

Reverse logistics strategy that allows the recovery of bottles glass in optimal conditions for the Cauca Liquor Industry

Estrategia de logística inversa que permita la recuperación de envases de vidrio en óptimas condiciones para la Industria Licorera del Cauca

Estratégia de logística reversa que permite a recuperação de embalagens de vidro em condições ótimas para a Indústria de Licor Cauca

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Abstract

Introduction: The article is the result of the research on reverse logistics strategies that allow the recovery of glass bottles in optimal conditions for the Cauca Liquor Industry, developed at the Fundación Universitaria de Popayán in 2024.

Methods: The methodology began with a diagnosis of the use of glass containers in the liquor industry. Based on this analysis, strategies were developed to improve container recovery. Innovative technologies were studied, a collaboration with local communities was proposed, and transportation routes were optimized to ensure a more efficient collection process.

Results: The study identified several key solutions. The importance of integrating technologies to facilitate the sorting and collection of glass containers was emphasized. The active involvement of local communities in the collection process was also highlighted. Additionally, the optimization of transportation routes contributed to more efficient management.

Conclusions: This paper demonstrates that reverse logistics is essential for the sustainability of the I.L.C. Implementing strategies for the recovery and reuse of glass containers not only supports the circular economy but also reduces environmental impact.

Originality: This study provides innovative solutions to a specific problem faced by the I.L.C., offering a unique approach to solving the glass container shortage.

Limitation: The implementation of these strategies may face challenges related to available infrastructure and the collaboration of all involved stakeholders.

Keywords: Costs, efficiency, reverse logistics, production.

Resumen

Introducción: El artículo es producto de la investigación Estrategia de logística inversa que permite la recuperación de botellas de vidrio en condiciones óptimas para la Industria Licorera del Cauca, desarrollada en la Fundación Universitaria de Popayán en el año 2024.

Metodología: La metodología inició con un diagnóstico sobre el empleo de envases de vidrio en la industria licorera. Con base en este análisis, se desarrollaron estrategias orientadas a mejorar la recuperación de envases. Se estudiaron tecnologías innovadoras, se propuso realizar una colaboración con comunidades locales y se optimizaron las rutas de transporte, con el objetivo de asegurar un proceso de recolección más eficiente.

Resultados: El estudio identificó varias soluciones clave. Se destacó la importancia de integrar tecnologías para facilitar la clasificación y recolección de los envases de vidrio. También se resaltó la participación activa de las comunidades locales en el proceso de recolección. La optimización de rutas de transporte contribuyó a una gestión más eficiente.

Conclusiones: Este artículo demuestra que la logística inversa es fundamental para la sostenibilidad de la I.L.C. La implementación de estrategias de recuperación y reutilización de envases de vidrio no solo apoya la economía circular, sino que también reduce el impacto ambiental.

Originalidad: Este estudio aporta soluciones innovadoras a un problema específico de la I.L.C, ofreciendo un enfoque único para resolver la escasez de envases de vidrio. *Limitación:* La implementación de las estrategias podría enfrentar desafíos relacionados con la infraestructura disponible y la colaboración de todos los actores involucrados.

Palabras clave : Costos, eficiencia, logística inversa, producción, impacto ambiental

Resumo

Introdução: Este artigo é produto do projeto de pesquisa "Estratégia de Logística Reversa para a Recuperação de Garrafas de Vidro em Condições Ótimas para a Indústria de Bebidas Alcoólicas do Cauca", desenvolvido na Fundação Universitária Popayán em 2024.

Metodologia: A metodologia teve início com uma avaliação diagnóstica do uso de recipientes de vidro na indústria de bebidas alcoólicas. Com base nessa análise, foram desenvolvidas estratégias para aprimorar a recuperação de recipientes. Tecnologias inovadoras foram estudadas, a colaboração com as comunidades locais foi proposta e as rotas de transporte foram otimizadas para garantir um processo de coleta mais eficiente.

Resultados: O estudo identificou diversas soluções-chave. A importância da integração de tecnologias para facilitar a triagem e a coleta de recipientes de vidro foi destacada. A participação ativa das comunidades locais no processo de coleta também foi enfatizada. A otimização das rotas de transporte contribuiu para uma gestão mais eficiente.

Conclusões: Este artigo demonstra que a logística reversa é essencial para a sustentabilidade da Indústria de Bebidas Alcoólicas do Cauca. A implementação de estratégias de recuperação e reutilização de recipientes de vidro não apenas apoia a economia circular, mas também reduz o impacto ambiental.

Originalidade: Este estudo apresenta soluções inovadoras para um problema específico na ILC, oferecendo uma abordagem única para lidar com a escassez de recipientes de vidro. Limitação: A implementação das estratégias pode enfrentar desafios relacionados à infraestrutura disponível e à colaboração de todas as partes interessadas.

Palavras-chave: Custos, eficiência, logística reversa, produção, impacto ambiental

1. INTRODUCTION

The dynamism of the environment compels organizations to develop capabilities that differentiate them from competitors, enabling them to either enter or maintain a strong position in the market. These capabilities must align not only with consumer demands but also with legal requirements and environmental conditions.

