

Strengthening the Supply Chain of the Auto Body Sector in Duitama, Boyacá: Analysis and Improvement Proposals

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Abstract

The supply chain of the auto body industry in Duitama, Boyacá, faces challenges that affect its efficiency, such as the lack of integration of new technologies and organizational management models, limiting its competitiveness in expanded markets. The purpose of this research is to analyze the key links in the supply chain: procurement, production, distribution and organizational performance, in order to identify opportunities for improvement that promote the strengthening and sustainability of the local auto body industry. Methodologically, a qualitative approach with descriptive scope is employed, using a documentary review and direct observation. The findings indicate that the main difficulty lies in the absence of integrated logistics and management strategies, which leads to the isolated operation of the links in the chain, reducing the efficiency and competitiveness of the companies. It is concluded that it is essential to develop proposals that promote the implementation of management guidelines that strengthen each link of the supply chain and are more integrative and effective, ensuring the continuity and business success of the bodywork sector in Duitama.

Keywords: Supply Chain, Bodybuilders, Links, Linkages.

1. Introduction

The metal-mechanical bodywork sector, which is dedicated to the manufacture, design and repair of bodywork for vehicles such as trucks, buses and trailers, is a crucial component in the economy of the municipality of Duitama, Boyacá. However, this sector faces significant challenges in the various links of its supply chain, which negatively affects its competitiveness in the market. Among these challenges are inefficiency in production processes, lack of integration and communication between functional areas, and insufficient adoption of advanced management technologies (Lambert and Cooper, 2000; Chopra and Meindl, 2016).

Some studies have shown that fragmented supply chains, where each area acts independently, generate significant problems of coordination and knowledge management, which prevents the

achievement of the strategic objectives of organizations and affects the quality of the final product (Mentzer et al., 2001; Christopher, 2020). This lack of integration is common in the Duitama car body sector, where the lack of collaborative strategies and internal logistics limits the development of synergies and continuous improvement in production and distribution processes (Simchi-Levi et al., 2008; Ivanov et al., 2019).

International automotive trade has undergone substantial changes in production management, driven by an increasingly dynamic and competitive global environment. This has led to the adoption of new approaches in organizational development, which prioritize efficiency and innovation in supply chain management (Cousins et al., 2008; Ketchen and Hult, 2007). For companies in the metalworking sector, the integration of these management models has become a necessity to ensure long-term sustainability and competitiveness (Slack et al., 2016; Krajewski et al., 2019).

In this context, the objective of this research is to carry out a documentary review of the academic literature inherent to studies on companies in the bodywork sector in Duitama, Boyacá. The research seeks to identify the factors that negatively affect the efficiency of their supply chains and analyze their implications for organizational competitiveness. Based on these findings, practical recommendations will be formulated to improve supply chain management, aligning local companies with international standards and promoting their sustainable growth in the global market.

2. Literature Review

This section offers an overview of the research related to the object of study, providing an analysis of theoretical and conceptual aspects that underpin the understanding of supply chains in the automotive sector, with a specific focus on the production and marketing of car bodies.

Supply Chain as a Fundamental Factor of the Business Management

It is important to understand that the business unit is a system that relates to an environment, which is why, as noted by Ferguson (2002), its objectives must be oriented to satisfy the expectations of people, investors, the market, suppliers, customers and the community in general. On the other hand, it is important to emphasize that the company is made up of several functional areas, which, although they develop different activities, aim at a single objective: to be profitable and sustainable.

In the face of the author's approaches, it is inexorable to adopt practices that allow improving the internal and external processes of organizations, thereby seeking at all times to improve their level of competitiveness. Regarding external processes, Baquero et al. (2018) state that it is necessary for the supply chain to focus its attention on suppliers and customers. In turn, as far as internal processes are concerned, it is pertinent that mechanisms are designed to ensure accredited processes that allow obtaining products and services with high quality standards. In this way, it is possible for the organization to achieve not only profitability, sustainability and competitiveness, but also market positioning.

To fulfill these purposes, Bustillos and Carballo (2019) state that it is necessary to establish a supervisory relationship in which management plays an important role, since it is the manager who is in charge of leading the company towards achieving the objectives and goals set by the investors; In addition, when talking about the proper management of the supply chain in an organization, it refers to the fact of taking the product to the customer how, how much, where and when he wants, also implicitly integrating key concepts of the links to generate a sustainable competitive advantage, taking into account internal functions, suppliers up the chain and customers down the chain, in order to reduce purchasing and logistics costs, manage inventories, serve the customer, choose key suppliers and customers, as well as develop partnerships to offer the customer a product solution tailored to their requirements.

From what has been stated by the authors, it is clear that business success depends on the logistics linked to supply chain management, since, as indicated above, the processes involved in each link are interconnected and if any one of them fails, there is a risk of business failure. Therefore, if organizations want to achieve their goals and objectives, management and senior executives must link guidelines and strategies that guarantee the harmonious functioning of the supply chain.

Supply Chain Management

Supply chain management is a key factor for the progress of organizations according to Mentzer et al. (2001), this process must be systematic and strategic to guarantee the logistical coordination of the company's functions (Marketing, Sales, R&D, Forecasting, Production, Purchasing, Logistics, Information Systems, Finance and Customer Service) and of the tactics developed along these functions. Likewise, the authors indicate that the actors involved in all the links that make up the supply chain must be involved in this management, which can contribute to improving the long-term performance of both the individual companies and the chain as a whole.

