Towards a Hybrid Conceptual Operational Management Model of Cañazo Supply Chain: A Research on the Sugar-Cane Spirit from Peru

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Abstract – The present research seeks to show the importance of applying process management techniques and food safety norms in the operational processes of the supply chain to know the meaning and the need for an integrated hybrid model. The article reviews the sugarcane distillery sector of Peru and its main operational problems. Based on the literature reviewed and discussed with academics who have knowledge of the food supply chain, an integrated hybrid model was developed to help any distillery with lower levels of competitiveness than its competitors in other sectors, such as pisco, applying techniques of process management and food safety to increase the efficiency of liquor distilleries. The findings confirm that distilleries can increase their efficiency, thanks to the higher performance of their operations after their alignment with the integrated model.

Keywords *– Sugar cane, supply chain, management, food safety, integrated operational management, efficiency process management, Peru.*

1. Introduction

Cañazo or cane liquor is the product of the distillation of fermented musts of sugarcane juice. This traditional drink is one of the most consumed beverages in Peru over 80 years according to the Peru's Production Ministry, not only as an alcoholic beverage but as a medicinal drink in many Andean regions of the country. The distillery sector in the Apurímac-Peru region is made up of 12 companies that have been working with efficiencies of less than 50%, causing economic losses of approximately $400,000 per year.

An improvement management approach in this case study serves as a pilot that generates a sustainable model over time, through which the entire sector can improve their production processes and positively impact their profitability.

During the last 15 years, management models have been widely used in the industry [1] to meet the specific needs of all stakeholders as shown in figure 1, as they allow the processes to align with the key strategic objectives of the supply chain. With the integrated management model applied in the supply chain in this case study, the aim is to enhance the performance parameters in the processes by applying tools of food safety management and efficiency process management [1].

2. Literature review

The research process began with the search, compilation, analysis and trends from academic journals that were published by the main publishers such as Science Direct, Scopus, Wiley, Francis & Taylor, Emerald Insight, Springer, among others.

In this section we will review 3 sets of knowledge related to food safety management, efficiency process management and integrated management models, respectively.

2.1 Food safety management

Food safety management refers to the management of hygiene and cleanliness aspects that could cause contamination in the production chain of a food product [3],[5]. Health management systems are based on mandatory models that all companies in the

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food and beverages sector must follow in order to guarantee the safety of the product along the production chain [6],[7]. The changes in norms are made by the governments of each country in their search to create a market that offers products with health guarantees, has driven companies to develop management systems such as safety food management [7]. These models are audited and can be accredited by state agencies, so that obtaining an FSM certification in addition to guaranteeing the safety of the production process, is also a competitive advantage for the company [2],[9].