This research applies the principles of reverse logistics, which focuses on the planning and control of waste returns—from consumption points to manufacturers or distributors—for recovery, repair, recycling, or disposal.

In today's business landscape, companies are responsible not just for ensuring quality and affordability, but also for adding value to their products by considering environmental factors. Growing concerns over excessive pollution have driven companies to build reverse logistics capabilities, particularly in managing waste and returned products. This allows them to recover economic value and reduce waste generation. As a result, reverse logistics has become a key business strategy, helping companies reduce costs, decrease environmental impact, and enhance their reputation, thereby improving customer loyalty.

The research addresses an ongoing issue faced by many organizations, including the Cauca Liquor Industry, which struggles with the shortage of raw materials (such as packaging), affecting productivity.

The Cauca Liquor Industry has yet to implement a reverse logistics approach, as it had not previously encountered a situation of raw material scarcity. As a result, no strategies have been developed for recovering raw materials for reuse. By introducing a robust reverse logistics strategy, the industry could reduce costs and minimize glass contamination, leading to more sustainable practices.

Literature Review

A. Reverse Logistics

Reverse logistics encompasses various aspects derived from supply chain management, including the transfer of materials from the user or consumer to the producer or collection point for reuse, recycling, or eventual final disposal. Some definitions of reverse logistics also include the stages of dismantling or processing materials for recycling or disposal in an environmentally friendly manner.

According to [1][2], reverse logistics is a significant sector within logistics, comprising a wide range of activities. Some of these activities are primarily ecological, such as the recovery and recycling of products to prevent environmental deterioration. Others focus on improving production and supply processes, offering greater benefits.

In Europe, reverse logistics is understood from the perspective of recovering and economically utilizing used materials and products, for which the manufacturer holds certain responsibilities [3].

According to [4], reverse logistics involves the planning, development, and efficient control of the flow of materials, products, and information from the point of origin to the point of consumption. The aim is to satisfy consumer needs while recovering waste and managing it so that it can be reintroduced into the supply chain, thus adding value.

Reverse logistics is a strategy aimed at reusing products once they have reached the end of their life cycle. Its purpose is to mitigate contamination and expand market opportunities. This practice involves techniques such as incineration, prefabrication, and remanufacturing, which allow products to be given new life, contributing to both environmental and economic sustainability [5].

B. Contributions of Reverse Logistics in Business Practices

The main objective of this research was to propose and evaluate an improvement based on reverse logistics, which aims to improve returns. This was applied to a 250 ml returnable soft drink bottle company, reducing the need to purchase new containers. Four critical research points were identified: storage management, container returns, the purchase of new bottles, and the evaluation of bottle conditions. These factors influence the decision to purchase new packaging and the associated costs [6].

Reverse logistics, or "Reverse Logistics" as it is known globally, has gained increasing importance over the past fifteen years in the planning of waste management across the entire supply chain (SC). Its growing significance is due to two primary reasons [7]:

Social responsibility: Finding solutions to manage the vast amounts of waste generated by companies worldwide, with serious environmental consequences.

Added value in the service: Providing clients with solutions that contribute to environmental protection, offering an alternative for better disposal of residual materials throughout the logistics process.

The current trend of optimizing production processes, coupled with growing social awareness about environmental protection, creates an ideal scenario for studying measures that allow for the reuse of packaging or the recycling of raw materials. It is essential for industries to generate production strategies aimed at minimizing environmental impact, not only as a part of internal processes but also as a competitive advantage [8].

New environmentally friendly production and quality trends are evident in modern companies. Logistics, as an important business activity, has also evolved in this direction. Reverse logistics strategies emerged at the end of the last century, aiming to return products, containers, and packaging for direct reuse, saving components, recycling materials, or ensuring correct disposal with minimal environmental impact. Despite significant progress, reverse logistics remains a relatively new concept, especially in developing countries, where much remains to be done [9].

Reverse logistics practices provide companies with a competitive advantage when effectively implemented, reducing environmental pollution and saving costs.

Research has demonstrated that the main objective of developing reverse logistics for returnable glass containers in a company also required the implementation of a production line for glass containers at the Lima Plant to serve the metropolitan Lima area. This implementation will reduce production costs and save on raw materials [10].

Other studies showed that beverage companies in Cuenca, aiming to raise social awareness, reduced packaging waste by adopting a new beverage marketing alternative that allowed for the reuse of packaging. A qualitative and quantitative investigation revealed that young consumers were more inclined to use a packaging reuse mechanism. As a result of this research, strategies and tactics were developed for the campaign “It’s Time to Reuse” [11].

Reverse logistics also offers companies the opportunity to meet sustainability goals. Repairing, reconditioning, and recycling products help keep them out of landfills [12].

C. Green Logistics and Circular Economy

The decision to explore logistics and its relationship with the circular economy stems from the abundant information available on each topic individually, along with the opportunity to produce documentary material on specific cases within the sector. While there are existing documents linking logistics with sustainability—one of the reasons why green logistics emerged at an organizational level—few present cases as analysis tools [13].