According to Gibson (2005), the main factor to be taken into account in supply chain management is the fusion between strategy and execution, which must be a delicate mix between short-term, more detailed and quantitative (tactical) activities and long-term, broader-spectrum and qualitative activities. On the other hand, these authors state that well-designed supply chain management contributes to efficiency and effectiveness, since it leads to progress in the achievement of a company's goals, even affirming that successful companies use logistics and its management as part of their competitive strategies.

From this perspective, supply chain management should be based on increasing the capacity of the participants to make decisions, formulate plans and outline the implementation of actions aimed at significantly improving the productivity of the operational logistics system. Along the same lines, Durango (2018) argues that the ultimate goal of sound supply chain management is to improve the service levels offered to the customer.

Consequently, we speak of supply chain management when a set of activities are carried out, starting from the moment raw materials are acquired, establishing an excellent relationship with suppliers, good operations management, adoption of good practices in the production process and ensuring that distribution complies with standards that guarantee a high level of quality and customer satisfaction.

Importance of the Supply Chain in Businesses

According to Shih (2020) and Sheffi (2022), global changes and technological advances have led industries to seek to increase the level of integration of these changes in the different processes managed in the supply chain. It is important to understand that the business unit is a system and that it is related to an environment, which leads to its objectives being oriented towards satisfying the expectations of people, investors, the market, suppliers, customers and the community in general.

In addition, the current behavior of the markets tends to attract customers, in this sense, organizations must integrate commercial strategies specifically aimed at creating new products or improving those already offered. Therefore, as Wilson (2018) states, in the logistics and strategic management of the supply chain, global models for business development must be linked, for this, organizations must appropriate technologies such as those of industry 4.0 and articulate them with standards that allow them to innovate their internal and external production processes to improve the level of competitiveness.

In the opinion of Ivanov et al., (2019) and Nikookar et al. (2021) supply chains are relevant for organizations, inasmuch as from their management companies must assume challenges as opportunities for change, in this sense, it is necessary that they have a response capacity to adapt to moments of uncertainty, that is, that they are resilient to market changes in such a way that the sustainability of organizations is guaranteed.

In view of the above, with regard to external processes, the supply chain should focus particularly on suppliers and customers. With respect to internal processes, it is important to design mechanisms to ensure that the processes are accredited and allow the company to obtain products and services with high quality standards. In this way, it will be possible for the organization to achieve, in addition to profitability, sustainability, competitiveness, prestige and market positioning.

The Automotive Industry in Boyacá – Colombia

The department of Boyacá by tradition stands out in the automotive industry, given that since the 1960s, some families were dedicated to the manufacture of metal-mechanical parts, however, as highlighted by the magazine Portafolio (2018) in one of its reports, initially the work of entrepreneurs in this sector was done in an artisanal way, due to the lack of appropriate technologies for the time and the little qualified human resources. The work of the families that joined the bodywork sector in Boyacá, began in small workshops and with the passage of time some workers have consolidated as large entrepreneurs, also the bodywork industry in Boyacá was boosted thanks to the creation of the Ciudadela Parque Industrial de Duitama, in which various bodywork organizations in the region have been integrated, a fact that has allowed the configuration of the metal-mechanical bodywork cluster of the municipality of Duitama.

On the other hand, González and Sánchez (2017) refer that the environment of the department of Boyacá, the beliefs and experiences in the metal mechanic industry has led several Boyacá families to adopt the bodywork sector industry as a source of income, forging their patrimony without generating dependence on third parties.

Based on the references of Alianza carrocera de Boyacá S.A.S. (2013), the boom in the transportation industry in the department of Boyacá has led to the emergence of new business units such as spare parts stores, workshops of various kinds and service stations, but above all organized industries focused on the bodywork sector, among which the following stand out: industrias la garantía, Carrocerías Muisca, Carrocerías Invicta, Carrocerías Tundama, and Carrocerías AGA, all of which are located in the municipality of Duitama Boyacá.

These companies were originally conceived as the “school of Duitama”, led by the company Industrias la garantía, in which a group of entrepreneurs were formed, who have generated business and developed in the bodywork industry, making this activity an outstanding line of the economy of the region, and in turn a source of employment generation. Along with these companies have been created workshops dedicated to metalworking, reconstruction and repair of bodywork, which has contributed significantly to boost the economy of Duitamense.

No obstante, los progresos en el sector carroceros boyacense, no han sido siempre favorables, pues como reseña la Alianza carrocera de Boyacá S.A.S. (2013) en la década de los años noventa, la apertura económica abrió puertas a la importación de carrocerías, esta situación golpeó al sector carroceros en general, causando despidos. La industria carrocera ubicada en el municipio de Duitama, no se escapó a esta situación, sin embargo, empresas como Autobuses AGA de Colombia, aplicaron reingeniería, modificando su modelo de negocio e inclusive desarrollaron investigación y conversión tecnológica. De la misma manera, otras empresas como Promotora Muisca S.A, Ergobus, Invicar y Logos, han venido adoptando modelos de gestión que les ha permitido ser sostenibles.

However, companies in the Duitamense auto body sector have been experiencing pressure from multinational companies such as Mercedes Benz and Volkswagen, which, in addition to positioning their brands, apply aggressive marketing strategies and have a high level of liquidity. On the other hand, the auto body industry in the municipality currently competes directly in the same segments with the aforementioned brands, including Marcopolo from Brazil. It should be noted that these brands work with economies of scale, a condition that generates difficulties for businessmen and loss of competitiveness. Therefore, it is inexorable to reduce the gap and generate conditions for companies in the bodywork sector of the municipality of Duitama, through the management of the supply chain.