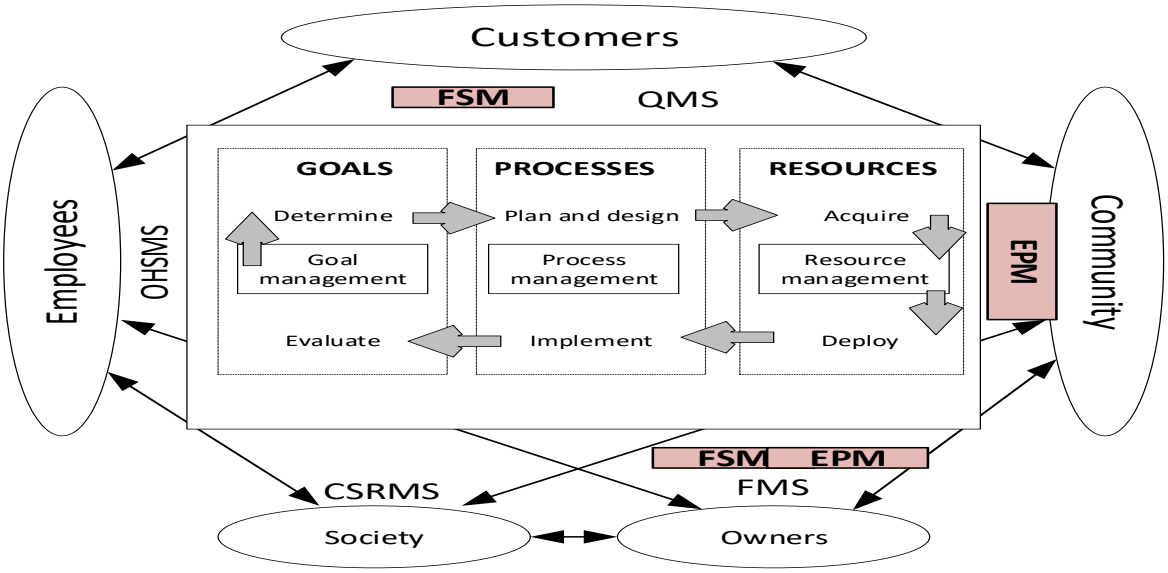

Figure 1*:* Framework for hybrid integrated management model (HIMM),Source: Adapted from [9], [1], [7], [10]

Table 1: Food safety management articles, Source: Adapted from [10],[13]

Author	*Tittle*	*Key findings in the research*
[11]	Motivations and benefits of Halal food safety certification	Review the motivation and benefits of implementing HFSC (Halal food safety certification) from the upstream perspectives.
[15]	Developing a solution for small businesses: The creation of Salamt Zadna, a unique food safety management system for small businesses in Abu Dhabi	This paper describes the process of developing, implementing and evaluating an innovative solution to enhance food safety and promote Hazard Analysis and Critical Control Point-based food safety management techniques in small independent restaurants.
[6]	Food safety assessment in India: modelling enablers	This study is designed to systematically investigate the factors responsible for assessment of food supply chain and evaluation of food safety systems in India.
[16]	Effective implementation of ISO 50001 energy management system: Applying Lean Six Sigma approach	The model has shown the compatibility of Six Sigma approach with the ISO 50001 framework and has provided guidelines for effective system implementation.
[17]	Review of the food processing supply chain literature	The purpose of this paper is to understand the meaning and operationalization of food supply chains in the context of the UK and India.
[18]	The effect of different starch liberation and saccharification methods	The aim of this study was to evaluate the influence of different starch liberation and saccharification methods on microbiological contamination of distillery mashes.
[19]	Development of a Layout Model Suitable for the Food Industry	The paper formulates a model that simplifies the layout planning process for the

		food processing facilities (FPF) in order to help the designers.
[20]	Sampling arthropod pests and natural enemies in stored barley	Application of pest management programs for the food industry reduces pesticide applications, increases the effectiveness of pest suppression to acceptable levels.
[21]	Disinfection efficacy over yeast biofilms of juice processing industries	The effectiveness of cleaning and disinfection procedures commonly used in juice industry was tested on the removal and killing of cells.

2.2 Efficiency process management

Process management focused on efficiency is based on the efficient use of resources and consists of a strategy in which operational processes are aligned with strategic objectives [22]. As seen in Table II, several articles were reviewed to obtain knowledge of application of models that manage the processes of a company, so as to ensure the sustainability of the project; multiple risks must be considered during the design process of the model [20],[23]. Finally, efficiency criteria were evaluated in the company's operational processes to measure and demonstrate the achievement of the outlined objectives [27].

Table 2: Efficiency process management articles, Source: Adapted from: [24], [25], [28]

Author	***Tittle***	***Key finding with respect to the research***
[22]	Model for BPM implementation assessment: evidence from companies in Indonesia	The purpose of this paper is to propose a model that combines the BPM lifecycle, program/project implementation framework, principles of good practice.
[25]	Identifying do's and don'ts using the integrated business process management framework	The authors observe that actionable guidelines are missing from many references works on business process management (BPM).
[29]	Standardization - one of the tools of continuous improvement	In this contribution is described 5S method, which is used in organizations to eliminate, respectively elimination of waste in the workplace through five steps.
[30]	Product Standardization of Ginger and Red Ginger Simplicia through Washing Time	This study has been conducted on product standardization of ginger and red ginger simplicia as one of post-harvest processed form.
[24]	Paradigms in business process management specifications: a critical overview	The purpose of this paper is to explore BPM specifications and compare the BPM implementation potential under each paradigm.