The concept of the circular economy refers to a new perspective that advocates for the reuse of materials as many times as necessary to fully exploit their useful life. According to [14], the circular economy is defined as a tool for managing reusable elements that can re-enter the production process.

Reverse logistics is often associated with green logistics, but the distinction between the two should be recognized. “Reverse logistics is defined as all efforts to move goods to recover value, while green logistics refers to reducing or eliminating the ecological impact of logistics.” Both concepts go hand in hand [15].

Another aspect of green logistics is the set of initiatives in transportation and logistics aimed at reducing the negative environmental impact associated with these activities, primarily by reducing emissions and waste [16].

Reverse logistics involves moving goods (products and resources) from the consumer back along the supply chain to the manufacturer. This includes recovering defective products or reclaiming the use value of discarded products. If recovery is not possible, proper disposal through reuse or destruction must be ensured. It differs from green logistics, as reverse logistics specifically focuses on minimizing the ecological impact of logistics activities [17].

D. Reduce, Reuse, and Recycle

“Reduce” involves the appropriate segregation of waste, efficient management of effluents, energy, and minimizing excess. “Reuse” refers to reprocessing devices, while “Recycle” involves transforming waste [18].

Programs supported by the “3Rs” (Reduce, Reuse, Recycle) allow students to engage with various environmental issues in both educational and personal spheres. Environmental training within formal education fosters good environmental practices that contribute to health and the preservation of the environment [19].

Research highlights the global pollution problem, emphasizing the need to reduce it to ensure a livable world for future generations. This research outlines the state of the environment and its impact on the country [22].

The author also discusses the use of discarded glass bottles, which are transformed into reusable products such as glasses, vases, and cups [21].

Recycling is a key component of reducing environmental pollution and addresses the issue of waste accumulation at collection points, which are often used as landfills. Effective recycling not only helps the environment but also generates income, improving the socioeconomic conditions of the region [22].

Environmental awareness and the correct selection and separation of waste are critical for optimal recycling. Additionally, to promote the circular economy, reducing unnecessary consumption and reusing waste are essential for the planet’s sustainability [23].

General Objective:

To formulate reverse logistics strategies that enable the recovery and reuse of glass containers in the liquor industry of Cauca.

Specific Objectives:

1. To conduct a current diagnosis of the use of glass containers within the liquor industry of Cauca.
2. To develop reverse logistics strategies that facilitate the recovery of glass containers for the I.L.C. (Cauca Liquor Industry).
3. To determine the most effective strategy for recovering glass containers and returning them to the I.L.C. for reuse.

2. Methodology

PHASE 1: Carry out a current diagnosis of the use of glass containers in the Cauca liquor industry.:

In the initial phase, a diagnosis was conducted to assess the current situation of the Cauca Liquor Industry (I.L.C.), specifically concerning the shortage of raw materials (glass containers) and how the company is managing the absence of this crucial resource. To provide an accurate diagnosis, various reverse logistics tools, focusing on the treatment of products and raw materials, were utilized. The main cause of the raw material shortage was identified as the supplier's failure to meet packaging demands.

The supplier had to close its largest furnace, which was responsible for generating substantial emissions, leading to the suspension of production. As a result, the supplier was unable to meet the high demand for glass containers. The remaining ovens lacked the capacity to handle the required volume, exacerbating the issue. To address this, the supplier is currently constructing a new oven, expected to be completed in two years.

Due to this reduced production capacity, the supplier could not fulfill the full demand for raw materials (glass containers) from its clients, including the Cauca Liquor Industry. As a consequence, alternative measures had to be explored to mitigate the shortage of glass containers, which are essential for producing approximately 4 million bottles of brandy (anise liquor) annually.

In addition to this challenge, the company is also required to comply with Resolution 1407 of 2018, which mandates environmental management for packaging waste made of paper, cardboard, plastic, glass, metal, and other materials.[24]



Fig. 1: Compliance with the resolution

REPACK – This is the environmental management plan for container and packaging waste, as defined by Resolution 1407 of 2018, and **ReLic** – Environmental Management Plan for the Recovery of Containers and Packaging in the Liquor Sector by the Colombian Association of Liquor Companies (ACIL).[25]

- The **ReLic** Container and Packaging Management Plan was created and disseminated to all liquor stores nationwide to comply with the aforementioned resolution. The plan focuses on the following programs:
 - **Extended Producer Responsibility**
 - **Circular Economy Management**
 - **Corporate Social Responsibility and Responsible Consumption**
 - **Recovery of Containers and Packaging**

Different approaches and strategies were discussed for the design of reverse logistics networks that allow efficient management of glass bottles. These strategies may include optimizing transportation routes, locating collection and processing centers, and ensuring coordination between the various actors in the reverse supply chain. In addition, aspects such as consumer demand, operational and environmental costs, and government regulations related to waste management were considered.

This reverse logistics strategy takes advantage of the existing distribution network through wholesalers, who are already involved in delivering finished products to establishments. By including them in the container return process, the supply chain can be optimized, ensuring a continuous and efficient flow of empty glass containers back to the Cauca Liquor Industry.