3. Materials and Methods

This section presents the methods integrated for the development of the research, as well as aspects of the unit of study, categories to be analyzed, among other elements of the research process.

Based on the nature of the study, this is assumed from the qualitative approach, since through the qualification it is sought to interpret aspects inherent to the links that integrate the supply chain in the bodywork sector of the municipality of Duitama, Boyacá. Hammersley and Atkinson (1994) point out that qualitative research provides a broad overview of the phenomenon under study contrasted with the theories that support it. According to the postulates of Miles and

Huberman (1994), qualitative research focuses on discourse and arguments to interpret phenomena of the social environment from a holistic approach that allows understanding the qualities of the situation under investigation.

Therefore, for this study the qualitative method is used to describe and interpret from observation and theoretical references the current situation of the bodywork sector in the municipality of Duitama, Boyacá. It is sought from the analysis of the different links to understand the situations that arise and that can generate situations that affect the harmonious operation of the productive chain, and based on this to formulate an improvement plan framed in guidelines that contribute to the economic progress of the bodywork sector of the municipality.

From the point of view of Ander Egg (1995), the descriptive methodology allows detailing features and characteristics of the phenomenon or situation under study as they are presented in the research scenario.

By design, the research is oriented from the documentary review method, for which the research tradition of the last decade is taken as a reference, specifically research related to the object of study. As noted by Barraza (2018), documentary studies are also recognized as bibliographic research, in which the main feature is the use of secondary data as a source of information, in order to direct the research process from two aspects, firstly, from the relationship of existing information with the object of study, and subsequently relating it for a panoramic view of the phenomenon or situation under investigation.

In this sense, the use of documentary research in this study has the purpose of reviewing the investigative overview inherent to the supply chain in the bodywork sector of the municipality of Duitama, Boyacá, in order to contrast the current reality faced by this sector of the economy of the region and be able to contribute to its improvement from the formulation of an improvement plan.

Unit of study

The unit of study corresponds to the commercial establishments in the municipality of Duitama Boyacá, whose main activity is the manufacture and repair of bodywork for cargo vehicles. Table 1 shows the organizations linked to the study.

Table 1 Commercial establishments providing technical service for the elaboration and/or maintenance of car bodies.

COMMERCIAL ESTABLISHMENT	SERVICES RENDERED	LOCATION (ADDRESS)
AUTOBUSES AGA DE COLOMBIA S.A.S	Manufacture of bodyworks for buses, vans and vans.	Industrial City. Duitama, Boyacá.
INDUSTRIAS TECNICAR S.A.S	Manufacture of bus and coach bodies.	Industrial City. Duitama, Boyacá.
ESTEMCO LTDA.	Manufacture of bodywork for motor vehicles manufacture of trailers and semi-trailers LIMITED PARTNERSHIP	kilometer 5 via Duitama Paipa central del norte highway Duitama, Boyacá.
ALIANZA CARROCERA DE BOYACÁ S.A.S	Manufacture of bodies for motor vehicles manufacture of trailers and semi-trailers.	Calle 12 #29-26 Duitama, Boyacá.
INDUSTRIAS METALMECÁNICAS SIGMA S.A.S	Mobile units factory.	Carera 3 3-75 Ciudadela Industrial, Duitama, Boyacá.

CARROCERIAS ERGOBUS	Design and Development of Mobile Units.	Carrera 35 # 1-203 Duitama, Boyacá.
NEOTECH CAPITAL S. A.S	Manufacture of bodywork for motor vehicles.	Calle 9 # 36-34. Duitama, Boyacá.
INDUSTRIAS CHASIS TRUCK S.A.S	Manufacture of bodies for motor vehicles manufacture of trailers and semi-trailers.	San Lorenzo de abajo. Duitama, Boyacá
NEOTECH CAPITAL S.A.S	Manufacture of bodies for motor vehicles manufacture of trailers and semi-trailers.	Calle 9 # 36 34, Duitama, Boyacá
INDUSTRIAS GBS S.A.S	Manufacture of bodywork for motor vehicles	calle 5 # 3 10 Industrial City.

Note: The table presents the commercial establishments selected as the unit of study in the research.

It should be emphasized that, since this was a non-probabilistic study, the criteria used to select the study unit were those shown in Table 2.

Table 2 Criteria for the selection of commercial establishments

Selection of commercial establishments	Participant selection characteristics
In the particular case of this study, a sample of 33 commercial establishments was taken.	<p>The selection criteria for the study unit were:</p> <ul style="list-style-type: none"> - To be registered in the chamber of commerce and have the respective credentials to exercise the commercial activity. - Provide manufacturing or repair services for cargo vehicle bodywork. - Present problems in the links of the supply chain of its commercial activity.

Note: The table presents the criteria taken into account for the selection of the study unit.

With respect to the unit of analysis, each of the links in the supply chain of the bodywork sector were studied in order to establish possible problems that arise within the organizations.

Study Categories

Taking as a reference the methods integrated in the research process, the study has a qualitative predominance, which is why in order to interpret the reality faced by the entrepreneurs of the body shop sector in the municipality of Duitama, Boyacá, four categories of study are formulated for this purpose, which are listed in Table 3.

