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Developing a Streamlined Tool for Supply Chain Evaluation in Ecuadorian Small and Medium-Sized Enterprises

Jorge Andrés ORELLANA-MITTE[1], Jonnatan Fernando AVILÉS-GONZÁLEZ[2], Julio MOSQUERA-GUTIERRES[2]

[1] *Universidad del Azuay, Department of Production and Operations Engineering, Ecuador*
[2] *Universidad del Azuay, Statistics Center for Research, Development and Control, Ecuador*

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Abstract
This paper proposes a tool that simplifies the methodology for supply chain analysis in small and medium-sized enterprises. This approach is based on a compilation of methodologies and performance indicators obtained through an empirical literature review and is followed by the development of the proposed tool. The evaluation instrument was validated through an expert judgment process and quantified by Aiken's V coefficient, with favorable results. A survey was conducted with a sample of twenty local companies in Cuenca, Ecuador, to assess the tool's performance across different productive sectors. The results indicate that the majority of the businesses studied manage functional products and possess routinized supply chains with a low degree of focal firm influence. Additionally, opportunities for improvement in their management are identified, with the least-controlled components being production and procurement.

Keywords
Evaluation instrument, expert judgement, performance indicators, small and medium enterprises, supply chain.

Introduction

The rapid economic growth and increased competitiveness of Cuenca have highlighted the critical role of effective supply chain management (SCM) for businesses. Proper management of the supply chain is essential for introducing new products, meeting market demands, and enhancing organizational performance. Efficient SCM is integral to achieving organizational goals such as maximizing customer value, optimizing resource management, and improving profit margins.

Porter (1985) emphasizes that the value a company creates for its customers and the associated costs are pivotal to gaining a competitive edge. SCM directly addresses these elements by ensuring goods and services are delivered to customers at the right time, in the right place, in the correct quantity, and at the lowest possible cost (Lai et al., 2002). Despite its importance, SCM remains underdeveloped in many small and medium enterprises (SMEs), where management practices are often informal or vaguely defined. This lack of structured management can lead to issues such as supply shortages, stockouts, production errors, and delays, which result in lost sales and wasted resources.

The SCOR® model is one of the most recognized frameworks for analyzing supply chains. It offers four levels of abstraction, from general to specific, and is designed to provide a comprehensive description of various flows within the supply chain (Supply-Chain Council, 2008). However, its implementation demands substantial resources, particularly in terms of information management, which can be a significant barrier for organizations with limited documentation and preparation. Saragih et al. (2020) underline that SCM in companies encompasses both strategic and tactical dimensions, integrating short-term quantitative tasks with long-term qualitative strategies.

An alternative to complex models is the development of a more straightforward assessment tool that uses indicators to evaluate the state of production processes within companies relative to their supply chains.

***Corresponding author**: Jorge Andrés Orellana-Mitte – Production and Operations Engineering, Universidad del Azuay, Av. 24 de Mayo 7-77 y Hernán Malo, 010204, Cuenca, Ecuador, phone: +49 176 45171102, e-mail: jorgeaorellanam@hotmail.com*

This research introduces such a solution, designed to assess and analyze supply chain management. The resulting framework identifies key characteristics of the supply chain, diagnoses management weaknesses, and provides a foundation for developing targeted improvement strategies.

Literature review

The objective of supply chain management is to integrate processes for the control and improvement of the chain, recognizing that it represents the network of organizations involved horizontally in various processes and activities that generate value in the form of products and services, delivered to the end consumer (Christopher, 2022). According to Montoya-Torres et al. (2023), "... organizations need to develop, accumulate accurate knowledge of their supply chain and understand the nature of their partnerships with other stakeholders". (p. 12). It is crucial for companies to know the type of chain they operate and align their organizational management strategies accordingly. Additionally, the use of appropriate indicators to analyze performance is essential.

Performance Indicators in Companies

According to Ballou (1992), in a productive organization, hierarchies are differentiated. This includes the strategic, operational, and tactical levels. Efforts to exercise adequate control over the performance of the supply chain should be directed towards these levels. In terms of SCM, Lee and Billington (1992) observed that different areas of the chain will not enhance efficiency if each pursues different and independent goals unrelated to the rest. In the work of Gunasekaran et al. (2004), various authors' perspectives on measuring the performance of the classical supply chain (SC) and how it should be addressed are compiled. Taking into account the considerations of Gunasekaran et al. (2004), similarities are identified with the work of Arzu Akyuz and Erman Erkan (2010), who summarize that, for a correct measurement of chain performance, indicators should:

- Capture the essence of the organizational performance.
- Reflect a balance between financial and non-financial metrics.
- Prioritize or assign greater weight to different aspects.
- Facilitate integration.
- Be experience-based.
- Result in a minimum number of metrics.

Additionally, Jurburg and Tanco (2012) conducted an exploratory survey about logistics management in companies from Uruguay. The results led to the development of a qualitative/quantitative rapid diagnostic methodology for the supply chain, centered around questionnaires. In Sarkar and Moon (2014), the authors present a model illustrating the relationship between the increase in quality and how it is affected by associated costs and production time; these factors are identified as essential within effective process management. In Latin America, Salas-Navarro et al. (2019) studied the levels of competitiveness and productivity of companies by designing an evaluation model for supply chain management. The study takes into account five critical components in the chain: procurement, storage, inventory management, distribution, and reverse logistics. For the elaboration of their methodology, questions were formulated on how to conduct a proper management analysis in the logistics processes of companies in the metal-mechanical sector in Colombia. For each question, a weighting was established at the discretion of the principal investigator.

Classification of Supply Chains

The accurate characterization of the type of supply chain is vital for a diagnostic study of the chain. Fisher (1997) developed a framework for classifying a company's product offerings based on the nature of their demand. The author proposes classifying products as either functional or innovative, according to their intrinsic characteristics. The characteristics defined by the author include the product life cycle, product variety per line, level of uncertainty in demand forecasting, and market standards. These are detailed below:

- **Functional Products:** Characterized by little variation over time, addressing basic needs, predictable demand, and long life cycles. They are generally low-margin products but stable with low obsolescence costs.
- **Innovative Products:** Characterized by short life cycles, high profit margins, and unpredictable demand. The life cycle and variety defining these products further increase unpredictability in sales.

Likewise, Fisher expresses that a supply chain serves two functions: a physical function and a market-facing function. The physical function involves the conversion of raw materials into components and, over time, into the finished product until it reaches the final customer. On the other hand, the market-facing function ensures that the products introduced into the market are compatible with what consumers are willing to purchase. Based on these two functions, the author defines two types of chains: physically efficient chains

and market-responsive chains. The first aims to meet the needs of predictable demand at the lowest possible cost. The second focuses on responding promptly to the unpredictability of demand, placing efficiency and effectiveness in the background. The author proposes that functional products should be part of physically efficient chains, while innovative products require chains that are market-responsive.

However, in the work of Harland et al. (2001), the authors define four types of SCM based on characteristics and activities, and are classified along two dimensions: the degree of dynamism and the degree of influence on the focal company under study. The combination of these two aspects provides the following characterization:

Supply Chain Type 1 – Dynamic with Low Degree of Focal Firm Influence.