By analyzing and synthesizing practices and strategies used in different industrial contexts to efficiently manage the flow of products and materials from the final consumer to the original manufacturer or supplier, it becomes clear that effective returns management is crucial. This aspect of reverse logistics involves not only the receipt and processing of returned products but also the ability to accurately forecast the quantity and type of products that will be returned in the future.

This strategy contributes significantly to the field of supply chain management by offering a systematic and practical approach to designing and optimizing closed-loop supply chain networks, with special attention to managing returnable packaging as an integral part of reverse logistics.

There are several reasons why reverse logistics has become essential. It directly impacts business results, with product return rates, which vary from 2% to 50%

depending on the sector. By the late 2000s, the cost of returned products exceeded £6 billion in the United Kingdom and \$100 billion in the United States.

Collection Centers (Paths and Towns that are Difficult to Access)

The strategy provides a comprehensive view of reverse logistics network design, particularly focusing on addressing remote and hard-to-reach areas. It offers valuable information for professionals and academics interested in improving the efficiency and effectiveness of reverse logistics, particularly in geographically challenging environments.[30]

Reverse logistics is also crucial in green supply chain management, where it contributes to environmental sustainability by facilitating the recovery and recycling of end-of-life products. The development of specific strategies to reach remote areas for product collection may involve innovative technologies, collaboration with local communities, and the optimization of transportation routes.[31]

The goal is to recover residual material from products to reuse it as raw material in new production, thus reducing the need for new raw materials and minimizing waste. With advanced technologies, it is possible to transform waste into new products that meet the same quality standards as the original ones, contributing to sustainability. [32]

Organizations often neglect the management of their products once they have reached final disposal. This leads to new challenges when receiving returns, especially from hard-to-reach areas. These challenges include additional costs for logistics operations and potential loss of customer trust. Therefore, organizations are looking for tools to reduce these additional costs and provide quick, satisfactory responses to product returns. Reverse logistics is one such tool.[33]

Through the analysis of each phase, the importance of reverse logistics was highlighted as a strategy to protect the environment by adequately managing packaging returns, recycling, reusing, and properly disposing of products. This strategy can contribute to greater efficiency and the recovery of value from products.

The proposed strategy is based on the formation of groups of glass container reclaimers, offering economic incentives for their work. These reclaimers will transport the containers to a storage location, where the containers will be verified and rewarded for their work. Finally, the batch of recovered containers will be sent to the Cauca Liquor Industry monthly. This strategy encourages community participation, environmental sustainability, and socioeconomic development in the region.

To address this, it is essential to develop new business models that leverage the principles of the circular economy while optimizing the use of natural resources. This process also involves creating job opportunities in sectors that contribute to Colombia's economic growth, promoting shared and sustainable prosperity as a key element of the country's competitive advantage.[34]

Return of Empty Containers

This strategy is commonly used by brewing companies where the distributor (truck) delivers the product and collects the empty containers. If the liquor industry adopts this strategy, negotiations can be held with distributors and customers, offering bonuses for returning these important containers.

In this way, glass bottles can be collected for reuse up to 30 times, extending their useful life and reducing environmental impact. Once their life cycle ends, the bottles can be recycled to create new glass bottles, closing the packaging cycle.[35]

The increasing importance of reverse logistics has been noted within companies' productivity and competitiveness, especially those with production processes aimed at reducing waste at the end of a product's life. This practice has become one of the key tools for addressing climate change and promoting environmental care.[36]

It is also crucial that reverse logistics practices ensure that the quantity of returned containers is always greater than or equal to the minimum percentage required for recovery. This helps ensure that the supply chain remains efficient and sustainable. [37]

The objectives of reverse logistics focus on proper product handling to enable recovery and transformation processes, reducing costs, providing economic benefits, and minimizing environmental impacts, all while fostering mutual benefits among the involved parties.[38]

PHASE 3: Determine the Most Appropriate Strategy to Recover Glass Containers and Return Them to the I.L.C.

Delivery and Return of Packaging

A highly effective strategy to ensure the delivery and return of containers involves engaging wholesale customers. These customers play a crucial role in distributing products to various establishments like shops, nightclubs, tobacconists, bars, and canteens. The idea is to establish a system in which wholesale customers also act as collection agents, collecting empty glass containers from the establishments where

they deliver products. This ensures that containers are returned consistently to the Cauca Liquor Industry.

To implement this strategy, agreements could be established with wholesale customers, offering them incentives to participate in the container collection and return process. These incentives could include discounts on future purchases, bonuses, or special recognition.

Moreover, wholesale customers could be provided with the necessary equipment to safely transport empty containers, such as special boxes or containers. This would facilitate the handling and integrity of the containers during the return process. It is important to establish an adequate tracking system to monitor the return of containers by wholesale customers. This would help track the effectiveness of the strategy and allow for continuous improvements.

Efficient product distribution is critical in the alcoholic beverage sector, where logistics and strategic wholesaler locations play a vital role. Licorera del Cauca, a company dedicated to producing and distributing liquors in Colombia, has identified several key areas of action to optimize its operations. A detailed table (Table 1) has been prepared to better understand this distribution strategy.

Table 1.