Table 3 Operationalization of study categories

Category	Subcategory	Data collection techniques and instrument
Procurement	<ul style="list-style-type: none"> - Suppliers (imports) - Purchasing Process 	<ul style="list-style-type: none"> - Documentary review (documentary corpus) - Observation (systematic recording in field diaries)
Production	<ul style="list-style-type: none"> - Related technology - Human resources - Physical plant 	<ul style="list-style-type: none"> - Documentary review (documentary corpus) - Observation (systematic recording in field diaries)
Distribution	<ul style="list-style-type: none"> - Delivery times - Distribution channels 	<ul style="list-style-type: none"> - Documentary review (documentary corpus) - Observation (systematic recording in field diaries)
Organizational Performance	<ul style="list-style-type: none"> - Customer service - Communication media and dissemination of commercial activity 	<ul style="list-style-type: none"> - Documentary review (documentary corpus) - Observation (systematic recording in field diaries)

Note: The table presents the study categories through which the processes in the supply chain that are closely related to the production and commercialization of bodywork for cargo vehicles in the municipality of Duitama, Boyacá are interpreted.

Through the proposed categories, we seek to delve into the problems that arise in each of the links that make up the supply chain in the bodywork sector in the municipality of Duitama, Boyacá.

Phases of the research

The stages formulated are related to the objectives that direct the research process, in this sense, the study is framed in four phases.

First Phase - Document Retrieval

The first phase of the study focuses on the recovery of information inherent to the supply chain of the auto body sector in the municipality of Duitama Boyacá, for which different searches are made in documents such as articles, theses, books, among others. The way in which the documents were retrieved is described in detail in the results section.

Second Phase - Analysis

This phase of the research process focuses on the analysis of the documents collected, in order to establish positive and negative aspects of the different links that make up the supply chain under study.

Third Phase – Improvement

The third phase of the research process is aimed at formulating guidelines integrated in improvement plans, which allow optimizing the mechanics of operation in each of the links analyzed in the supply chain of the Duitamense bodywork sector.

Fourth Phase - Reflection

The last phase of the study is oriented to the reflection of the needs that entrepreneurs must face in the links that make up the supply chain of the bodywork sector in the municipality of Duitama, Boyacá.

4. Results

This section presents the results that emerge from the research process, which are oriented to the analysis of the study categories, in order to elucidate the events that occurred in the activities of each of the links that make up the supply chain of the bodywork sector in the municipality of Duitama - Boyacá. The results outlined in this section are the result of the fulfillment of the study objectives and the development of each of the stages established in the methodological design.

Results Document Retrieval Phase

In order to fulfill the first objective of the study: To review the research tradition inherent to the supply chain of the car body sector in the municipality of Duitama, the methods used in the study

were taken into account, and based on this, a work plan was formulated for the recovery of documents related to the object of the study, specifically the search and selection of bibliographic references was framed in two moments: firstly, a search of documents that link inherent themes to the supply chain of the car body sector in the municipality of Duitama was carried out, using databases, repositories of universities in the department of Boyacá, and searches of material not published digitally. In a second stage, once the bibliographic material was available, it was classified by reference to the study categories (supply, production, distribution and organizational performance).

It should be emphasized that, in order to retrieve the references consulted, some inclusion and exclusion criteria were established for the selection of bibliographic material and its linkage to the study, the following criteria were established:

- Academic productions that link the study of the supply chain of the bodywork sector.
- Articles, theses, book chapters, among others, that analyze the links that make up the supply chain under study.
- Bibliographic material related to the supply chain of the auto body sector in the municipality of Duitama - Boyacá.
- Academic publications submitted to peer review and published in journals with recognized indexing.

Likewise, for the exclusion of bibliographic sources, the following criteria were taken into account:

- To eliminate documentary sources, in which topics related to the object of study are not linked.
- Not taking into account articles in which, although allusion is made to the supply chain of the bodywork sector, the links that constitute it are not analyzed.
- Omitting documentary material that does not offer the expected scientific rigor in the results.

The bibliographic material related to the study was organized through a documentary corpus, in which about 35 research studies related to the object of study were registered.

Results Analysis Phase

After configuring the documentary corpus of research references, the information is analyzed, framing it in each of the established study categories. The following results are derived from this analysis:

Category: Procurement

The analysis of this category focused on interpreting the processes of procurement of inputs for the production and maintenance of bodywork in the automotive sector in Duitama, Boyacá. In the study by Jiménez (2012), it was identified that the metal-mechanical companies in the municipality presented management problems that affect the supply chain. In addition, it was evidenced that the origin of raw materials, predominantly of local and national origin, represented 70% in medium-sized companies and 76.9% in micro and small companies.

However, on occasions, entrepreneurs had to resort to international markets due to the high demand for inputs, which generated delays in production due to logistical problems and lack of control in the acquisition of these materials (Jiménez, 2012; Nuñez, 2012).

The study by Nuñez (2012) highlighted the lack of knowledge of entrepreneurs on issues such as customs procedures and the selection of suppliers, which led them to depend on intermediaries, making procurement more expensive. Research by Alianza Carrocera de Boyacá S.A.S. (2013) pointed to competition from companies strategically located outside the municipality, which forced local entrepreneurs to resort to the resale market and assume high costs to obtain inputs. For its part, the TEAM consulting group (2014) noted the lack of an effective supplier system and an adequate cost structure in Duitama companies, which led to weak integration in the supply chain.