It functions under dynamic conditions, and the focal company within it has little influence on other stakeholders in the chain. This type poses the greatest challenge for businesses in terms of administration. It is considered dynamic for two reasons: the internal characteristics of operational processes and external market conditions. The high variety of processes, a large number of configurations, or low production volumes per product type cause internal dynamics in this type of chain; likewise, dynamism is mainly determined by factors that create uncertainty in demand. These chains tend to compete on innovation rather than in costs. On the other hand, the low level of influence is caused by the relatively low direct value that the focal company contributes to the supply chain, compared to other actors within it.

Supply Chain Type 2 – Dynamic with High Degree of Focal Firm Influence.

Operates under dynamic conditions, and the focal company within it has significant influence on the actions of other stakeholders in the chain. The high level of influence is evidenced by the significant indirect value perceived by the rest of stakeholders, generally due to its innovation capabilities. The high degree of influence of the focal company allows it to choose partners rather than being chosen, and at the same time, to manage the chain with decisions that may involve other actors.

Supply Chain Type 3 – Routinized with Low Degree of Focal Firm Influence.

Works under stable conditions arising from a low variety of products or high production volumes in controlled processes, constant demand, a low number of competitors with similar products, and a low frequency of new product introductions to the market. In routinized supply chains, cost and quality are the main factors in seeking competitiveness, usually present in mature industries with more practical chains. Similar to the first characterization, the low level of influence of the focal company on the rest of the chain is caused by the relatively low direct value that the focal company contributes to the supply chain compared to other members.

Supply Chain Type 4 – Routinized with High Degree of Focal Firm Influence.

Runs under stable conditions. The high degree of influence of the focal company often represents conditions where it has strong control over the SC, meaning its management could be relatively effective. Therefore, the focal company is in a position to choose whom to associate with and make decisions that influence the rest of the chain.

According to Marques et al. (2009), the most critical aspect of Harland's classification is its timeliness for chain analysis, considering the rapidly changing and dynamic reality of markets. In accordance with the author, it is advisable to compare it with other market and SCM models, such as those proposed by Fisher and Fine. Charles H. Fine (2000) suggests that the structure of a supply chain is not stable and typically fluctuates between an integral and a modular form. Additionally, the author emphasizes that companies must control the chain for their own survival, producing only what adds value to them and outsourcing the rest. Analyzing the positions of the authors, Fisher's efficient chains converge with the ideas of a routinized chain, while responsive chains relate to the dynamic approach proposed in Harland's characterization.

In Calderón et al. (2017), the authors propose a methodology for the classification of supply chains based on Harland's characterization, considering the convergence between the proposals of Charles H. Fine and Fisher. The result is a complement to the model, a coordinate axis whose quadrants arise from the classification of Fisher and Fine, allowing the company to shift between quadrants according to the characteristics of its product and the focus of its supply chain management.

Based on this, a data collection instrument is proposed in the form of a questionnaire, with closed-ended questions, considering both qualitative and quantitative variables. The questionnaire consists of two parts: the first part is for the identification of the type of product and the degree of vertical integration, key characteristics used to define the type of chain. The second part focuses on identifying relevant factors in supply chain management and how they are handled in terms of costs, time, and quality.

Materials & Methods

Determining the type of Supply Chain

To identify the type of supply chain, this study developed a classification model based on the "Dynamic Classification Model of Networks" (Fig. 1) by Marques et al., taking into account the adaptations proposed by Calderón et al. (2017). The aim was to obtain a characterization that considered the evolution of companies over time and the dynamism of the Ecuadorian market.

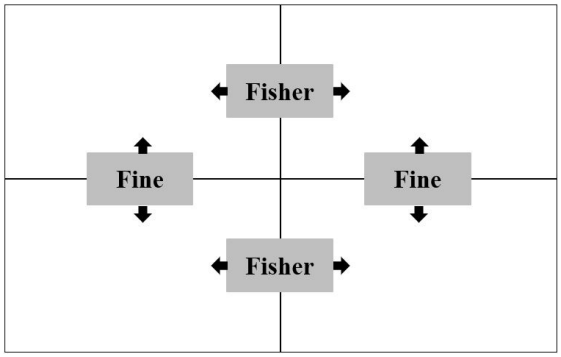

Fig. 1. Dynamic Classification Model of Networks by Marques et al. (2009)

With the matrix presented in Figure 2, supply chains are classified considering the type of product according to Fisher's theory and the degree of integration according to Fine's model. The distribution of the quadrants places companies with functional products on the left and companies with innovative products on the right. On the vertical axis, companies are positioned according to their degree of vertical integration, based on Fine's model. In this way, the type of supply chain associated with the product under study is identified.

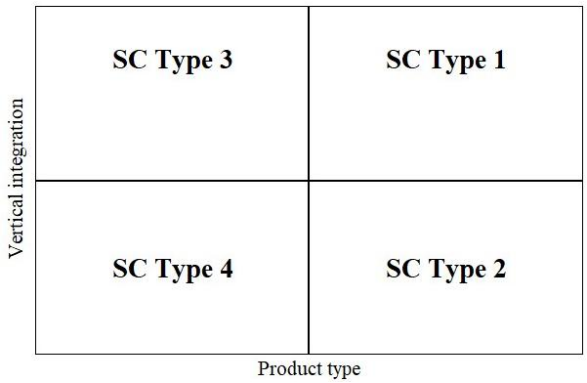

Fig. 2. Adapted Model for Supply Chain Classification

To classify products as functional or innovative, four criteria were employed and each was assigned an assessment weight considering its relative importance in the classification. These criteria are:

- Life cycle – 30%
- Demand Variability – 30%
- Variety of products – 30%
- Contribution Margin – 10%

The product **life cycle** refers to the stages a product goes through from its market introduction to its disappearance. In this regard, functional products have extended life cycles, while innovative products have short life cycles, often lasting only a few months (Chase et al., 2009). The breakdown is as follows: 0 to 1 year, a weighting of 1; 1 to 2 years, a weighting of 0.67; 2 to 5 years, a weighting of 0.33; and more than 5 years, a weighting of 0.

The level of **demand variability** measures the sales variation on a monthly basis for a product line within a company. Innovative products exhibit highly variable demand, while functional products tend to be more stable. The categories for classification are: none, with a weighting of 0; low, with a weighting of 0.33; medium, with a weighting of 0.67; and high, with a weighting of 1. This criterion is assessed using the question "Demand Variability" in the questionnaire referenced in Appendix A.

Regarding **product variety**, it is considered that companies with functional products produce a low variety of items per line, meaning products that share similar characteristics. In contrast, companies with innovative products encompass a wide variety of items per line. This criterion subdivides categories as follows: 1 to 10 products, a weighting of 0; 10 to 20 products, a weighting of 0.33; 20 to 40 products, a weighting of 0.67; and more than 40 products, a weighting of 1.

The **contribution margin** is used to determine the contribution to sales, in percentage terms, of a product or product line to the company. If this contribution is less than 20%, it is considered a functional product; if it exceeds this percentage, it is considered innovative. The weight of this criterion is 10%, lower than the other three, because in countries with high economic uncertainty, such as the current case in Ecuador, higher margins are common. The categories are subdivided as follows: between 0 and 10%, a weighting of 0; between 10 and 20%, a weighting of 0.33; between 20 and 40%, a weighting of 0.67; and if it is greater than 40%, a weighting of 1.