Wholesalers	Municipalities	Annual demand for cases of brandy
1	Santander	120,000
2	Popayan	120,000
3	Maroon	120,000
4	Popayan	120,000
5	Popayan	120,000
6	Popayan	120,000
7	Popayan	120,000
8	Puerto Tejada	60,000
9	Puerto Tejada	60,000
10	Popayan	60,000
eleven	Santander	60,000

Source: own work

The table provides valuable insights into the distribution strategy of Licorera del Cauca, indicating a concentration of distributors in Popayán, which suggests a strong logistical focus on proximity to the production facility and primary consumption centers. This geographic concentration makes sense given the likely higher demand for

Licorera del Cauca products in the region, which justifies the allocation of resources and logistical efforts toward this location.

The two wholesalers located in Santander and Puerto Tejada point to a strategy of market expansion and regional penetration. These distributors help tap into demand for quality spirits beyond the immediate area of Popayán, suggesting that Licorera del Cauca is looking to grow its presence and capitalize on the broader market.

The single wholesaler in Corinth might represent a more selective distribution approach. This could be due to factors like lower demand, demographics, local competition, or economic conditions that make it less profitable or viable to distribute in this area at the same scale as other regions. It could also be an early stage of market development, where more distributors might be added in the future depending on market dynamics.

Overall, the distribution strategy seems to align with Licorera del Cauca’s growth plans, optimizing its logistics and resources based on demand patterns and regional market conditions.

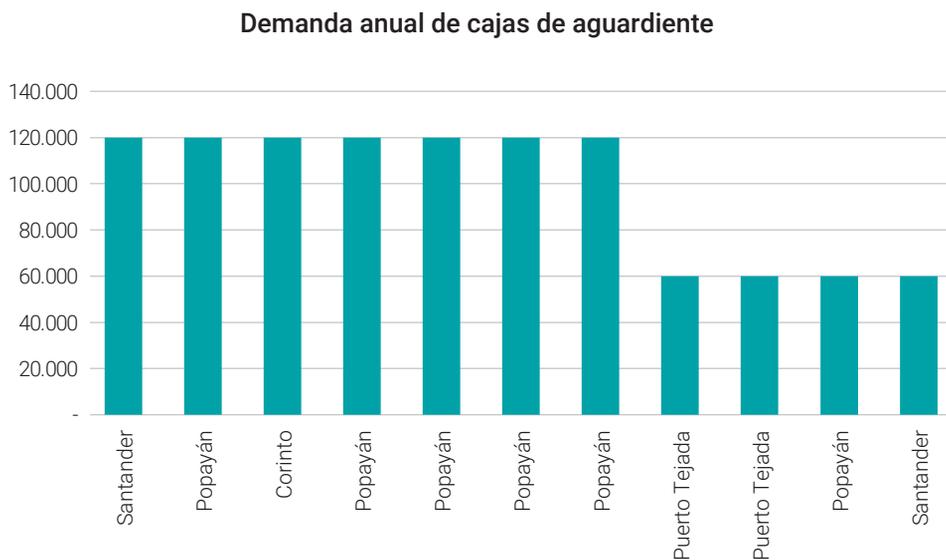


Fig. 2, Bar graph to identify product demand

Source: own work

Six of the wholesalers located in Popayán requested 120,000 boxes of Caucaño brandy annually, while the last wholesaler only required 60,000 boxes of the same product.

In Santander, one of the wholesalers requested 120,000 boxes of Caucano brandy annually, while the other only required 60,000 boxes of the product.

In Puerto Tejada, the two wholesalers requested 60,000 cases of liquor each from the Cauca liquor industry.

In Corinth, the wholesaler requested 60,000 boxes of Caucano brandy annually.

Table 2

Wholesalers	(All)
Row labels	Sum of annual demand for cases of liquor
Maroon	120,000
Popayan	660,000
Puerto Tejada	120,000
Santander	180,000
Grand Total	1,080,000

Source: own work

Below is a summary of the demand for boxes of Caucano brandy by municipality, as shown in Table 2. In Popayán, the highest demand is observed, with a total of 660,000 boxes of brandy requested annually. In Puerto Tejada, the annual demand is 120,000 cases of liquor. In Santander, the total demand is 180,000 cases of Caucano brandy per year. Finally, in Corinth, demand reached 120,000 cases of brandy.