The study “Innovation Ecosystem” (Duitama Chamber of Commerce and UPTC, 2016) showed that, despite the difficulties, 97% of the companies in the bodywork sector defined their raw materials and 88% had established suppliers. However, faced with the high demand for services, the companies had to resort to importing inputs, which generated additional problems due to the lack of adequate methodologies for inventory management and control of raw material needs. The lack of organization and associative strategies was also a limiting factor in the efficient procurement of inputs.

Finally, it was observed that the companies lacked an inventory system to regulate the availability of raw materials and a database of suppliers. This situation forced entrepreneurs to resort to intermediaries to import inputs, which increased costs. In addition, it was noted that the lack of a free trade zone negatively affected the competitiveness of the sector by increasing the costs of importing materials needed for production (Jiménez, 2012; Nuñez, 2012; TEAM, 2014; Duitama Chamber of Commerce and UPTC, 2016).

Category: Production

The analysis of the production link in the supply chain of the auto body sector in Duitama, Boyacá, revealed a lack of technological adoption and deficiencies in the management of human resources and physical plants. Jiménez Orozco (2012) found that, although most entrepreneurs used process maps to improve results, 53.3% did not prioritize quality, which limited their competitiveness. Studies by Nuñez (2012) and Grupo Consultor TEAM (2014) noted that productive capacity was restricted, in part, by the need for intermediaries for exports and the lack of adequate technology. Mojica (2015) confirmed that entrepreneurs had difficulties in adopting new technologies and coordinating processes, thus limiting standardization, automation and product diversification.

Additionally, studies indicated that most companies did not conduct scientific research or technology transfer, which undermined innovation and the ability to expand their portfolio (Mojica, 2015; Figueredo et al., 2020). The lack of qualification of human resources and the absence of talent management plans were also recurrent problems, as well as informal hiring and weak managerial skills (Mojica, 2015; ORMET Boyacá, 2014). This panorama was complicated by low business associativity, which hindered the creation of strategic alliances needed to improve competitiveness and explore new markets.

Regarding infrastructure, the non-participant observation technique revealed that most of the physical plants were inadequate for the optimal functioning of each organizational subsystem, affecting productive processes (Figueredo et al., 2020). In addition, limited access to raw materials diminished productive capacity, while imports competed with local production (Figueredo et al., 2020). Field observations corroborated that the companies faced significant problems related to the lack of qualified human resources and scarce technological innovation, affecting compliance in the delivery of tasks (Mojica, 2015).

In consensus, studies concluded that the limited adoption of advanced technology, low human resource training and lack of adequate infrastructure were the main factors restricting the development of auto body companies in the municipality of Duitama, Boyacá (Jiménez, 2012; Mojica, 2015; Figueredo et al., 2020). These findings highlighted the need to design strategies to safeguard the work of national entrepreneurs and foster innovation to strengthen the production chain.

Distribution Category

In the distribution category, the documentary analysis revealed limiting factors in the business development of the Duitama auto body sector, mainly in the distribution link. Jiménez (2012) identified that the delivery of finished products was carried out directly by the auto body companies, without a strategic marketing approach. The study highlighted the need for these organizations to have a marketing department that would evaluate variables such as distribution channels, points of sale, and competitor analysis to generate competitive advantages. Mojica (2015) also noted that the lack of effective marketing strategies and a marketing plan decreased market share and reduced the competitiveness of these companies.

On the other hand, Nuñez (2012) observed that auto body companies faced market participation problems due to the lack of innovation in commercialization and marketing channels, which resulted in static markets and low inventory turnover, affecting their growth and their ability to compete in national and global markets. In addition, these companies limited their commercial activity to the local and national environment, as they lacked knowledge of customs handling and procedures, and did not have specialized personnel to expand their commercial horizons.

Figueredo et al. (2020) found that the lack of adequate distribution channels and means of distribution compromised the companies' ability to reach a greater number of clients, while foreign companies captured underserved clients through more effective customer service strategies. Likewise, Mojica (2015) highlighted that only 27% of the companies monitored the market, neglecting distribution plans, sales projection, delivery control and transportation processes, which contributed to their distance from competitiveness.

In general terms, the studies reviewed pointed to the need for car body companies to establish more efficient strategies for the distribution of their products, ensuring the timely fulfillment of customer requirements and maintaining high quality standards in order to compete in the global market.

Organizational Performance Category

In the organizational performance category, the study by Jiménez (2012) pointed out that most of the companies in the auto body sector in Duitama had not articulated a coherent logistics policy that integrated the different links in the supply chain, resulting in a lack of coordination that negatively affected organizational performance. The study concluded that it was necessary to have a logistics area that would promote the integration of all areas in order to achieve organizational goals and objectives more effectively.

Núñez (2012) highlighted that organizational performance also depended on customer satisfaction, an aspect that companies often neglected by not implementing strategies to learn customers' opinions about the services provided. In addition, his research indicated that most organizations had not adopted strategies to build customer loyalty. Mojica (2015) corroborated these findings, noting that companies did not adequately analyze customer needs, as their marketing plans were designed without considering service levels adapted to customer typology or providing after-sales support.

Figueredo et al. (2020) considered that the organizational performance link was key to business progress, but the lack of a long-term strategic vision in most entrepreneurs limited its development, focusing only on meeting the immediate needs of customers. This study identified a lack of monitoring of productive activities, as well as the absence of service portfolios adapted to the needs of each client, which showed an insufficient logistics organization in the bodywork sector.

Finally, through observation techniques, it was corroborated that the auto body organizations in Duitama did not have a logistics structure focused on the harmonization of the links in the supply chain, operating as autonomous subsystems without following a coordinated process. It was also observed that the companies did not follow up with customers to measure their satisfaction, nor did they offer after-sales service or incentives for customer loyalty, which significantly affected their organizational performance.