To define the product type (P), the adapted formula from Calderón et al. (2017) uses the weighting corresponding to the life cycle (C), the demand uncertainty level (I), the product variety (V), and the contribution

margin (M), as seen in Equation (1).

$$P = 0.3C + 0.3I + 0.3V + 0.1M \tag{1}$$

The product type P takes values from 0 to 1 and is classified according to the following parameters:

- 0 to 0.25: Functional product.
- 0.25 to 0.50: Predominantly functional.
- 0.50 to 0.75: Predominantly innovative.
- 0.75 to 1: Innovative product.

Regarding the vertical axis, companies are positioned based on their degree of vertical integration. Five levels of this variable are defined based on Villarreal Solís and Gómez Romero (2009):

Level 2: The company focuses on its core activity, outsourcing part of its production and making purchases from suppliers and sales to distributors or wholesalers.

Level 1: The company focuses on production, making purchases from suppliers and sales to distributors or wholesalers.

Level 0: The company produces and engages in some form of supply and/or distribution activity.

Level −1: The company produces and controls part of the supply and distribution of the finished product, relying less on third parties.

Level −2: The company fully controls the value chain of the product, from the production of raw materials to sales to the final consumer.

Once the company is located in the corresponding quadrant, it is possible to define the characteristics of the supply chain under study and appropriate management strategies according to Harland's taxonomy.

Evaluation of the Supply Chain Management

For the analysis of supply chain management, an empirical literature review was conducted. It began with the identification of keywords in numerous resources related to management and the use of the most common indicators for each component. Scientific literature was reviewed in order of importance, including research articles, review articles, books, and conference proceedings. A total of 360 keywords were identified, leading to a subsequent review where relevant publications for the study were selected. Articles and publications from over 40 authors were chosen. Various methodologies and indicators were extracted, with the most relevant results summarized in Table 1.

In this second review, 410 questions were compiled based on the indicators mentioned in the publications and categorized according to the administrative levels of Ballou (1992), the organizational structure of Duncan

Table 1
Performance Indicators in the Supply Chain

Supply Chain Component	Measurement Criteria	Indicator	Author
Procurement	Costs	Transportation costs	Wisner (2012)
	Quality	Defect percentage	Wisner (2012)
	Time	Supplier response time	Kumar (2007)
	Quality	Delivery delays	Shepherd & Günter (2011)
Production	Costs	Manufacturing activities costs	Gunasekaran (2004)
	Time	Process cycle time	Wu (2009)
	Time	Production plan compliance	Ivanov (2019)
	Quality, costs	Defective products	Huang (2006)
	Quality	Perceived customer quality	Gutiérrez Ortiz (2017)
Storage	Costs	Labor cost	Christopher (2022)
	Costs, quality	Cost of damage or deterioration	Christopher (2022)
	Time	Storage time or hanging time	Packowski (2014)
	Time	Forecast accuracy	Packowski (2014)
	Costs	Inventory obsolescence	Shepherd & Günter (2011)
Distribution	Costs	Total logistic cost	Shepherd & Günter (2011)
	Quality	Dispatch errors	Shepherd & Günter (2011)
	Time	Delivery times	Lu (2011)
	Time, quality	Distribution plan compliance	Ivanov (2019)

(1979), and the evaluation dimensions of cost, time, and quality. Questions were selected based on relevance, literature frequency, measurability, and expert consensus. The study focuses on core supply chain components: procurement, production, warehousing, and distribution, and it excludes post-sale areas such as customer service, returns management, and reverse logistics.

For the discrimination of questions and indicators, the Delphi method was employed (Linstone and Turoff, 1975). This involved a refined adjustment of the question bank, which was evaluated by a group of eight experts in production, logistics, and supply chain matters, including professors from the University of Azuay. Through individual interviews, each expert provided their opinions on different questions within the evaluation method. Subsequently, the professionals' perspectives were gathered; a number of questions and indicators were excluded and subjected to re-evaluation by the experts in several rounds until a consensus was reached on the different categorizations. Based on the experts' feedback, the questionnaire to assess the state of supply chain management was restructured. The methodology employed is presented in the flowchart in Figure 3.

The result is the questionnaire attached in Appendix 1 at the end of the document. In Section A: Identification of the Type of Supply Chain Management, the questions for categorizing the supply chain are addressed. In Section B: Evaluation of the Supply Chain Management, the state of management in different parts and aspects of the chain is scored using a defined scale. In this section, questions are grouped according to the area they analyze within the chain and are subcategorized into cost, time, and quality dimensions.

It begins with the rating of relevance for the company using a Likert scale (Joshi et al., 2015), from 1 to 5, to assess the level of importance of the three fundamental aspects (cost, time, and quality) in each of the supply chain components, as follows:

- 0 – Null relevance: the aspect is not important for the study.
- 1 – Low relevance: the company may be affected by this aspect.
- 2 – Moderately low relevance: the company is affected to a low extent.
- 3 – Medium relevance: the company is moderately affected.
- 4 – Moderately high relevance: the company is highly affected.
- 5 – High relevance: the company is critically affected.

The next step is the assessment of the company regarding its supply chain management using the same scale to evaluate the current state of the exposed subcategories. The result is a weighted rating of supply chain management in the company, giving greater weight to factors that have a bigger impact on its processes. A quantitative rating is provided for each component, along with a qualitative assessment and an overall rating for the entire supply chain (Tab. 5), in addition to an indicative radar chart and corresponding traffic light color coding for each result.

With the chain management analysis questionnaire, it is possible to identify the most relevant points for the company and how effectively each component is being managed. This, combined with the categorization from Section A, will allow for the consideration of management strategies according to the proposed methodology in an initial diagnosis.

Content Validity Analysis of the Questionnaire

The following is extracted from Escobar-Pérez and Cuervo-Martínez (2008):

Content validity is established in different situations, with two of the most common being: (a) test design, and (b) validation of an instrument that was originally developed for a different population but was adapted through a translation procedure (semantic equivalence) (p. 27).

In the present case, the goal is to determine the validity of the supply chain analysis tool design. An expert judgment procedure was employed, along with Aiken's V coefficient, to assess expert agreement and quantitatively determine the degree of validity of the proposed instrument.

The procedure for quantifying content validity is presented. The data used were derived from the "Expert

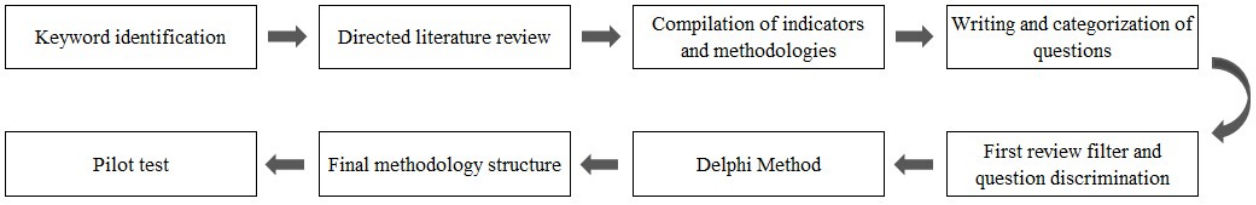

Fig. 3. Methodology Implemented for the Evaluation of the Supply Chain Management

Assessment Questionnaire" (see Appendix B), which consisted of 29 items evaluated by a panel of seven experts in the field. These judges were engineers with a high academic degree and extensive experience in supply chain management. They were provided with an assessment sheet and asked for a detailed review of each item, considering attributes and criteria that demonstrate its relevance in relation to the study objectives and the content to be evaluated.

