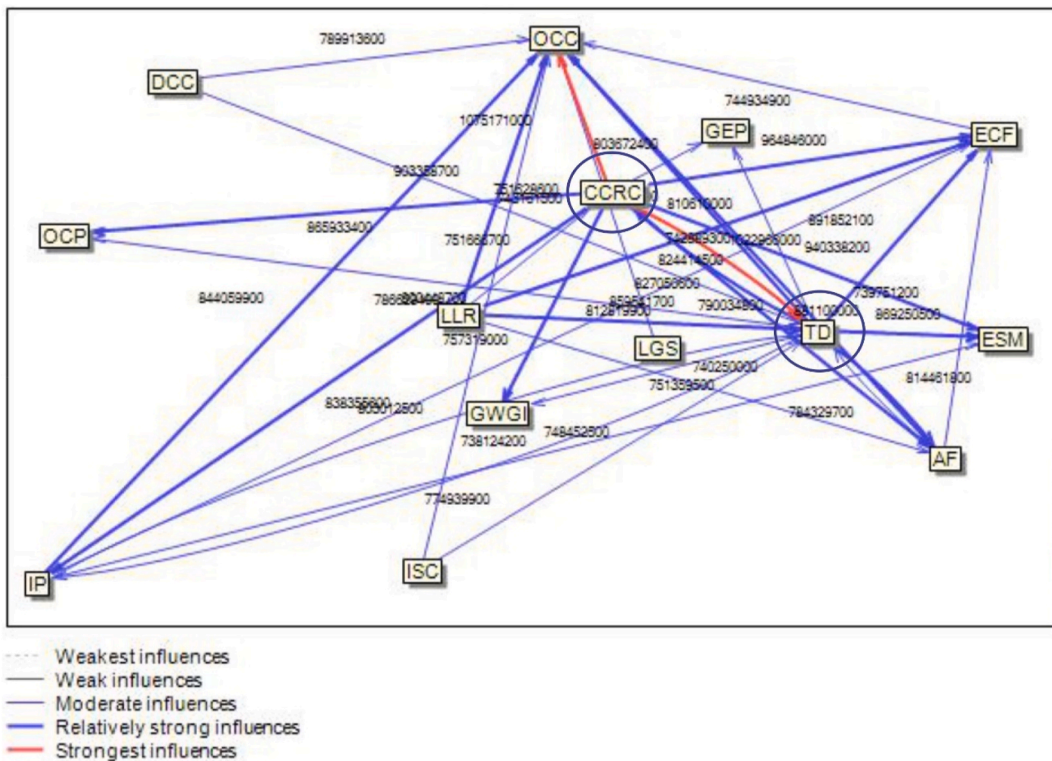


Fig. 5. Map of indirect influences of relevant variables in the medium term. CCRC: Creation of the coffee research center, TD: Development Technology.

ones are the creation of a research center for the development of technologies, achieving greater organic certifications in coffee. In other words, the coffee associations of the Amazonas region have to prioritize these strategies to achieve their objectives.

4.7. Matrix of direct, indirect and potential influences

Fig. 6 shows the direct, indirect and potential influences, in which some variables emerge that did not appear in the short and medium term; among the most important are the increase in organic production, achieving a high price and international demand for organic coffee, and the diversity of microclimates.

The short-term variables found within the study could be achieved with the planning of goals, detailed plan for the execution of activities, using available resources efficiently and establishing clear and effective communication. The medium-term variables could be achieved by identifying opportunities to optimize processes and implement gradual changes to improve productivity. And finally, the long-term variables could be achieved with strategic vision, continuous innovation, leadership development and continuous collaboration and planning models [54].

4.8. Motricity and dependence

The MICMAC analysis identified 8 key variables (Quadrant I). These variables will contribute to decisions about the future, which is uncertain due to sociopolitical changes and changing technology, such as the production of organic coffee for selected markets, access to financing through competitive funds, an increase in coffee production to cover the unsatisfied demand, the development of technologies to improve coffee quality, the creation of a coffee research center, an increase in skills and competencies, high price and international demand for specialty and organic coffees, and the expansion of the coffee frontier, which are variables that have a high influence and dependency. In other words, companies should work on them; otherwise, they are variables that affect coffee guilds (Fig. 7 and Table 7) [7]. Nazarljadi et al. [6] evaluated the novel MICMAC approach for cross-impact analysis with application to urban water and wastewater management in Iran and achieved stability of variables with a power of 4.