Results Phase - Improvement

The third phase of this study focuses on the formulation of a set of guidelines aimed at generating an integral improvement plan for the supply chain of the Duitama auto body sector. The objective of this phase is to optimize the mechanics of operation in the previously analyzed links, which include supplier management, production, distribution and organizational performance. To this end, an analysis of the critical areas that require intervention has been carried out, in order to propose solutions that improve the operational efficiency and competitiveness of the sector.

The results obtained in this phase reflect the need for greater standardization of processes, the incorporation of emerging technologies, and the implementation of sustainability strategies to reduce costs and increase quality at each stage of the supply chain. In addition, key factors related to human resource management and continuous training were identified as key elements to ensure the success of the proposed improvement plans. These results will be fundamental in guiding the strategic decisions of the auto body sector in the coming years.

- Procurement Link Improvement Plan

The procurement link is a critical factor in the operational efficiency of Duitama's car body companies. According to recent authors, a correct management of the supply chain and an adequate selection of suppliers are essential to avoid delays and cost overruns in the acquisition of raw materials (Wang, et al., 2020). In the case of the auto body sector, companies face problems derived from the lack of stable suppliers, delays in the importation of inputs, and dependence on intermediaries in customs processes, which affects profits and generates non-compliance in delivery deadlines to customers. The improvement plan focuses on strengthening these aspects through the strategic selection of suppliers, staff training, and the promotion of business partnerships.

One of the first actions required is the implementation of a supplier evaluation and selection system to ensure the quality of materials and compliance with delivery deadlines. According to Barratt (2018), organizations that establish long-term relationships with reliable suppliers significantly improve their responsiveness to market demand. In this sense, the creation of a portfolio of standardized suppliers is suggested, prioritizing those that meet quality and timeliness requirements. Supplier management, supported by recent studies, is key to optimize sourcing and reduce the negative impact on the supply chain (Sarkis, et al., 2019).

Another essential element is the training of personnel in international trade and customs matters. The lack of knowledge in these processes has led companies to depend on intermediaries for imports, which increases operating costs. To counteract this situation, it is essential to form internal teams that can directly manage customs operations, as suggested by authors such as Knemeyer and Murphy (2018), who emphasize that training in international logistics reduces errors and streamlines the supply chain. In addition, having trained personnel allows companies to save time and money, contributing to the improvement of the flow of inputs.

Finally, the creation of a business cluster is essential to improve procurement efficiency. According to recent studies, inter-firm collaboration allows organizations to obtain economies of scale, especially in the joint purchase of inputs (Christopher, 2020). The associativity between entrepreneurs in the auto body sector would strengthen their bargaining power with international suppliers, reduce delivery times and minimize the risk of raw material shortages. In addition, the implementation of efficient inventory control systems, as pointed out by Lee and Tang (2021), ensures constant monitoring of production needs, avoiding interruptions in the production process.

Therefore, improving the supply link in the Duitama auto body sector requires a comprehensive strategy that includes supplier selection, personnel training and the creation of a business cluster. These actions, supported by recent literature, will optimize the supply chain, reduce the costs associated with intermediaries, and improve the operational efficiency of the auto body companies. The adoption of these measures will help strengthen the sector's competitiveness in the local and international markets.

- Production Link Improvement Plan

The improvement plan for the production link in the companies of the bodywork sector in Duitama, Boyacá, is based on the need to modernize the technologies used and optimize the coordination of production resources. It has been identified that close to 60% of the companies have not implemented state-of-the-art technologies, which has a negative impact on the efficiency and quality of the final products. According to Monczka et al. (2020), the lack of integration of disruptive technologies, such as Industry 4.0, limits the ability of companies to improve their competitiveness. Therefore, one of the first actions proposed is investment in innovative technologies to optimize production processes.

In addition, it has been evidenced that the lack of professionals trained in the use of advanced technologies represents a significant obstacle to the proper functioning of the production link. Wamba et al. (2018) point out that the training of personnel in new technologies is essential to achieve the full adoption of Industry 4.0 in the production sector. In this sense, it is suggested that auto body companies establish partnerships with educational institutions to train their operators, so that they can efficiently manage the acquired technologies, thus ensuring product quality.

The layout of work spaces is also a critical area for improvement. In many companies, it was observed that productive tasks are developed in spaces that are not adequate for each function, which affects productivity. Arntz et al. (2019) emphasize that a correct layout of work areas is key to the success of productive processes, as it allows for greater operational efficiency. Therefore, the segmentation of productive spaces is proposed so that each task is performed in the most appropriate area, thus contributing to the optimization of the overall process.

Ultimately, there is a need for an in-depth analysis of the times and movements at each stage of the production process to avoid delays and meet the delivery times agreed with customers. Srai et al. (2020) emphasize the importance of studying production times and implementing continuous improvements that allow a significant reduction in delays. The implementation of these actions will not only improve the quality of production, but will also open new opportunities for car body companies, facilitating their incursion into larger and more demanding markets.

- Distribution Link Improvement Plan

In order to strengthen the distribution link in companies in the bodywork sector in Duitama, Boyacá, it is crucial to implement an improvement plan based on strategies that optimize both the delivery of finished products and the dissemination of the service portfolio. One of the most recurrent problems is the lack of adequate distribution channels, which affects the efficient delivery of products to the final customer. According to Chávez et al. (2019), the formation of strategic alliances between companies can be an effective solution to optimize logistics processes and improve competitiveness. In this sense, partnerships between companies in the sector can enable the consolidation of agreements with fixed carriers that guarantee quality service, reducing operating costs and improving customer satisfaction.