After the judges' evaluation, the data were recorded in a database and processed with open-source statistical software. To determine the content validity of the questionnaire, Aiken's V coefficient was employed.

Aiken's V coefficient

The following is cited from Aiken (1980):

Assume that each of N raters inspects a single item or questionnaire and indicates, on a c-category ordinal rating scale (lowest validity category through highest validity category), his or her judgment of the content validity of the item or questionnaire. After all N raters have made their judgments, a scorer assigns a weight of 0 to each of the n_0 ratings falling in the lowest category, a weight of 1 to the n_1 ratings in the next higher category, and so on through a weight of $c-1$ to each of the n_{c-1} ratings in the highest (cth) category. (p. 956)

Then, a content validity index may be defined as

$$V = \sum_{i=1}^{c-1} \frac{in_i}{N\,(c-1)} \tag{2}$$

The coefficient can be used on the ratings of a set of judges regarding an item. These ratings can be dichotomous or polytomous. In this case, we have polytomous ratings (from 1 to 4). The V coefficient can take values between 0 and 1; a value closer to 1 indicates a greater degree of agreement among judges, implying a higher confirmation of content validity. However, like any statistic, V is influenced by the inherent variability in the sample, so it is necessary to establish the potential range of values that the parameter could encompass. In this scenario, confidence intervals (CI) are presented as a more effective approximation. The data analysis environment RStudio facilitated the calculation of the V values and their confidence intervals. The results are presented in Table 2 in the following section.

Finally, to assess the tool's performance across various productive sectors, a survey was conducted with a sample of 20 companies from different industries in the city of Cuenca, including 15 small and medium-sized manufacturing enterprises and five service companies. The sample was selected using a convenience judgmental random sampling approach, aimed at exploration and ensuring diversity and balance across local industrial sectors. This approach was intended to evaluate the behavior and applicability of the supply chain evaluation tool in different areas of Ecuador's industry.

Results

The results of the quantification of content validity place the V coefficient within the confidence intervals in all sections of the evaluation instrument. Furthermore, no result was found below 0.90, indicating a high degree of agreement among the judges in the validation of the different dimensions that the tool assesses.

Table 2
Assessment of Content Validity Using Aiken's V Coefficient

Sections	V	CI
Section A	0.95	0.92 – 0.97
Procurement	0.91	0.88 – 0.93
Production	0.99	0.97 – 0.99
Warehousing	0.94	0.92 – 0.96
Distribution	0.97	0.95 – 0.98

Results of the Survey

The results obtained through the application of the proposed tool are presented in the following figures (Fig. 4 and 5).

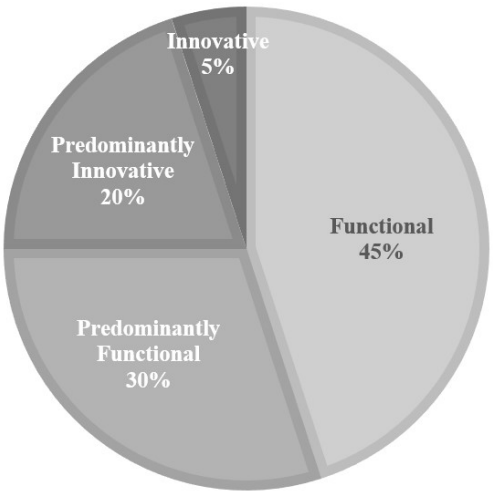

Fig. 4. Product Types

In determining the type of product, it is evident that 45% of the studied companies handle functional

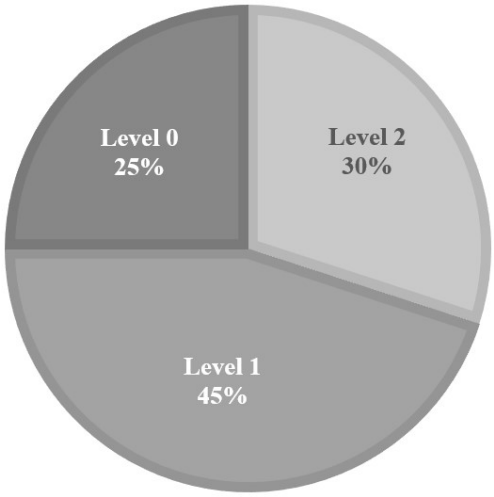

Fig. 5. Integration Levels of the Enterprises Studied

products, 30% handle predominantly functional products, and the remaining 25% consist of predominantly innovative and innovative products. Regarding the degree of vertical integration, it is confirmed that 45% of the organizations carry out activities corresponding to Level 1 of integration, where the company focuses only on production; 30% correspond to Level 2, in which there is a degree of outsourcing in production activities; 25% correspond to Level 0, and none of the studied organizations identified with Levels –1 and –2, indicating low involvement in supply and distribution activities.

After determining the type of product and the degree of vertical integration, companies were placed in the proposed matrix for analysis and identification of the type of supply chain.

Of the studied companies, 60% are identified in the upper-left quadrant (Fig. 6), corresponding to Type 3: Routinized Supply Chain with Low Degree of Focal Firm Influence, while 15% are located in the upper-right quadrant, corresponding to Dynamic with Low Degree of Focal Firm Influence. It is important to note that 15% of the companies are positioned between Quadrants 3 and 4, classifying them as Routinized Supply Chains, and 10% are located between Quadrants 1 and 2, being classified as Dynamic Supply Chains due to their degree of vertical integration. These companies occupy an intermediate position in terms of focal firm influence, as they engage in some form of procurement and/or distribution activity.

Since the majority of companies fall within the upper-left quadrant, Table 3 presents the proposed management strategies for the organizations and businesses under study, according to the cited authors for the corresponding chain type.

According to the proposed methodology and based on the taxonomy by Harland et al., Type 3 supply chains operate under stable conditions and constant demand, with a low number of competitors offering similar products and infrequent introduction of new products to the market. These types of chains tend to prioritize cost efficiency and quality as competitive priorities. Additionally, they exhibit a low degree of influence over other stakeholders in the chain, focusing on their core activities.

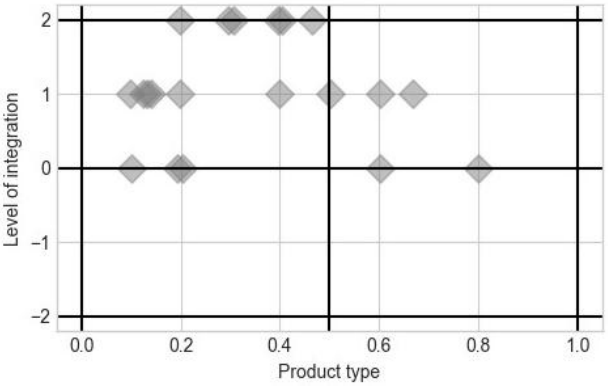

Fig. 6. Classification Model Adapted from Marques et al. (2009) Applied to SMEs in Cuenca

Table 3
Management Strategies by Supply Chain Type

Strategies for:	**Routinized SC with Low Degree of Focal Firm Influence**
Demand	Efficiently meet a predictable demand.
Manufacturing	Streamlined flows and standardized products or services, with greater focus on high production volumes.
Lead time	Reduce lead times as long as doing so does not excessively increase costs.
Inventory	Maintain minimal inventories with high turnover.
Suppliers	Greater emphasis on low prices, consistent quality, and on-time deliveries.
Product design	Maximize performance and minimize costs.
Integration	Limited or no vertical integration.
Innovation	Limited in-house innovation; encourage other stakeholders in the chain to invest in innovation as much as possible.