[28]	Exploring the design process of reconfigurable industrial production systems	The purpose of this paper is to explore activities, challenges, and suggest tactics for the design of industrial reconfigurable production systems that can easily adapt to changing market opportunities.
[31]	Impact and significance of microbial contamination during fermentation for bioethanol production	In this article, the impact and significance of microbial contaminants (lactic acid bacteria and wild yeasts) during fermentation of must for bioethanol production are reviewed.
[32]	The role of spontaneous fermentation for the production of cachaça: a case study	This work aimed to assess the microbial population dynamics during one fermentation cycle —a case study for the production of cachaça, as well as to correlate the chemical, and sensory profiles of the distillate.

After reviewing the literature in Table 2, we had the necessary knowledge to develop the management of processes based on efficiency such as: management components, design methodology of a model and operational characteristics of the distillery sector processes.

2.3 Hybrid management model

The hybrid management model is the integration of two models applied simultaneously, while at the same time having to be compatible with each other while when for the same objective [7], [8], [25], [33]. Table 3 shows revised articles with models of 'integrated process management' and 'food safety management' and how these increase the competitiveness of manufacturers in the food sector. It is also known that these two are compatible with each other and recommends finally applying them to the same time [1], [23], [27], [34].

Finally, the models that manage the integration of the supply chain directly impact business performance. [35]

Table 3: Integral process management articles, Source: Adapted from: [1], [5], [36]

Author	***Tittle***	***Key findings in the research***
[23]	Supply chain management and quality management integration: A conceptual model proposal	The purpose of this paper is to develop a theoretical basis for integration of quality management (QM) and supply chain management (SCM).
[37]	Integrating sustainability aspects into an integrated management system	The purpose of this paper is the further development of an Excel-based integrated management system for the tool and cutlery industry regarding sustainability
[5]	Food integrated management systems: dairy industry insights	The purpose of this paper is to study the management systems integration from both sector and size perspectives.
[7]	Instrument for evaluating IMS and sustainable performance	This manuscript presents an instrument to assess the integration of different MSs and its effect on sustainable performance.

[1]	A case study of a simultaneous integration in an SME: Implementation process and cost analysis	The purpose of this paper is to analyze the simultaneous implementation of an integrated management system (IMS) in a small and medium-sized enterprise (SME) and its impact on costs.
[38]	An Exploratory Study on Knowledge Management Process Barriers in the Oil Industry	This paper identifies and discusses barriers affecting knowledge management (KM) processes in the oil industry.
[27]	Organizational learning, knowledge management capability and supply chain management practices	The purpose of this paper is to examine the effect of knowledge management capabilities (KMCs) on organizational learning (OL) and supply chain management practices (SCMPs).
[36]	Knowledge management capability and supply chain management practices in the Saudi food industry	The main goal of this research is to examine the effect of knowledge management capabilities on supply chain management practices and organizational performance.
[33]	SMART KM model: the integrated knowledge management framework for organizational excellence	The purpose of this paper is to critically address the key issues facing organizations in implementing KMF and/or KM initiatives and how to develop fit-for-purpose KMF for organizational excellence.

3. Research Methodology

A system that integrates the management of health together with the management of efficiency arises from the search of literature with respect to the problems observed in the case study. In addition to the proposed systems to solve the problem, literature was found that optimizes the time and cost of implementing the system, applying the two methodologies simultaneously [1]. On the one hand, knowledge of health management systems helps to reduce risks of contamination in the alcohol supply chain and consequently the increase of production efficiency [11],[12],[34]. On the other hand, the reviewed literature regarding process management systems that seek to increase efficiency as a strategic objective, allow us to map the processes and redesign them so that they are aligned with the corporate strategy, all this following the PDCA cycle [8], [10], [40].