Suma de Demanda anual de cajas de aguardiente

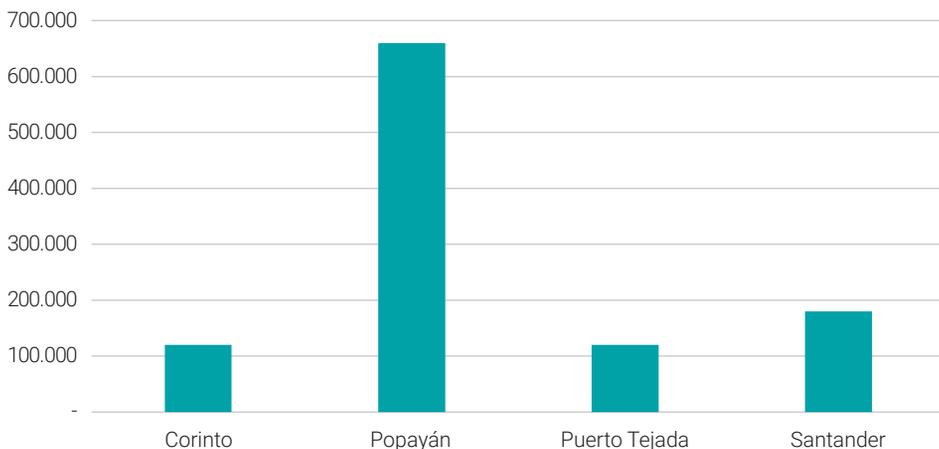


Fig.3: Product demand bar graph year

Source: own work

In the previous Fig. 3, the demand from each municipality is graphically represented, with Popayán showing the largest demand for the Cauca Liquor Industry, followed by Santander, then Puerto Tejada, and finally Corinth.

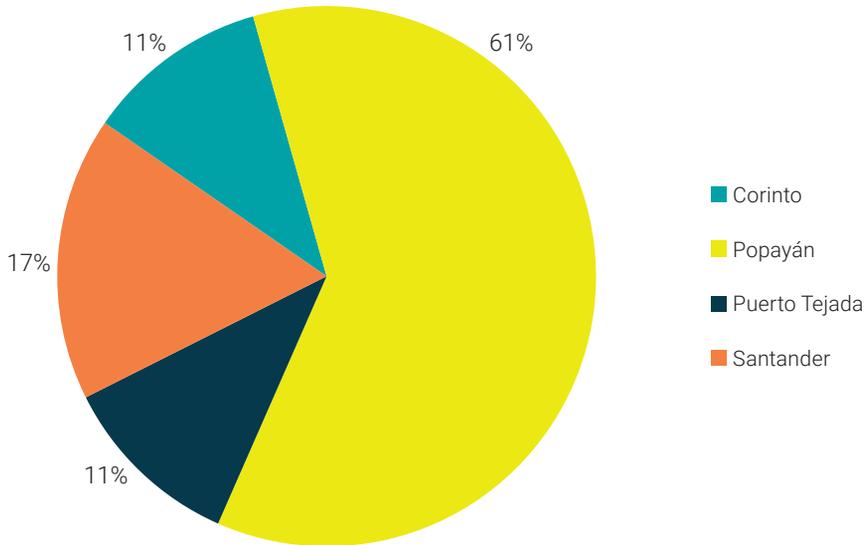


Fig.4: Pie chart
Source: own work

Popayán accounts for 61% of the demand for the Cauca Liquor Industry, while Santander represents 17%. Puerto Tejada follows with 11%, and Corinth makes up the remaining portion of the demand.



Fig.5: Intermunicipal distribution routes

Reference: TodoColombia.co,2010(accessed November 21, 2024) , edited by the authors.

Considering that inter-municipal logistics is more expensive than municipal logistics, the remuneration and benefits for these wholesalers will be higher. Specifically, they are 5% higher than those received by municipal wholesalers.

The following table provides crucial information on the distance between the liquor industry and the points of influence of each wholesaler. This data is essential for calculating the distance that cargo trucks must travel to carry out their distribution work.

Table 3

Wholesalers	Municipalities	Annual demand for cases of brandy	Distance(Km)	Duration(min)
1	Santander	120,000	84	120
2	Popayan	120,000	17	42
3	Maroon	120,000	120	178
4	Popayan	120,000	9	25
5	Popayan	120,000	eleven	31
6	Popayan	120,000	fifteen	38
7	Popayan	120,000	12	32
8	Puerto Tejada	60,000	110	140
9	Puerto Tejada	60,000	102	135
10	Popayan	60,000	5	18
eleven	Santander	60,000	75	115

Source: own work

In determining transportation costs, the following formula is used:

$$T = CF + CV (D),$$

where CF covers expenses related to the salaries and social security contributions of drivers, as well as taxes on the vehicle and the activity. On the other hand, CV encompasses all costs that arise independently on each trip, such as fuel costs, indirect costs, depreciation, and maintenance. Finally, the D value represents the distance in kilometers from the point of origin to the final destination. To obtain the total cost, this value is multiplied by 2.

Table 4

Wholesalers	Fixed costs	Variable costs	Distance(Km)	Total Round Trip Costs
1	\$221,700	\$2,691	84	\$895,488
2	\$221,700	\$2,691	17	\$534,894
3	\$221,700	\$2,691	120	\$1,089,240
4	\$301,800	\$3,320	9	\$663,360
5	\$301,800	\$3,320	eleven	\$676,640
6	\$221,700	\$2,691	fifteen	\$524,130
7	\$221,700	\$2,691	12	\$507,984
8	\$301,800	\$3,320	110	\$1,334,000
9	\$301,800	\$3,320	102	\$1,280,880
10	\$175,200	\$1,450	5	\$364,900
eleven	\$301,800	\$3,320	75	\$1,101,600

Source: own work

It is crucial to analyze transportation costs when implementing a strategy to reduce empty returns, especially in a reverse logistics model. This evaluation helps optimize the efficient collection of returned products, minimizes environmental impacts, and improves customer service by offering rapid problem resolution. Additionally, it allows for effective management of return costs, enabling informed decisions on return policies and pricing strategies. In summary, understanding and optimizing transportation costs are essential for improving operational efficiency and enhancing customer experience in a reverse logistics context.