Regarding the results of the second section of the questionnaire, which assesses supply chain management on a scale from 1 to 5, the following rating system was used (Tab. 4).

Table 4
Supply Chain Management Scoring Scale

1–2	Satisfactory	
2–3	Needs Improvement	
3–4	At Risk	
4–5	Critical	

It is observed that 55% of the companies received a rating of "Needs Improvement" in their management; 40% received a rating of "Satisfactory"; the remaining received a score of "At Risk". None of the companies in the study scored above 4 on the scale to be considered "Critical". Service businesses, on average, received a better rating in their supply chain management and encountered no issues in applying the tool. The overall results of the study are as follows (Tab. 5).

Table 5
Survey Results by Supply Chain Component

Component	**Score**	**Rating**	**Visual Rating**
Procurement	2.23	Needs Improvement	
Production	2.37	Needs Improvement	
Warehousing	1.88	Satisfactory	
Distribution	2.14	Needs Improvement	
Overall	2.16	Needs Improvement	

Considering that the rating is more favorable the lower the score on the scale, it is evident that the procurement and production components are the least controlled. In contrast, the warehousing component shows a higher degree of effective management in the companies under study. Overall, the evaluated companies received a rating of "Needs Improvement", indicating opportunities to enhance their performance. The organizations' goal will be to achieve a rating of "Satisfactory" in their management processes. Once this goal is achieved, given the current volatile economic and political landscape, it will be crucial to continuously implement better practices that enable the supply chain to manage inherent fluctuations efficiently, as having a robust supply chain and proper management strategies could enable a firm to react more effectively in case of disruptions (Tang, 2006).

A radar diagram was also generated, serving as an additional visual indicator for companies, as illustrated in Figure 7. It displays the ratings and the areas toward which improvement efforts should be directed, corresponding to the overall results of supply chain management in the survey.

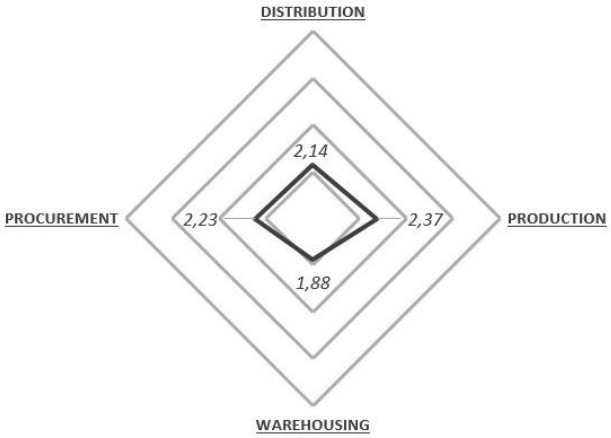

Fig. 7. Radar Chart of Overall Supply Chain Performance of the Companies Studied

Discussion

The presentation of the evaluation tool and its associated questionnaire was generally well received, particularly in Section A, which focused on identifying the type of supply chain. In this section, participants were able to reach consensus with minimal difficulty, reflecting that this aspect of the tool aligns well with their understanding and operational knowledge. However, Section B, which evaluates supply chain management, revealed discrepancies in ratings and opinions among participants. This divergence was most notable in cases where there was a perceived imbalance of authority, particularly when higher-ranking personnel were present.

One major issue encountered was the potential for biased responses, particularly in Section B, where more subjective assessments of supply chain management were required. Participants from lower-level operational areas appeared to withhold critical feedback in the presence of administrative personnel or higher-ranking officials. This dynamic likely resulted in overly favorable assessments in some cases, as respondents hesitated to highlight deficiencies, delays, or inefficiencies that could reflect negatively on their departments. This potential bias introduces a limitation to the tool's effectiveness in accurately capturing operational weaknesses.

Addressing Challenges and Limitations

To overcome these challenges, the study proposes key methodological adjustments. First, increasing the number of participants to at least five per company would ensure a broader range of opinions, helping to mitigate individual biases and enhance the diversity of perspectives on the organization's supply chain. Second, Section A could be completed collectively by the entire group, facilitating a shared understanding of the supply chain's structure before delving into more detailed evaluations. Third, and most critically, individual sections of the questionnaire (particularly Section B) should be completed in private, through one-on-one interviews between the researcher and each respondent. This approach would reduce the likelihood of biased responses due to hierarchical pressure and allow participants to provide more candid feedback.

Implementing these recommendations in future applications of the tool should improve the accuracy and reliability of the assessments, thereby addressing the primary limitations observed during the study.

Insights from Surveyed Companies

The application of the tool in service companies revealed interesting dynamics. Although the tool was designed to accommodate both manufacturing and service sectors, several service companies faced challenges in fitting their responses within the framework provided. Specifically, some sections of the questionnaire, such as those related to distribution, were not relevant to their operations and were therefore omitted or rated as having no significance. This flexibility in adapting the tool to different business types, while necessary, introduces variability in the responses and presents a challenge to achieving uniformity in the evaluation process.

Interestingly, some manufacturing companies also applied similar adaptations. For instance, they rated certain factors as irrelevant or assigned zero relevance to supply chain elements that were not applicable to their specific operations. This highlights the need for a flexible tool that can cater to the distinct requirements of various industries while still maintaining core comparability across sectors.

Significance and Implications of Adapting the Instrument Across Different Sectors

The primary goal of this research was to develop a versatile tool capable of adapting to the specific value-creating activities of both manufacturing and service companies, in contrast to more rigid supply chain evaluation methodologies. Therefore, the tool's adaptability is recognized as a key asset.

Moreover, the study's results indicate strong alignment between the tool's theoretical framework and the actual characteristics of the companies studied. Specifically, 80% of the companies demonstrated more than 50% adherence to the proposed supply chain classification model. This level of alignment suggests that the instrument effectively captures key aspects of supply chain management in diverse organizational contexts, and that the proposed management strategies resonate with the operational realities of these companies.

Conclusions

The present work proposes an easily applicable tool for Small and Medium-sized Enterprises focused on evaluating supply chain management. The methodology developed incorporates the most relevant indicators, as identified by various authors in the field.

This approach serves two main purposes: it enables the assessment of the type of supply chain companies operate and evaluates how different components of the chain are managed. In addition, it helps identify areas for improvement and suggests strategies that may be applied by other organizations with similar supply chain characteristics.

The validity of the assessment instrument was confirmed through expert judgment, in which a panel of seven supply chain professionals evaluated the tool across various dimensions. The results, quantified using Aiken's V coefficient, were highly favorable, indicating strong agreement among experts regarding content validity. This validation was further supported by the Delphi method, applied during the tool's development with input from eight additional experts, confirming its theoretical relevance and effectiveness for supply chain analysis and evaluation.

In practical terms, the tool was applied through a survey of SMEs across various industries in Cuenca. The findings revealed:

- Functional Products and Routinized Supply Chains: Most companies deal with functional products and have a routinized supply chain, exhibiting a low level of influence from the focal company.
- Competitive Advantages: For these practical and efficient supply chains, cost consistency and product quality were identified as their main competitive advantages.
- Innovation and Influence: The low degree of influence over other stakeholders is associated with a less innovative profile of the focal company compared to other members of the chain.