Following Michel Godet's theory, the variables are classified according to their location, represented in Fig. 7 with circles. Thus, 8 key variables, 2 determining variables, 7 autonomous variables, 2 result variables, 2 regulating variables and 5 secondary leverage variables were found (Tables 7 and 8). In this research, using the foresight tool, it was possible to identify key factors in the short, medium and long term, systematically considering future conditions to ensure that current decisions are appropriate in the face of possible future challenges and opportunities. Thus, this tool is used in various fields [55], as Cook et al. [56] did in their study on

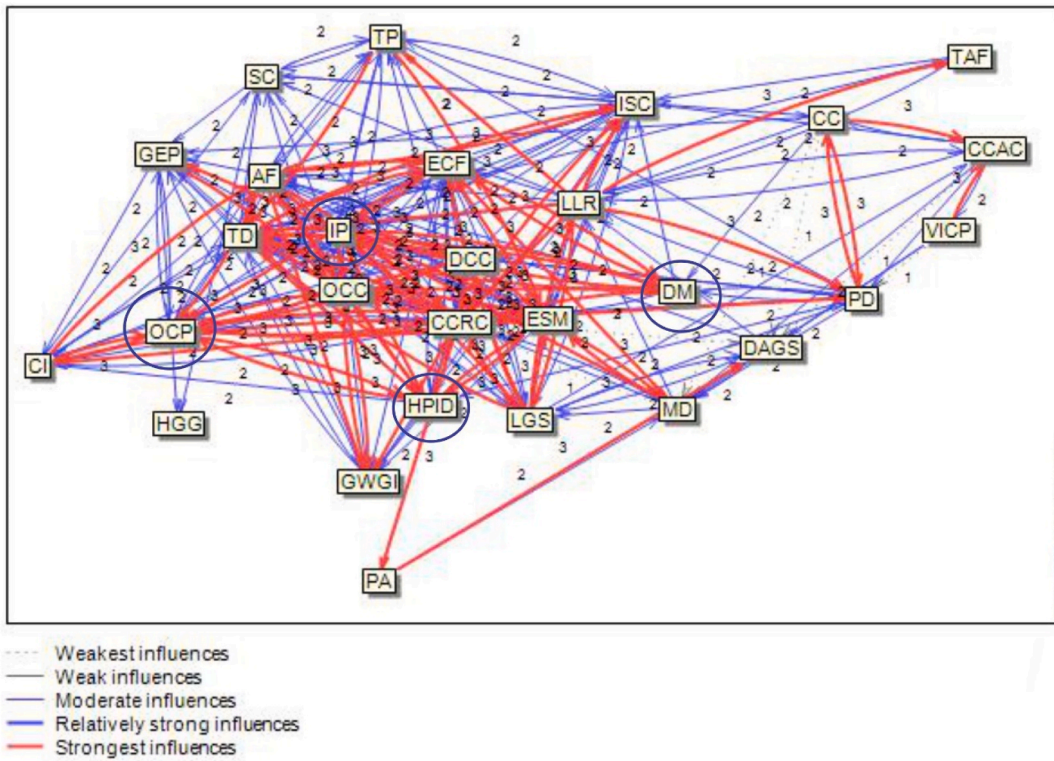


Fig. 6. Map of indirect, indirect and potential influences of relevant variables in the long term. OCP: Organic coffee production, IP: Increased production, DM: Diversity of microclimates, HPID: High price and international demand.