In order to carry out this research, a series of steps was proposed that finally conform a methodology with a logical order, based on other authors, under which literature of individual management models began to be collected to finally propose an integrated management model.

The proposal made at the end of the investigation provides a management system that assesses the current situation, then analyses it to finally propose a series of actions to certify the manufacturer's operations as innocuous and increases its efficiency.

The main question for the investigation is the following:

RQ: Can a simultaneous integrated system increase the efficiency of operations in the sugarcane supply chain? In the search for the answer to this question, a series of scientific articles were consulted that support and validate

the proposed integrated model. Figure 2 shows a diagram of the entire research process until the proposed model is presented.

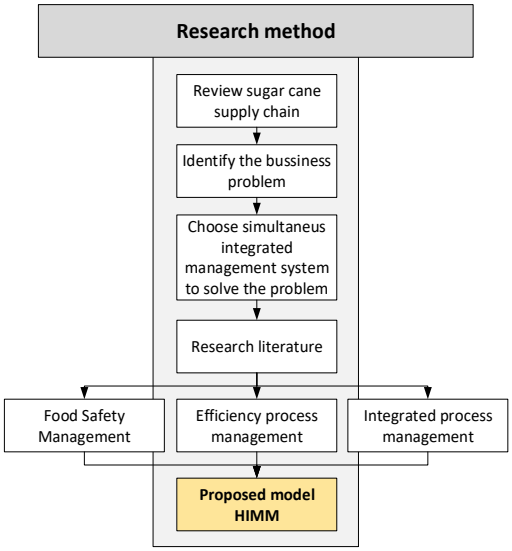

Figure 2: Research methodology, Source: Adapted from [5], [7], [16]

4. Conceptual Framework

The structure of the model has four fundamental components, which are: responsibility management, resource management, analysis and improvement and final modified manufacturing process [2],[22]. The management models are considered part of Supply Chain Improvements and follow the guidelines of the philosophy of continuous improvement, due to the implementation strategy of the model, based on PDCA (Plan, do, check and act) [27],[36], with the purpose of aligning the operative processes and the strategic objectives of the management of the company [24]. Figure 3 shows the proposed model and its components are explain below:

Responsibility management- Referred to the evaluation of strategic objectives, alignment of the metrics that will be used as a means of measuring operational processes and committing to strategic management (management) with active participation to achieve objectives set based on the vision and mission strategy [42]. Resource management- Part of the documentation is related to good manufacturing practices, knowledge management, apprenticeship processes to guarantee project sustainability [8],[9]. Analysis and Improvement- Contains the activities of process measurement, analysis and improvement proposal aligned to the strategic objectives proposed by management [34].

Manufacturing process- It is understood as development of the processes, before and after improvement [26].