- Management Improvement: There are opportunities for improvement in the procurement and production areas for most companies, though few presented critical management issues. The warehousing component demonstrated a comparatively higher level of process control.

The main benefits of applying the tool in SMEs include:

- Flexibility and Simplicity: The tool's implementation is straightforward and does not require the extensive documentation or information gathering typically required by other models.
- Efficiency: It operates with a minimal number of metrics, balancing indicators while prioritizing the most relevant factors for the sector, thus fulfilling the authors' intended objectives.

To improve future iterations of the tool, there are plans to standardize its application process. This will be done by creating a comprehensive instruction sheet to guide evaluators, ensuring consistent and accurate application across different settings.

Acknowledgments

Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s).

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APPENDIX A – SUPPLY CHAIN ANALYSIS QUESTIONNAIRE FOR SMEs

Supply Chain Analysis Questionnaire for SMEs				
Basic Information				
Name		Type (X)		Manufacturing
Position				Services
Company		Productive sector / Economic activity		
E-mail				

Section A: Supply Chain categorization	
Product or service line	
Mark with an (X) the single answer that best aligns with the current situation of the company.	

Life cycle (Since market launch)	
	Months to 1 year
	1 to 2 years
	2 to 5 years
	Longer than 5 years

Variety of products per line	
	1 to 10 products
	10 to 20 products
	20 to 40 products
	More than 40 products

Demand variability	
	Null
	Low
	Medium
	High

Contribution margin (of total sales)	
	0 to 10%
	10 to 20%
	20 to 40%
	Greater than 40%

Degree of vertical integration	
Mark with an (X) the single answer that best reflects the current situation of the company in response to the question: What degree of control do you have over the management of raw materials and/or finished products?	
	The company focuses on its core activity, outsourcing part of its production, and conducting purchases from suppliers and sales to distributors or wholesalers.
	The company focuses on production, making purchases from suppliers and sales to distributors or wholesalers.
	The company produces and engages in some form of procurement and/or distribution activity.
	The company produces and controls part of the supply and distribution of the finished product, reducing its dependence on third parties almost entirely.
	The company fully controls the product's value chain, from raw material production to the sale to the final consumer.

Section B: Supply Chain Management Evaluation
1) Rate the relevance of each aspect (cost, time, and quality) for every component of the supply chain. 2) Mark with an (X) the most adequate rating for each indicator in the different areas.

Scale for rating relevance:
0 – Null relevance – The aspect is not important for the firm.
1 – Low relevance – The company may be affected.
2 – Moderately low – The company is affected to a low extent.
3 – Medium relevance – The company is moderately affected.
4 – Moderately high – The company is highly affected.
5 – High relevance – The company is critically affected.

Scale for rating indicators
"Blank" – Unknown
1 – Low
2 – Moderately low
3 – Medium
4 – Moderately high
5 – High

Procurement		Level of relevance	**Rating** 1	2	3	4	5
Costs	Supply costs						
	Costs incurred due to waste						
Time	Delivery times (from suppliers)						
	Non-compliance with the work plan						
Quality	Occurrence of errors or delays						
	Quality non-compliance						

Production		Level of relevance	**Rating** 1	2	3	4	5
Costs	Production costs						
	Costs incurred due to waste						
Time	Production/execution times						
	Non-compliance with the work plan						
Quality	Occurrence of errors or delays						
	Quality non-compliance						

Warehousing		Level of relevance	**Rating** 1	2	3	4	5
Costs	Storage costs						
	Costs incurred due to waste						
Time	Storage times (in warehouse)						
	Non-compliance with the work plan						
Quality	Occurrences of errors or delays						
	Quality non-compliance						

Distribution		Level of relevance	**Rating** 1	2	3	4	5
Costs	Logistic costs						
	Costs incurred due to waste						
Time	Delivery times for products						
	Non-compliance with the work plan						
Quality	Occurrence of errors or delays						
	Quality non-compliance						

APPENDIX B – ASSESSMENT FORM TO DETERMINE CONTENT VALIDITY THROUGH EXPERT JUDGMENT

Content Validity Form

Instrument: Supply Chain Analysis Questionnaire for SMEs

Basic Information			
Full name		I.D. / Passport	
E-mail		Phone	
Academic degree		Educational level	

Rate each item according to the following indicators by marking the appropriate box with an (X):

Category	Rating	Indicator
Sufficiency		
The presented questions are sufficient to measure the studied dimension.	(1) Does not meet the criteria	The questions are not sufficient to measure the analyzed dimension.
	(2) Low level	The questions measure some aspect of the dimension but do not correspond to its overall measurement.
	(3) Moderate level	Some questions need to be added to assess the dimension comprehensively.
	(4) High level	The questions are sufficient to measure the dimension.
Clarity		
The question is easily understood; that is, its syntax and semantics are appropriate.	(1) Does not meet the criteria	The question is not clear.
	(2) Low level	The question requires several modifications in the use of words according to their meaning or their arrangement.
	(3) Moderate level	A very specific modification of some terms in the question is needed.
	(4) High level	The question is clear, with appropriate semantics and syntax.
Coherence		
The question has a logical connection to the dimension it is measuring.	(1) Does not meet the criteria	The question does not have a logical connection to the measured dimension.
	(2) Low level	The question has a tangential relationship with the dimension it is measuring.
	(3) Moderate level	The question has a moderate relationship with the dimension it is measuring.
	(4) High level	The question is fully related to the dimension it is measuring.
Relevance		
The question is essential or important; that is, it should be included.	(1) Does not meet the criteria	The question can be eliminated without affecting the measurement of the dimension.
	(2) Low level	The question has some relevance, but another question may include what it measures.
	(3) Moderate level	The question is relatively important.
	(4) High level	The question is very relevant and should be included.

Expert Assessment Questionnaire																	
Item	Statement	Sufficiency				Clarity				Coherence				Relevance				Observations
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
1																		
2																		
3																		
...																		
...																		
29																		

Place:

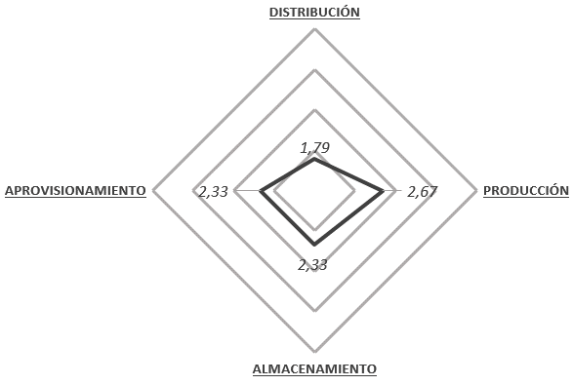
Date:

_____

Rater's signature

APPENDIX C – INDICATIVE RADARS: RESULTS OF THE APPLICATION OF THE SUPPLY CHAIN EVALUATION TOOL IN ECUADORIAN FIRMS

Results A–O correspond to manufacturing firms, and P–T are service firms. The radar charts retain their original Spanish labels: Distribución (Distribution), Producción (Production), Almacenamiento (Warehousing), and Aprovisionamiento (Procurement).