The use of technology is another key to improving the distribution link. According to Muñoz et al. (2020), digital marketing is a powerful tool that can increase the reach of companies in local and international markets. In the case of auto body companies, the creation of interactive digital platforms that offer customers the ability to configure services according to their needs can result in greater customer customization and loyalty. This approach is aligned with current marketing trends, where customer experience has become a determining factor in business success (López and García, 2021).

Likewise, the integration of new technologies such as artificial intelligence and augmented reality in distribution processes can be a catalyst of innovation for the sector. As Rodríguez and Pérez (2021) argue, these technologies enable better supply chain management and can optimize the relationship with customers by offering personalized experiences. The implementation of these technological advances would contribute not only to improve logistics efficiency, but also to broaden the portfolio of services offered, thus increasing the competitiveness of auto body companies in Duitama.

Therefore, to ensure the viability of the improvement plan, it is essential to carry out a continuous analysis of the performance of the new processes implemented. Constant monitoring, as recommended by Jimenez and Martinez (2018), allows adjusting strategies according to emerging needs and ensures the long-term sustainability of the improvements introduced. This proactive approach to distribution management can consolidate Duitama's auto body companies as leaders in their sector, both locally and in other markets.

- Organizational Performance Link Improvement Plan

The organizational performance improvement plan in the Duitama car body sector should focus on the effective integration of the different links in the supply chain, promoting the harmonization of processes and avoiding the disarticulation that affects decision making. The implementation of collaborative management models is essential to overcome the lack of cohesion between the links. According to García and Maldonado (2018), efficient management of the links in a production chain is key to business competitiveness, as it allows greater adaptability to market changes and customer demands. This strategy should focus on hiring personnel specialized in logistics and organizational management to ensure that processes are aligned with the organization's goals.

On the other hand, it is essential to establish direct feedback mechanisms with customers, both in the after-sales phase and in the design of personalized services. In this regard, Pérez et al. (2020) suggest that the use of digital technologies to capture customer feedback and adapt to their expectations contributes significantly to customer loyalty. In addition, digital marketing tools and the simulation of services through technological platforms could improve the customer experience, allowing the customer to actively participate in the personalization of products and services. The sector must move towards the adoption of 4.0 technologies, such as artificial intelligence, to optimize customer-company interaction in the configuration of auto parts.

A crucial element of the improvement plan is the implementation of an after-sales service system. According to studies by Rodríguez and Suárez (2019), after-sales service is one of the most effective strategies to ensure customer loyalty and create a solid base of referrals. The lack of

customer follow-up after the service has been one of the weak points of the Duitama bodywork sector, and to reverse this situation, support units should be established to address any inconvenience that customers may present, providing quick and effective solutions. In this way, the sector will be able to differentiate itself from other more advanced markets such as Cundinamarca and Antioquia.

In short, the massification of digital marketing and the visibility of the services offered by bodybuilder organizations is essential to improve their positioning in the market. According to Ramírez (2021), the digitalization of dissemination channels allows not only to reach a wider audience, but also to segment the services offered according to the different types of customers and their economic needs. The linking of digital media, such as social networks, and the advertising of service portfolios will make it easier for customers to access product simulations, promoting a higher level of interaction and satisfaction.

Results Reflection Phase - Discussion

The analysis of the categories studied highlights that competitiveness is an essential factor in ensuring the profitability and sustainability of companies. A low level of competitiveness not only negatively affects the business fabric, but also has repercussions on the decrease in wealth and social welfare of communities. This situation can increase unemployment levels and even lead to the closure of organizations in the most extreme cases. As pointed out by Vázquez-Ávila et al. (2020), competitiveness is crucial for the survival and success of companies in the current economic environment.

From this perspective, it is essential for organizations to maintain harmony in the operation of the links that make up their supply chain. Ensuring the satisfaction of customer expectations through the delivery of products or services at a fair price, in the shortest possible time and with high quality standards, is an imperative need. To achieve this, it is crucial to ensure that production costs are kept to a minimum without compromising quality. In this sense, Gómez-Montoya et al. (2019) emphasize the importance of efficient supply chain management to achieve a sustainable competitive advantage.

According to Porter (2008), suppliers exert a significant influence on companies, especially when it comes to acquiring raw materials or supplies for which few suppliers are available. This situation can lead to high prices, difficulties in price allocation and quality assurance of the services or goods offered. Reinforcing this idea, Martínez et al. (2021) point out that strategic supplier management is essential to maintain competitiveness in highly specialized industries such as car manufacturing.

Although these approaches represent a desirable ideal, the review of the research tradition and the observations made indicate that approximately 70% of the organizations in the bodywork sector in the municipality of Duitama do not integrate adequate technologies in their production processes. This deficiency contributes to low levels of competitiveness. One of the factors identified is the lack of knowledge of the technological offers adopted by similar companies in other regions of the country. In this regard, Carvajal et al. (2022) stress the importance of technological adoption as a key factor for improving competitiveness in the manufacturing industry.

The documentary analysis indicates that nearly 80% of the studies reviewed indicate that suppliers, particularly international suppliers, experience considerable delays in the delivery of raw materials. This is aggravated when the volume of demand is high, which generates losses in productivity and an increase in operating costs.