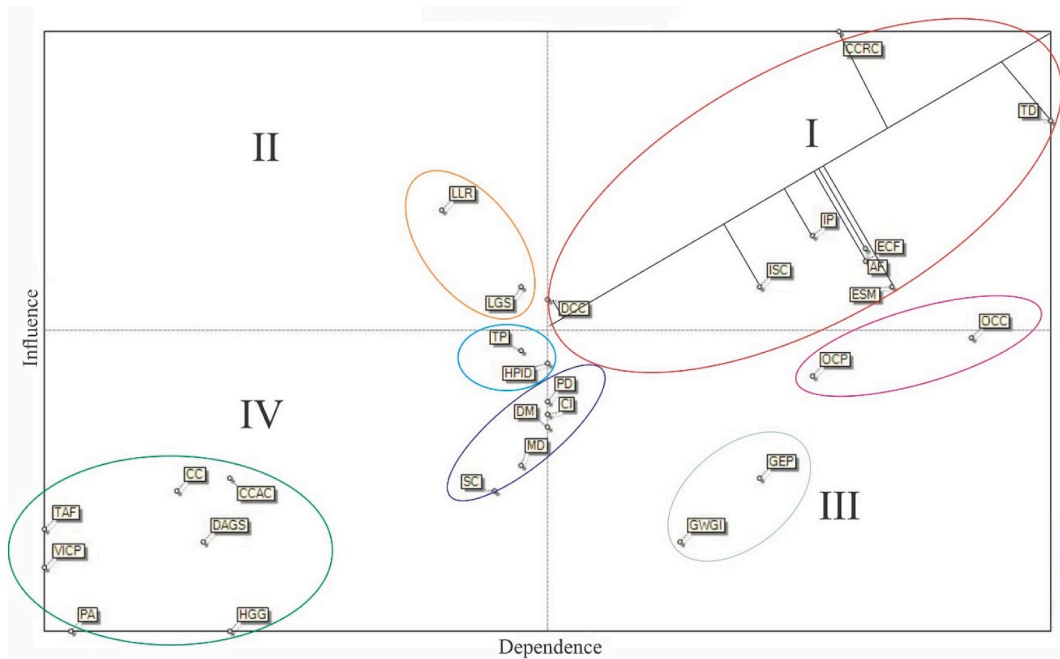


Fig. 7. Motricity and variable dependence.

Table 7
Classification of variables used in MICMAC.








Color	Classification
	Key variables
	Autonomous variables
	Regulating variables
	Secondary leverage variables
	Outcome variables
	Target variables
	Determining variables

Table 8
List of strategic variables.

STRATEGIC VARIABLES	
1	Entry to selected markets
2	Access to financing through competitive funds
3	Increase in coffee production
4	Development of technologies to improve coffee quality
5	Creation of a coffee research center
6	Increased skills and competencies
7	Domestic coffee consumption
8	Expansion of the coffee frontier

Table 9
Description of events and hypotheses according to strategic variables.

EV	Strategic variables	Description of the hypotheses proposed (H)
1	Production of organic coffee for selected markets	By the year 2030 more than 50% of the coffee guilds will register cups above 85 points and physical yields above 75, achieving access to European markets (H1).
2	Access to financing through competitive funds	By 2030, 50% of coffee growers' associations will have access to at least one competitive fund acquired by national programs and will have consolidated at least two agreements with universities and institutes at the regional or national level (H2).
3	Increased coffee production to meet unsatisfied demand	By 2030, coffee production in the Amazon region will have increased to approximately 25,000 tons (H3).
4	Development of technologies to improve coffee quality	By 2030 there will be consolidated research groups within the coffee guilds that develop research and generate new technologies to increase the quality of coffee, in addition to the management of financial and technological support for the acquisition of new technology to improve the quality and productivity of the supply of Amazonian coffee (H4).
5	Creation of a coffee research center	By 2030 there will be a coffee research center at the regional level, promoting research on resistant varieties, adaptation to different microclimates to improve coffee productivity and quality. (H5).
6	Increased skills and competencies	By 2030 there will be 75% of the coffee guild personnel trained by regional, national, and international institutions, providing follow-up and participating in world imports (H6).
7	High international price and demand for specialty and organic coffees	By 2030 there will be a zoning of the origin of organic coffee with sustainable production, where each coffee guild will have a market strategy that provides an economic bonus according to the origin and management of production; increasing the production of specialty coffees by 50% at the level of coffee guilds in the Amazon region, which will have a brand that shows the characteristic and differentiating identity of Peruvian coffee (H7).
8	Expansion of the coffee frontier	By 2030 there will be an increase from 2.5 to 3 ha of coffee per coffee producer with new improved varieties of coffee (H8).

foresight for environmental decision making by monitoring existing problems, highlighting emerging threats, identifying promising new opportunities, testing policy resilience and defining a research agenda. Wu et al. [57] used safety risk source analysis based on MICMAC techniques to identify valuable information on the risk management of urban rail transport construction in other countries or investigations related to factors affecting the quality of large marine structures [58].

The present study identified the specific role of each variable in direct and indirect relationships and recognized which variables should be studied first [59] thus, 8 key variables, 2 determinants, 4 dependent variables (2 target variables and 2 outcome variables) and 7 autonomous variables were identified. In the study by Nazlabadi et al. [6], no autonomous variables were reported, but

Table 10
Expert consensus according to hypotheses.