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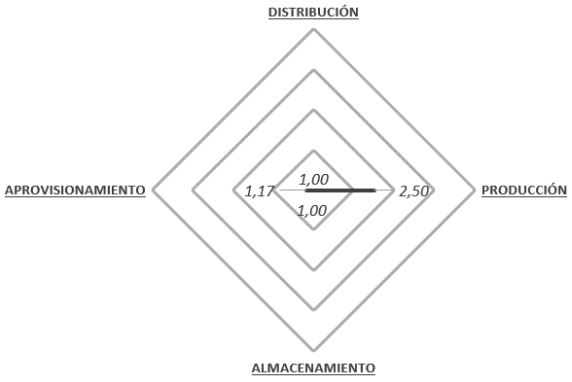

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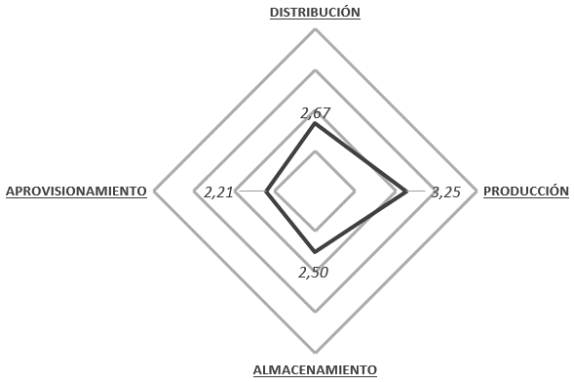

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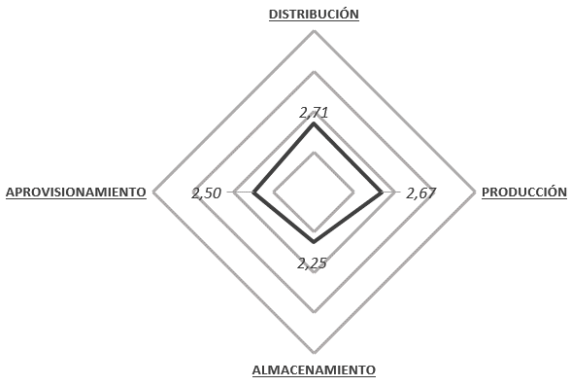

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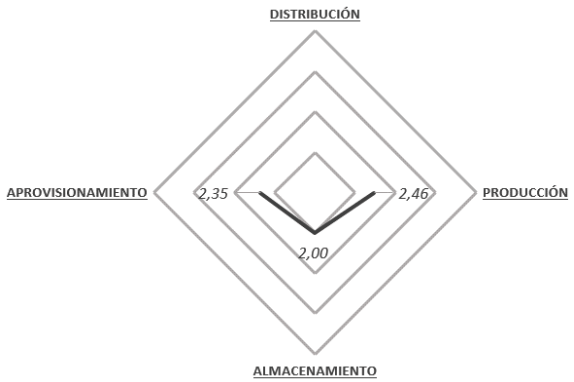

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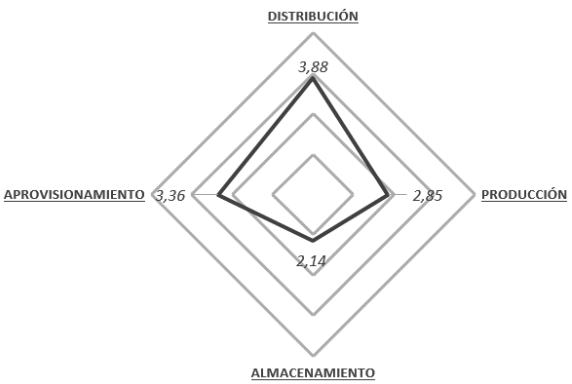

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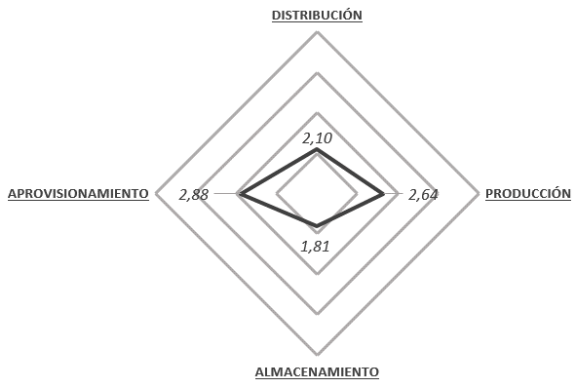

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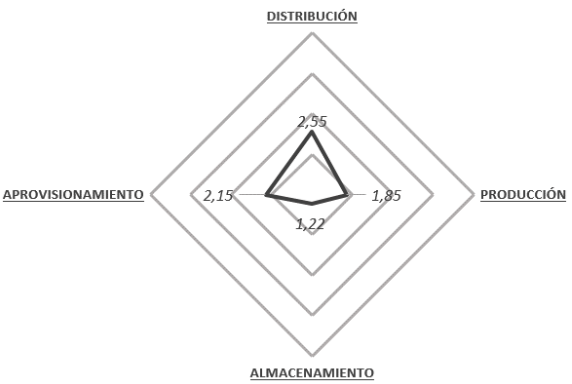

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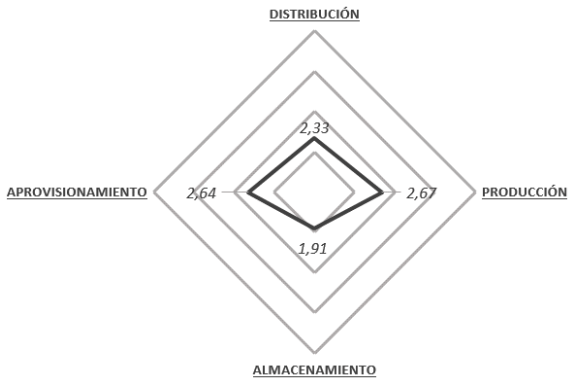
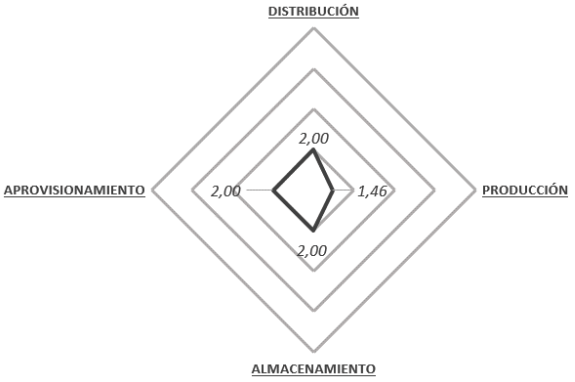
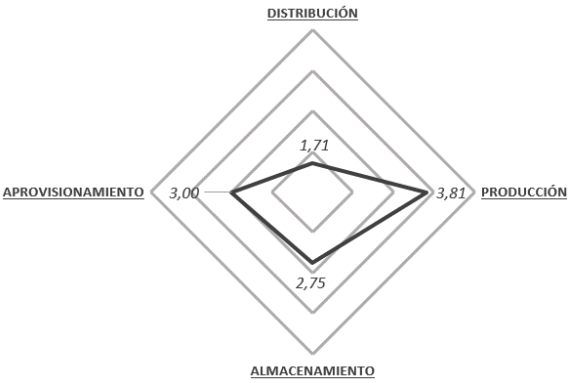