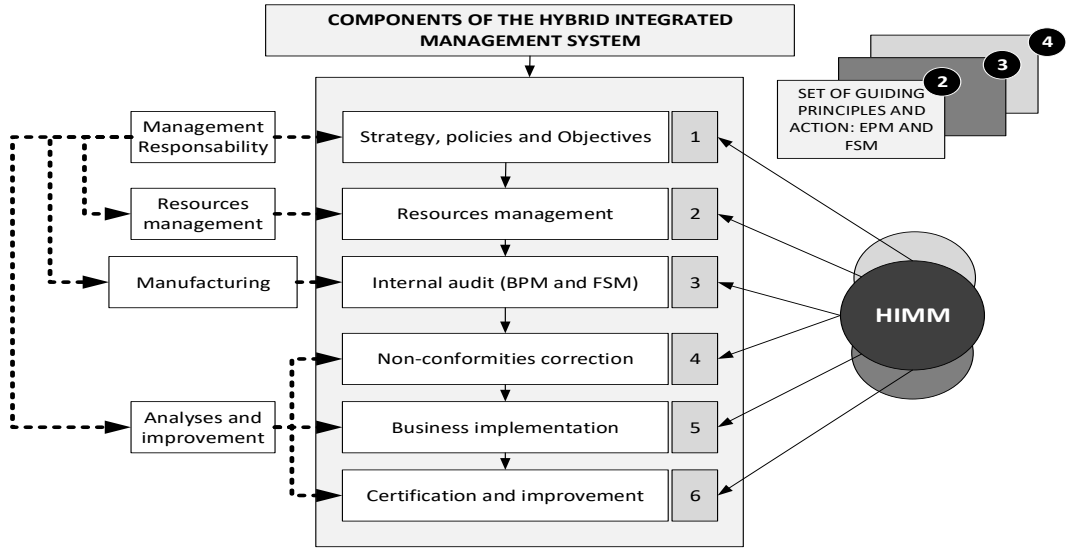

Figure 3: Research methodology, Source: Adapted from [5], [7], [16]

5. Applied methodology

The model was implemented in a company dedicated to the distillery sector in the southern region of Peru. The manufacturer (company) has been operating for more than 80 years and covers the following supply chain: Sugarcane harvesting, juice extraction, musts fermentation, distillation using the Potstill method, bottling in bottles and barrels, sale and finally after sales services. Figure 4 shows the Supply chain of the case study.

5.1 Current Problem

To identify the problem, we analyzed 11 distilleries in the sector studied, giving as average efficiency of the supply chain, a value of 47%, a value well below another sector of Peruvian liquor called Pisco, with efficiencies that exceed 80%. Table 4 shows the analysis performed in addition to confirming that the cause is related to a performance problem [24], [32], [43], [44].

Table 4: Metrics and current state of Peruvian cañazo industry, Source: Own elaboration

Variables	Current situation
Availability	92%
Yield	53%
Quality	96%
Efficiency	47%
Cañazo industry revenue (millions of dolars)	$ 1,3

To eliminate dispersion at the development of the analysis, the studied distilleries have the same characteristics: Business Size, geographic localization, raw material, maturity level and automation rate. The main objective of picking these distilleries is having a response to the problem that can solve all the sector low profit operations.

Several criteria of Food Safety Management were evaluated to assess the current compliance of the case study [5], resulting in a 51% compliance as it is shown in Table 5 with respect to the established metrics, with reference to the minimum acceptable rate of 85% [19].

Table 5 shows the fulfillment of the cañazo supply chain with respect to food safety management criteria.