H.	E.1	E. 2	E.3	E. 4	E. 5	E. 6	E. 7	E. 8	\bar{X} -SD	CV	Consensus
H1	65%	69%	75%	100%	62%	65%	50%	60%	68.25 ± 14.75%	22%	SI
H2	78%	70%	80%	60%	60%	65%	75%	80%	71 ± 8.50%	12%	SI
H3	65%	60%	65%	100%	60%	65%	50%	65%	66.25 ± 14.58%	22%	SI
H4	85%	66%	69%	30%	49%	70%	50%	55%	59.25 ± 16.83%	28%	SI
H5	78%	75%	75%	20%	70%	60%	60%	55%	62 ± 18.81%	31%	SI
H6	88%	70%	80%	40%	60%	55%	70%	60%	65.38 ± 15.01%	23%	SI
H7	75%	85%	85%	20%	60%	70%	70%	70%	66.88 ± 20.69%	31%	SI
H8	50%	55%	53%	20%	45%	70%	60%	70%	52.88 ± 16%	30%	SI

H=Hypothesis, E. = Expert, \bar{X} -SD = Average - Standard Deviation, CV=Coefficient of Variation.

Table 11
Identification of probable events.

EVENT	Very unlikely event 0%–30%	Unlikely event 30%–49%	Doubt exists 50%–60%	Probable event 61–70%	Very probable event 71% or more
E1				X	
E2					X
E3				X	
E4			X		
E5				X	
E6				X	
E7				X	
E8			X		

E. = Event.

dependent variables such as cultural and social trends, economic development policies, social awareness and 14 key variables affecting urban water and wastewater management in Iranian were reported.

4.9. Description of events and hypotheses and their validation through the DELPHI method

Table 9 shows the description of the current event of the coffee guilds and the description of the future hypothesis for 2030 according to the 8 strategic variables identified. The study used the Delphi method with the opinions of experts to propose possible events, giving them a percentage of probability that they could occur, and they were analyzed under the Schwartz axes. A similar methodology was used by Castellano [39], in which he designed future scenarios for an agro-exporting company.

4.10. Expert consensus

Table 10 shows the consensus of 5 experts according to the hypotheses of probable events for the year 2030, in which all of them had a positive response.

5. Identification of probable events

Table 11 shows the identification of probable events according to the results of the expert consensus. Thus, 1 strategy (E2) gave a result of over 71%, indicating that these events are very likely to occur, 5 events (E1, E3, E5, E6 and E7) with a percentage between 61 and 70% probable to occur and two strategies (E4 and E8) with a percentage of 50–60% with doubt that they could occur.

5.1. Construction of scenarios to implement actions to achieve objectives

According to the location of the variables in Peter Schwartz's axes, four scenarios were formulated: optimistic, pessimistic, alternative 1 and alternative 2 (Table 12), in which the categories are presented, each one with its causes and consequences according to the axis.

6. Limitations and future research directions

In all research there are certain limitations, the present study has a limited scope since it only counted with the participation of managers of the coffee guilds for the collection of information. Thus, it is recommended that a more in-depth study be carried out involving coffee guilds throughout the country in order to find key variables that will lead to the success and improvement of the

Table 12
Construction of scenarios.