DISTRIBUCIÓN
APROVISIONAMIENTO
PRODUCCIÓN
ALMACENAMIENTO
2,33
2,64
2,67
1,91

I


DISTRIBUCIÓN
APROVISIONAMIENTO
PRODUCCIÓN
ALMACENAMIENTO
2,00
2,00
1,46
2,00

J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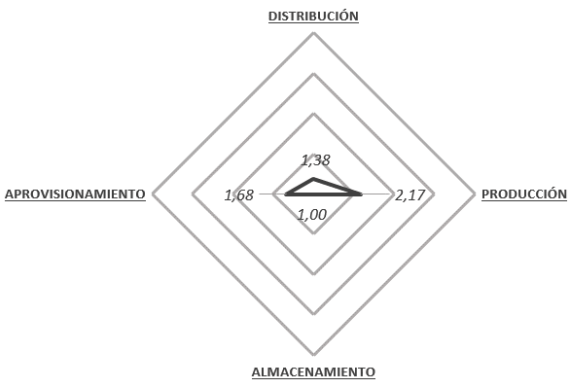
PRODUCCIÓN
ALMACENAMIENTO
1,71
3,00
3,81
2,75

K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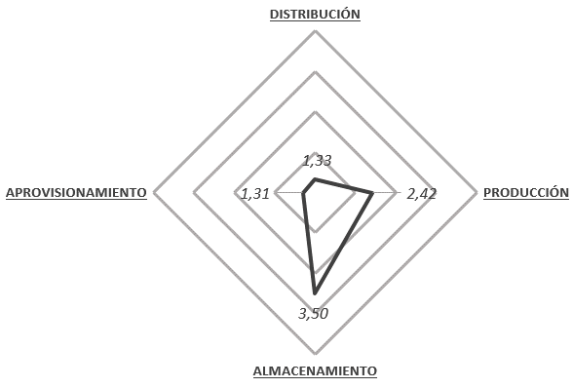
PRODUCCIÓN
ALMACENAMIENTO
1,38
1,68
2,17
1,00

L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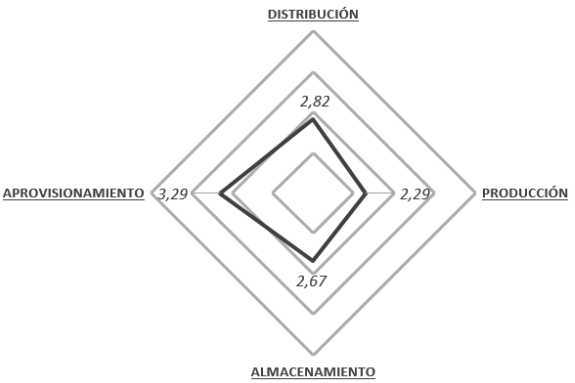
PRODUCCIÓN
ALMACENAMIENTO
1,33
1,31
2,42
3,50

M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PRODUCCIÓN
ALMACENAMIENTO
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3,29
2,29
2,67

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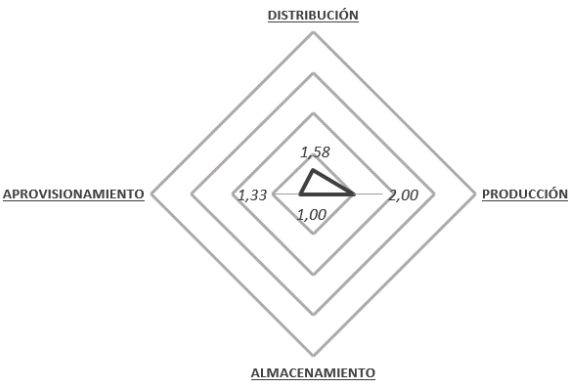
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PRODUCCIÓN
ALMACENAMIENTO
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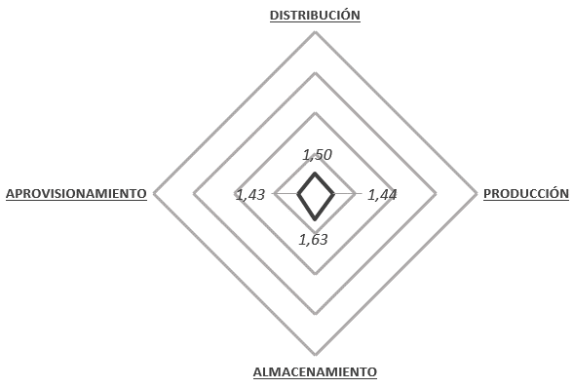
2,00
1,00

O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PRODUCCIÓN
ALMACENAMIENTO
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1,44
1,63

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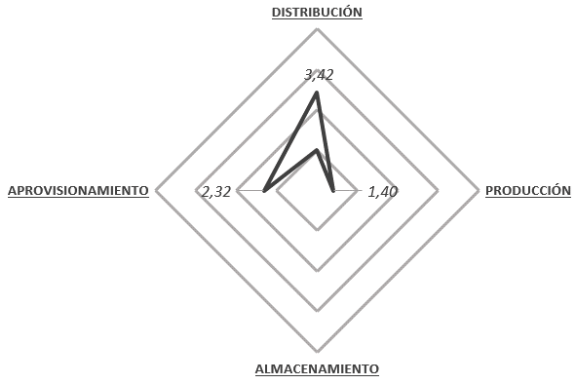
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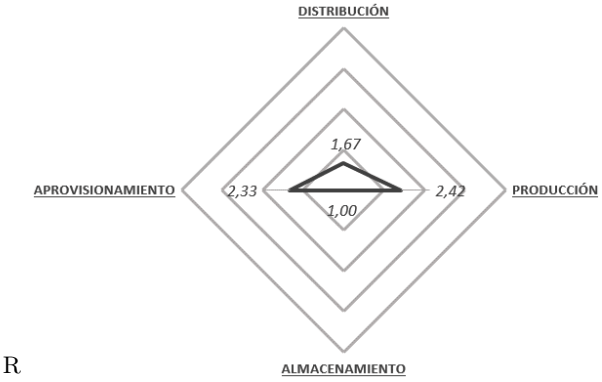
APROVISIONAMIENTO
2,32
1,40
PRODUCCIÓN
ALMACENAMIENTO

Q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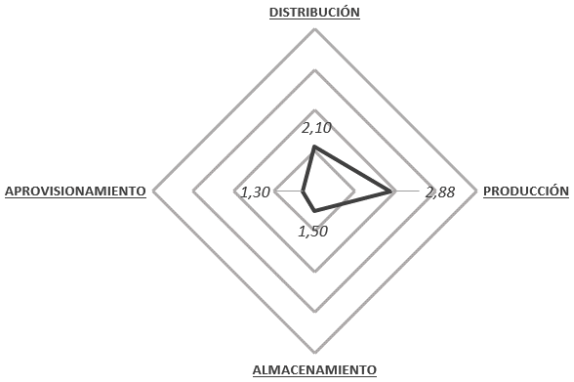
2,42
PRODUCCIÓN
1,00
ALMACENAMIENTO

R


DISTRIBUCIÓN
2,10
APROVISIONAMIENTO
1,30
2,88
PRODUCCIÓN
1,50
ALMACENAMIENTO

S


DISTRIBUCIÓN
APROVISIONAMIENTO
3,09
1,56
PRODUCCIÓN
1,50
ALMACENAMIENTO

T