Costos totales Ida y Vuelta

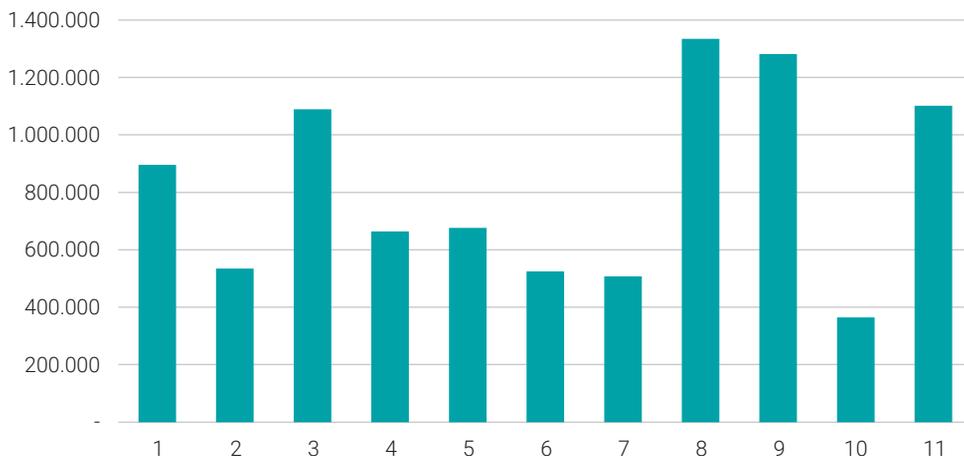


Fig.6: Costs
Source: own work

The graphical analysis reveals that wholesalers located in the most distant areas from the Cauca Liquor Industry incur higher transportation costs due to the longer distances they must travel. This pattern suggests that the Cauca Liquor Industry could enter into strategic negotiations with wholesalers in Popayán, as well as explore collaboration opportunities with those located in distant municipalities. Such initiatives could not only promote additional benefits for both parties but also contribute to the recovery of glass bottles, optimizing resources and reducing environmental impact.

3. Results and Discussion

Taking into account that the total number of boxes of finished product is 1,080,000, it is estimated that with the implementation of reverse logistics, at least 60% of glass packaging boxes in good condition can be recovered.

$$1,080,000 \times 60\% = 648,000 \text{ boxes}$$

I. Annual Economic and Environmental Analysis of Bottle Recovery Strategy

Table 5. Annual Economic Savings

Concept	Unit Value (COP)	Quantity (bottles)	Total Savings (COP)
Reduction in purchase of new bottles	\$1,000	648,000	\$648,000,000
Reduction in transportation costs	\$200	648,000	\$129,600,000
Total annual economic savings	-	-	\$777,600,000

Source: own work

Table 6. Annual Environmental Impact Reduction

Concept	Unit Value	Quantity (bottles)	Total Reduction
Reduction in CO2 emissions	0.5 kg CO2/bottle	648,000	324,000 kg of CO2
Reduction in energy consumption	2 kWh/bottle	648,000	1,296,000 kWh
Reduction in raw material usage	1.2 kg/bottle	648,000	777,600 kg

Source: own work

Table 7. Summary of Total Benefits

Benefit	Annual Value
Economic savings	\$777,600,000 COP
Reduction in CO2 emissions	324,000 kg of CO2
Reduction in energy consumption	1,296,000 kWh
Reduction in raw material usage	777,600 kg

Source: own work

Economic Savings Analysis

The implementation of a bottle return strategy, similar to the approach adopted by Bavaria, has resulted in significant economic savings for the liquor industry in the Cauca department, Colombia. By reusing 648,000 bottles per year, the company was able to reduce costs associated with purchasing new bottles by approximately COP 648,000,000. Additionally, transportation costs were reduced by COP 129,600,000. All these combined savings result in an annual economic benefit of COP 777,600,000. These findings highlight the financial potential of adopting circular economy practices, especially for industries with high bottle turnover.

Annual Environmental Impact Reduction

This strategy also provides substantial environmental benefits. The reuse of bottles helps lower the carbon footprint by 324,000 kg of CO2 per year, which is equivalent to the emissions of 70 passenger cars over a twelve-month period. Additionally, it reduces electricity consumption by 1,296,000 kWh per year, enough to power approximately 120 households for the same duration. Furthermore, the use of raw materials is significantly reduced by 777,600 kg, contributing to the conservation of natural resources such as sand and sodium carbonate. These indicators highlight the significant environmental benefits of implementing a bottle recovery system.

Summary of Total Benefits

The combined economic and environmental benefits highlight the effectiveness of the bottle recovery strategy. The company not only saves COP 777,600,000 annually but also significantly reduces its environmental impact by lowering CO2 emissions, energy consumption, and raw material usage. This dual benefit aligns with global sustainable development goals and reinforces the company's commitment to corporate social responsibility (CSR).