In line with the above, it is relevant to mention Porter (2008), who argues that suppliers exert a significant influence on companies, especially when it comes to acquiring raw materials or supplies of which few suppliers are available. This situation can lead to high prices, difficulties in price allocation and in guaranteeing the quality of the services or goods offered. Therefore, it is pertinent to explore strategies that facilitate the procurement of materials both domestically and internationally to meet the needs of the bodywork sector.

Delays in the shipment of materials and inputs have a direct negative impact on the production link, affecting compliance with customer delivery deadlines. According to Amat (1998), the productivity link encompasses various responsibilities and tasks that must be fulfilled so that production operations are carried out in compliance with the quality, deadline and cost conditions established in the organizational objectives. Along the same lines, Jiménez (2012) argues that the management of the production link should be oriented towards maximizing efficiency and effectiveness in order to achieve the expected results.

Regarding facilities, it is observed that most of the organizations in the Duitama car body sector lack adequate infrastructure to efficiently carry out the processes of the production link. On this point, Rodríguez et al. (2023) argue that investment in infrastructure and optimization of the production layout are fundamental to improve operational efficiency in the metal-mechanic industry.

Although this link is crucial to production processes, entrepreneurs have not adequately appreciated its importance within the supply chain. Studies indicate the presence of problems that limit the expansion of services offered by organizations in the bodybuilding sector. It is necessary for entrepreneurs to integrate innovative strategies, such as the creative economy, using mass media to publicize their portfolio of services. Likewise, the adoption of digital marketing could improve the commercialization of products and services of auto body companies in Duitama, facilitating their expansion to new markets. In this sense, Gómez and Otero (2020) highlight the importance of digital marketing as a tool for the expansion and competitiveness of SMEs in the Colombian context.

In relation to the organizational performance link, the study indicates that most of the companies in the auto body sector in Duitama, Boyacá, have not developed logistics policies aimed at achieving a harmonious operation between the different links of the supply chain. The studies analyzed and the observation made show a mismatch between the supply, production, distribution and organizational performance links. These areas tend to operate in a disjointed manner, which evidences the lack of continuous communication necessary for effective organizational management. This disarticulation represents a barrier that limits the achievement of business goals and objectives. In this regard, Arévalo et al. (2018) point out that the effective integration of logistics processes is fundamental for the success and competitiveness of manufacturing companies.

In general terms, the supply chain of the auto body sector in Duitama, Boyacá, faces significant problems in the supply, production, distribution and organizational performance links. These problems limit the progress of the metal-mechanic industry in the region. If corrective measures are not taken and effective strategies are not designed to overcome the difficulties identified, it is likely that the sector's companies will not be able to survive over time, which could have a critical impact on municipal development and job opportunities.

5. Conclusions

Based on the documentary review of the investigative tradition and the realization of some observations to the companies of the bodywork sector of Duitama Boyacá, through the investigative process it could be evidenced that there are different problems that limit the business progress of this sector of the economy of Duitama, in this sense it is concluded that:

The study reveals that one of the main obstacles to the harmonious development of the auto body sector in Duitama, Boyacá, is the lack of associativity among entrepreneurs. This lack of collaboration negatively affects the supply and distribution links of the supply chain. In procurement, the absence of an associative model forces entrepreneurs to import raw materials individually, resulting in retail purchases and high costs. In distribution, most companies lack efficient channels for transporting finished products, which generates uncertainty for both the organization and the customer.

The implementation of a cluster is a promising strategy to stimulate the growth of Duitama's auto body sector. This form of associativity could promote collaboration among entrepreneurs, foster the exchange of knowledge and resources, and optimize procurement, production, and distribution processes. It would also facilitate the creation of strategic alliances and the formation of networks of suppliers and distributors, which would translate into better negotiating conditions and access to a greater variety of resources and inputs.

The University Company State Society Committee (CUEES) plays a crucial role in the consolidation of the auto body industry cluster. By integrating businessmen, academics, local government representatives and the community, CUEES becomes an ideal space for the exchange of knowledge and the formation of strategic alliances. The participation of academia in this committee allows the application of research and scientific developments for the benefit of the industry, while the presence of local government facilitates the creation of an appropriate regulatory framework and public policies that promote the sector.

It is evident that there is a need to redefine the logistic processes in the organizations of the bodywork sector in Duitama in order to improve their positioning in the market and guarantee their sustainability. The lack of qualified personnel in organizational management is identified as one of the factors that affect the poor management of these processes. It is imperative that companies adopt continuous improvement guidelines in all the links of their supply chain, including the implementation of Industry 4.0 technologies and the hiring of human resources competent in their use.

The study also highlights the importance of focusing the activities of organizations in the car body sector on customer satisfaction. It identifies the need to create strategies that allow greater contact between the customer and the company, enabling their participation in production processes. The use of Industry 4.0 technologies, such as artificial intelligence, could allow customers to make prototypes of the required auto parts. In addition, it is recommended to improve the supply of the service portfolio through technology and establish a post-sale follow-up system to evaluate and improve customer satisfaction.

In conclusion, the improvement in the activities and processes of each of the links in the supply chain of the Duitama car body sector can be achieved through the integration of logistics strategies aimed at responding to the problematic situations identified. The associativity, materialized in the formation of a cluster and supported by CUEES, appears as a promising solution to face the challenges of the sector. It is essential that entrepreneurs become key players in this process, supporting each other and considering the implementation of associative models that seek the common good and the progress of the bodywork industrial sector in the region.

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