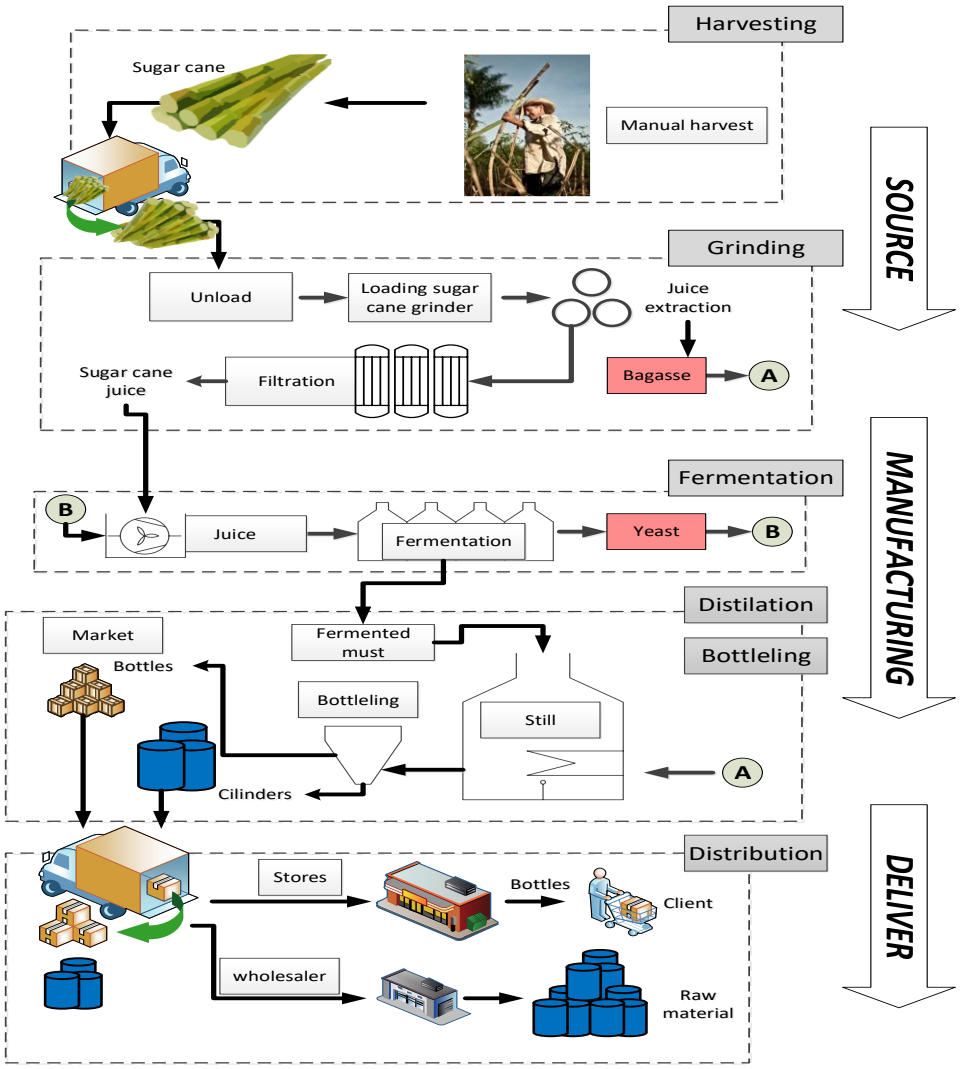

Figure 3: Cañazo Supply Chain, Source: Own elaboration

Table 5: Current state of Peruvian Cañazo case study, Source: Own elaboration

Food Safety management Criteria	***Cañazo Supply Chain fulfillment***					***SC current state***
	Harvest	*Juice extraction*	*Ferment*	*Distill*	*Bottleling*	
Facilities and equipments	82%	81%	44%	48%	94%	70%
Sanitary conditions	99%	100%	56%	59%	99%	83%
Documentation	38%	42%	38%	36%	55%	42%
Operatives methods	30%	22%	22%	29%	26%	26%
Traceability	0%	0%	0%	0%	0%	0%
Customer post sale service	0%	0%	0%	0%	0%	0%
Total Score						51%

5.2 HIMM application

First, the increase in performance was chosen as the strategic objective, then metrics were designated in each process to help meet the objective and finally the compatibility of the metrics used, was evaluated as these must comply with the 2 models applied simultaneously [42]; figure 5 shows the simultaneous development of the 3 mentioned stages. In this section, the strategic management must take into account the pillars of sustainability and the flows of the supply chain: Information, materials and economic.[9]