Major challenges when implementing this strategy in the liquor industry

Placing Trust in Third Parties: This strategy relies on the collaboration of wholesalers. Therefore, the success of the project is not entirely up to the Cauca Liquor Industry; instead, it depends on the interest and commitment of customers in recovering and returning containers in optimal condition.

Plant Adaptation: The liquor industry will need to invest in the pre-processing of containers, including quality checks and purification. This will require additional warehouse space and resources.

Benefits within the Liquor Industry

Waste Reduction: Reverse logistics allows the recovery of containers and packaging, reducing waste and contributing to environmental sustainability.

Cost Savings: Implementing a reverse logistics system can lead to significant savings in production costs, as containers and packaging can be reused or recycled rather than purchasing new ones.

Image and Reputation Improvement: By adopting a reverse logistics system, the liquor industry demonstrates its commitment to environmental responsibility and the community. This can enhance its image and reputation with customers and other market stakeholders.

Customer Loyalty: Customers may value the implementation of reverse logistics, fostering loyalty and strengthening business relationships.

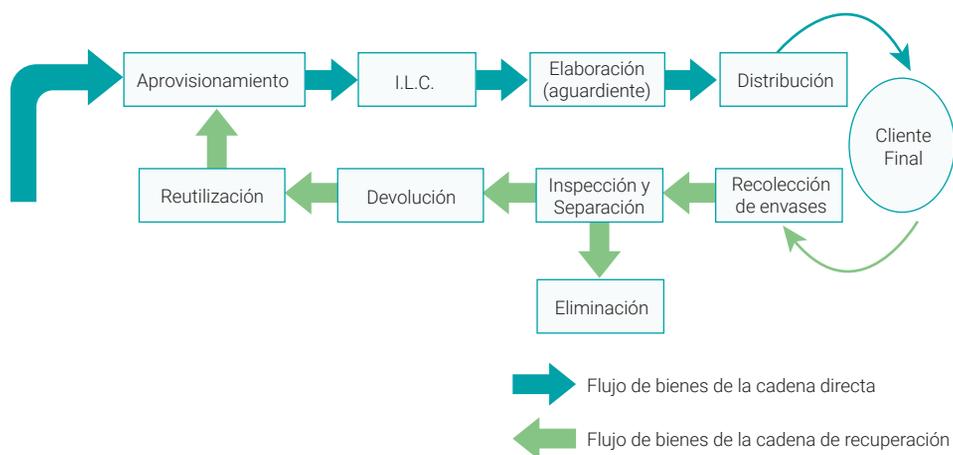


Fig.7: Reverse logistics circuit liquor industry of Cauca

Source: own work

The circuit illustrates the direct flow of goods in blue, while the green color represents the flow of recovered goods. Both flows aim to graphically represent the desired logistics process for the Cauca Liquor Industry. [4,5]

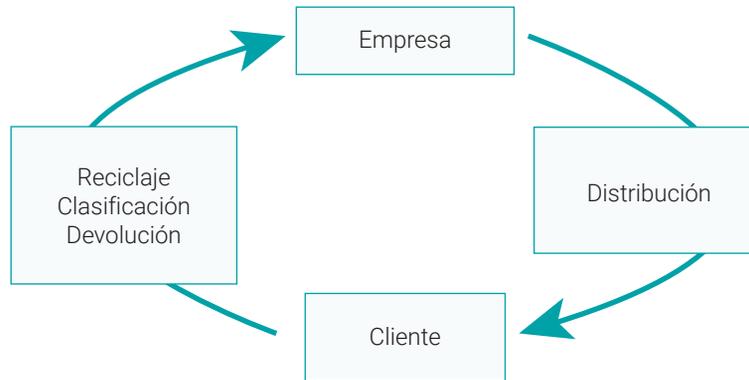


Fig.8: Reverse logistics circuit, own elaboration based on the following author[46]

Source: own work

II. CONCLUSION

The implementation of a reverse logistics system can help Licorera del Cauca improve its waste management and reduce its environmental impact by promoting the collection and recycling of glass containers used in production.

For a reverse logistics system to be effective, it is essential to involve all parties in the supply chain, including suppliers, customers, and end users, to ensure that glass containers are properly managed from manufacturing to final disposal.

Strategically locating glass container collection points can streamline the recycling process and minimize reverse logistics costs. Additionally, the implementation of consumer incentives and the adoption of new technologies can encourage the public to actively participate in the collection of glass containers.

The introduction of a reverse logistics system also presents an opportunity for Licorera del Cauca to enhance its brand image and reinforce its commitment to sustainable development and environmental care, potentially gaining a competitive edge over other companies in the sector.

In conclusion, implementing a reverse logistics system can provide benefits for both Licorera del Cauca and the environment by promoting the collection and recycling of glass containers used in production. This process requires the participation of all actors in the supply chain, along with effective location strategies, incentives, and

technological innovations. Furthermore, the successful adoption of reverse logistics can enhance the company's brand image and market positioning.

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