Optimistic scenario		
Categories in their best moment	Administrative +	Commercial +
Causes	Consequences	
Increase the coffee growing area to increase coffee production. They have a research center for the development of new technologies. Improve the quality of their product and enter new world markets. High prices for specialty coffees, increasing the income of producers. Financing is available through competitive funds. High investment for the development of new technologies They have a prospective strategic plan to confront risks.	These are coffee guilds that have a high production of specialty coffees and are competent in quality, offering their product to new markets and is a strong competitor.	
Pessimistic scenario Categories in their worst moment	Administrative -	Commercial -
Causes	Consequences	
They do not have an increase in coffee growing area and do not increase their coffee production. They do not have a research center for the development of new technologies. They are unable to improve the quality of their product and cannot enter new world markets. They are not trained in adaptation to climate change and have lost production. They do not have financing from competitive funds They do not have investment in new technologies and have weak processes. They do not have a prospective strategic plan to face risks.	Coffee guilds do not make any changes in their efforts to improve their competitiveness	
Alternative Scenario 1 Categories in their best moment (1) Categories in their worst moment (2)	Administrative +	Commercial -
Causes	Consequences	
They are financed by contestable funds Develop new technologies for the improvement of coffee quality. They have large areas of coffee expansion in which research can be developed through the coffee associations and the research center. The members of the coffee guilds are trained. There has not been good articulation with international markets, nor has it been possible to obtain an economic bonus for sustainable production. Coffee production has not increased and unsatisfied demand has not been met.	The coffee associations have developed good capacities and investments for the improvement of their industry, however, they have not been able to articulate markets and have lost markets because they do not meet the demand.	
Alternative Scenario 2 Categories in their worst moment (1) Categories in their best moment (2)	Administrative -	Commercial +
Causes	Consequences	
There is a good production of selected organic and specialty coffees for various European markets. There is a strategy on the part of coffee guilds to achieve economic plus for product sustainability. There is no training for project development and competition for competitive funds. There is no improvement in coffee quality technologies The creation of a research center has not been achieved and therefore there is a deficiency in research.	The coffee guilds have a good production of organic coffees achieving economic plus of sustainability of the product in foreign markets, but they still do not have a research center, putting at risk these qualities by not improving the continuous technology of their coffees.	
Desirable -bet scenario Categories in their best moment	Administrative +	Commercial +
Causes	Consequences	
To have a recognized brand and position Amazonas coffee worldwide. There is a research center that promotes the improvement of technology to improve the quality of the product. There is an increase in production and good demand from international markets.	he coffee guilds are in the same situation as their competitors, with competition for their positioning, taking into account the need to improve production, expansion, and strategies for entering new markets.	

competitiveness of coffee cultivation at the national level. In addition, it is also proposed to carry out a future study on the analysis of the actors involved and their role in the future using MACTOR methods.

7. Conclusions

With the help of MICMAC, it was possible to understand the indirect cross-impacts by considering the influence of time in the analysis. Through the structural analysis of the prospective approach using MID, the short-term variables are agricultural production, increased production, improved certifications and technology development; through MII, the medium-term variables found were to

conduct research, demand for demanding markets and government support; through the matrix of direct, indirect and potential influences, the long-term variables were found to be the increase in coffee-growing areas, conduct research and the creation of the research center.

Eight probable events were described, formulated as hypotheses for 2030: strategy 2, in which it is planned that the coffee guilds can access financing funds from national programs and consolidate agreements with universities, is an event that is very likely to occur; 5 events in which the coffee guilds achieve rates above 85 points and physical yields of 75; the increase in coffee production to 25,000 tons; having a coffee research center, trained personnel that participate in world imports and having a market strategy with an economic plus are likely to occur; and two strategies (E4 and E8) with a doubt that they could occur, such as the consolidation of research groups, the acquisition of financial support for the acquisition of technology and the increase of 2.5 to 3 ha of coffee per farmer, including new varieties.

Optimistic, pessimistic, alternative 1 and 2 and desirable scenarios were constructed, identifying the desirable scenario as the best.

The proposed method could also be considered a new contribution toward the coffee guilds of the Amazon region to face great future challenges. In addition, it provides a valuable tool to formulate policies to reveal the driving forces and to face in a more effective way the diverse uncertainties through the consideration of time. The main contribution of this research is proposing a risk response strategy selection method for a future organizational structure.

The present research on foresight analysis in business management has several significant impacts as it will enable organizations to anticipate trends, identify future opportunities and threats, and plan strategically to achieve their long-term objectives. By analyzing possible future scenarios, potential risks can be identified and proactive measures can be taken to mitigate them, which helps to minimize losses and maximize opportunities providing a strategic advantage by enabling companies to anticipate, prepare and respond more effectively to future changes and challenges.

Data availability statement

The research data were deposited in a public institutional repository of the Universidad Nacional Toribio Rodríguez de Mendoza de Amazonas. The link to the repository is as follows: <https://repositorio.untrm.edu.pe/handle/20.500.14077/3485>.

CRediT authorship contribution statement

Leidy G. Bobadilla: Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization, Writing – review & editing, Methodology, Investigation, Formal analysis, Conceptualization. **Jonathan-Alberto Campos Trigos:** Validation, Supervision, Resources, Formal analysis. **Meliza del Pilar Bustos Chavez:** Writing – original draft, Validation, Investigation. **Pablo-Alfredo Rituay Trujillo:** Writing – original draft, Validation, Software, Methodology, Funding acquisition. **Manuel Oliva:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

[52].

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Appendix A. Supplementary data

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