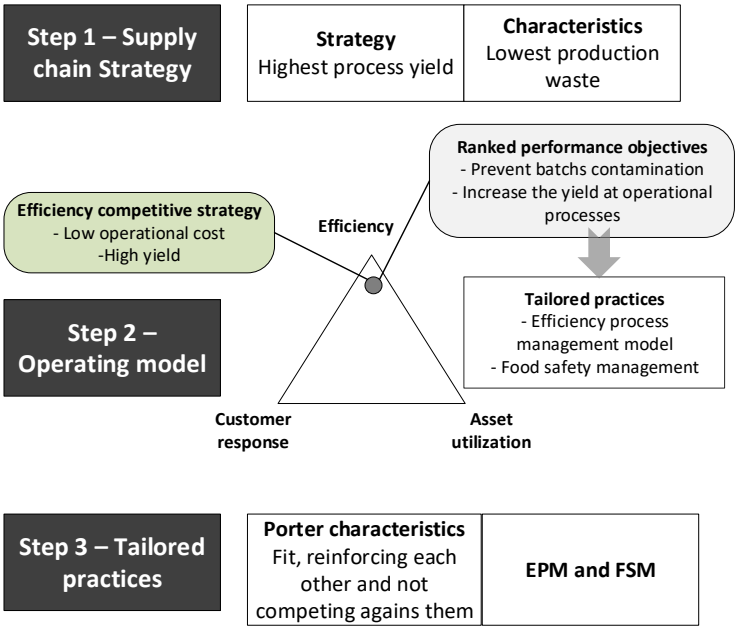

Figure 4: Responsibility management, Source: Adapted from [33], [42], [45]

As a second step, the documentation was developed with the purpose of managing the processes with a view to achieving the strategic objectives, these documents are regulated by the local government and are: Manual of good manufacturing practices and process instructions [24],[34]. Figure 6 shows the necessary documents for the application of simultaneous models corresponding to the food safety management model and business process management [13].

As a third step, an internal audit was conducted to determine the status of availability, quality and performance of the supply chain, as well as the current status of compliance with Food Safety Management criteria [1]. Both results were shown above in Tables 4 and 5.

Finally, the information was analyzed, and the model was proposed to increase the performance of the sugarcane supply chain. This consisted of training the personnel involved to comply with the requirements of the Food Safety Management manual, and necessary infrastructural improvements were made to ensure the safety of production according to Peruvian standards. On the other hand, the Efficiency Process Management seeks to redesign the processes with a focus on Manufacturing Efficiency, as these processes presented the lowest metrics with respect to performance, so it was proposed to ferment the sugarcane musts in a different way and add a new process called "Yeast Harvesting", which guarantees hygiene in this part of the supply chain, as well as monitor the operational metrics established such as PH, temperature and performance to achieve the strategic objective [22], [24].

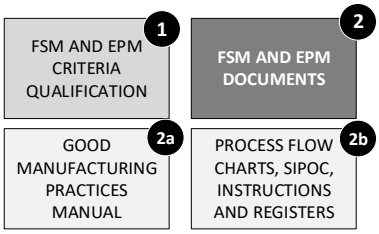

Figure 5: Food safety management and efficiency process management documents, Source: Adapted from [5], [15], [42]

6. Results and discussion

An analysis of the current processes and improved processes was carried out in order to verify the effectiveness of the proposed model [46]. The supply chain studied is shown in figure 7 together with the metric proposed for analysis, this represent the current process of the cane distillery sector, where the result yield is 44%, in addition on the right side, the main metric that efficiency factor is showed.

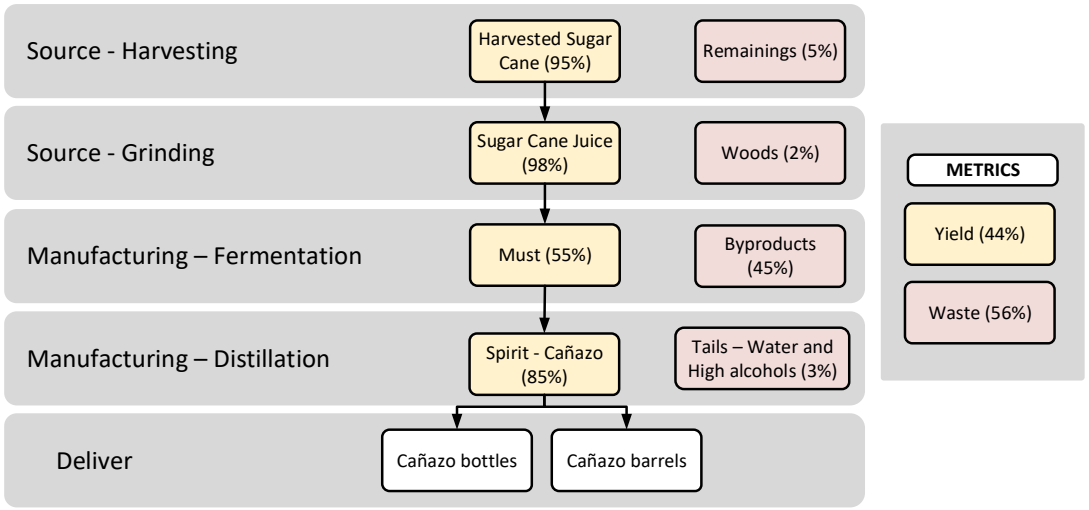

Figure 7: The current state of cañazo supply chain with efficiency metrics, Source: Adapted from: [22]

On the other hand, figure 8 show the improved scenario, in which processes of manufacturing were modified, as well generating the necessary documentation to improve the supply chain. As a result of the HIMM, it was possible to increase the liters of cañazo and incomes around the 35% per period monthly. Furthermore, the proposed model decreases the loss of material along the supply chain which leads to a direct increase in performance, and thanks to the alignment of right manufacturing practices, it generates a competitive advantage.

7. Future Research

Future research on the integration of distillate industry management systems can expand research frontiers to further integrate the supply chain in the management of relationships with suppliers and end consumers.

The proposed integrated model was applied to a specific industry of alcohol production, however, having a systemic approach, other food industries can adopt it and achieve similar operational and economic profitability benefits.

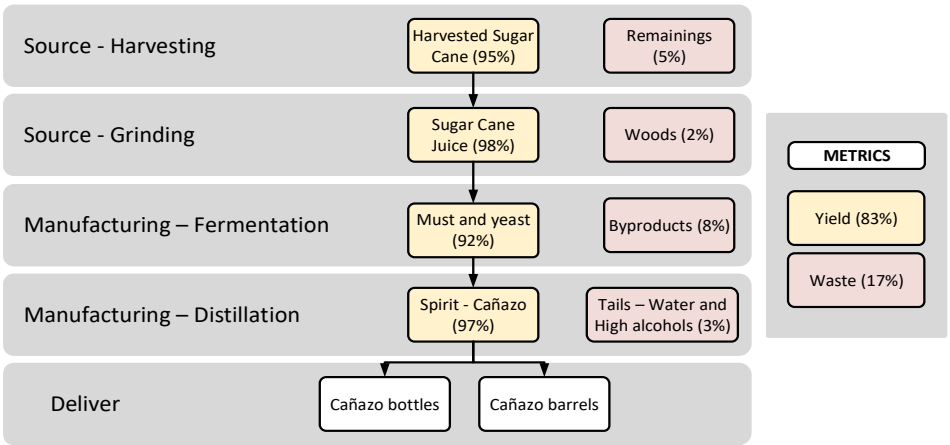

Figure 8: The future state of cañazo Supply Chain with efficiency metrics, Source: Adapted from: [22], [45]

8. Conclusion

The literature reviewed during the research process allowed knowing the current methodologies such as integrated management models focused to meet strategic requirements from top management, the case study applied a model that intercepts concepts of food safety management and efficiency process management

The supply chain is impacted in a positive way because the models complement the work methodology that was observed in the case study, managing to reduce contamination of the processed batches thanks to compliance with sanitary requirements issued by the food safety management model and, on the other hand, it was possible to increase the performance of operational processes. Finally, an increase in performance was achieved, which has positive impact of 30% in the economic income of the supply chain.

To achieve this growth, we resorted to the simultaneous application of two management models. For this purpose, multiple investigations were adapted and allowed the integration and correct symbiosis between the two mentioned models. Furthermore, in addition to applying them together, the implementation was carried out at the same time, to ensure that the criteria established by the experts of the industry, were followed.

Finally, the findings found allow to implement a hybrid integrated management model that can be applied to a distillery with poor levels of competitiveness, based on the calculation of its efficiency.

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