



## PROCESS ANALYSIS AND RISK MANAGEMENT IN A MINERAL WATER BOTTLING COMPANY

ANÁLISE DOS PROCESSOS E GESTÃO DE RISCOS EM UMA EMPRESA DE ENVASE DE ÁGUA MINERAL

ANÁLISIS DE PROCESOS Y GESTIÓN DE RIESGOS EN UNA EMPRESA DE ENVASADO DE ÁGUA MINERAL

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### ABSTRACT

Brazil is evolving in the bottling industry of mineral water, occupy occupying the position of one of the main water bottlers in the world. That said, this study proposes to discuss aspects related to the development of companies in the field and how they can improve their production process. This qualitative approach article verified the productive processes of a company and the risks to which the organization is exposed. Through process mapping and layout analysis, proposals for changes in the production area were elaborated to better store the final product and avoid possible rework related to packaging damage. In addition, based on the analysis of the risks associated with the organization and the use of the FMEA tool, suggestions for improvement were proposed for the company's financial department.

### RESUMO

O Brasil está em evolução na indústria de engarrafamento de água mineral, em que ocupa o posto de ser um dos principais envasadores do produto no mundo. Isto posto, este estudo se propõe a discutir aspectos relacionados ao desenvolvimento das empresas do ramo e como elas podem melhorar seu processo produtivo. O artigo de abordagem qualitativa verificou os processos produtivos da empresa e os riscos que a organização está exposta. Por meio de mapeamento de processos e análise de layout, foram elaboradas mudanças na área de produção para melhor armazenar o produto final e evitar possíveis retrabalhos relacionados a danos na embalagem. Além disso, a partir da análise dos riscos associados à organização e da utilização da ferramenta FMEA, foram propostas

sugestões de melhoria para o departamento financeiro da empresa.

### RESUMEN

Brasil está evolucionando en la industria de cuellos de botella del agua mineral, en la que ocupa la posición de ser uno de los principales embotelladores del producto en el mundo. Dicho esto, este estudio propone discutir aspectos relacionados con el desarrollo de las empresas en el campo y cómo pueden mejorar su proceso de producción. El artículo de enfoque cualitativo verificó los procesos productivos de una empresa y los riesgos a los que está expuesta la organización. A través del mapeo de procesos y el análisis de diseño, se elaboraron propuestas de cambios en el área de producción para almacenar mejor el producto final y evitar posibles retrabajos relacionados con daños en el empaque. Además, a partir del análisis de los riesgos asociados a la organización y el uso de la herramienta FMEA, se propusieron sugerencias de mejora para el departamento financiero de la empresa



## 1. INTRODUCTION

The mineral water market in Brazil is on the rise, growing by 61% from 2010 to 2018. According to International Bottled Water Association (IBWA) in 2019 Brazil ranked 6th among the largest bottled water producers in the world (Fusati, 2022). Furthermore, the national industry is made up of 74.78% of medium, small and micro companies (Rebob, 2022).

Bearing in mind the modern business situation, where there is a lot of competitiveness in the market, entities are required to frequently improve their production processes, as well as the quality of their products and services. In view of this, according to Veloso (1995), competition is associated with the ability to promote value to the customer through the cost-quality-time link.

Furthermore, through process mapping it is possible to obtain the aforementioned objectives, through complete visualization associated with deep knowledge of the activities performed in a given process. Hörbe et al. (2015) state that process mapping improves the understanding of the company's recent processes and helps to identify improvements to be made or even the need to implement new processes. Thus, it is through the application of process mapping that it is possible to reduce notable costs in the production.

In this framework, referring to tools for reducing impacts in the business environment for risk analysis and management, Failure Mode and Effects Analysis (FMEA) makes it possible to check possible problems in a process or product, through their histories. Furthermore, its purpose is to increase the reliability of the product or service, seeking to prevent imminent failures (Lélis, 2018).

Furthermore, according to Lélis (2018), the main advantages of FMEA are: improving the reliability of products and services; store the company's improvement history; increase customer satisfaction and company competitiveness, among others. Also noteworthy is the reduction in time and costs in developing new products, due to the history of improvements that standardize some processes in order to correct/avoid past failures.

Thus, given the organizational challenges of companies in the mineral water bottling sector and the importance of producing scientific content on the subject as well as the potential gains that lean production and process mapping and FMEA can provide for organizations through continuous improvement, this study sought to consider the applicability of these tools in a mineral water bottling factory in the north of Espírito Santo, and also understand the production system in force, its peculiarities, interactions with the external environment, layout, performance goals and customer satisfaction levels.

## 2. METHODOLOGY

To collect information, visits were made to the company and interviews were conducted using questionnaires, discussing specific points with the unit manager and employees. Next, the mineral water packaging processes were mapped using flowcharts. In addition, risk management was carried out using the FMEA tool in the Environmental, Strategic, Operational, Supply, Tax, Financial, Customer and Stock areas.



The case study method was used to expand our knowledge of individual, group and organizational phenomena. This research method allows us to focus on a specific case and obtain a more complete and holistic view of the real world, as described by Yin (2015).

The preparation of this article was based on a qualitative research carried out between March and June, 2020. Initially, a bibliographical research was carried out, focused on the aforementioned research objectives, followed by the delimitation of the activities to be examined. For the interview, the semi-structured method was used, with specific questions and space for interviewees to express their relevant considerations.

### 3. ANALYSIS OF PRODUCTION STEPS

In Figure 1 the stages of the company's production will be found, starting with the capture of water from the natural spring Jabuticabal I. Subsequently, the water is directed to the 3000-liter reservoir, which, after reaching its limit have been increased to a 160,000-liter tank, a lifting pump is used. It should be noted that all these initial processes are supervised by the National Department of Mineral Production (DNPM) and health surveillance.

One of the most used inputs is the 20 L gallon, which is delivered by the customers themselves through a cyclic feedback system. After the company receives the empty gallon, it goes through a cleaning and sanitization system, involving the removal of old labels, followed by pre-washing on a conveyor belt and deep cleaning using a rod.

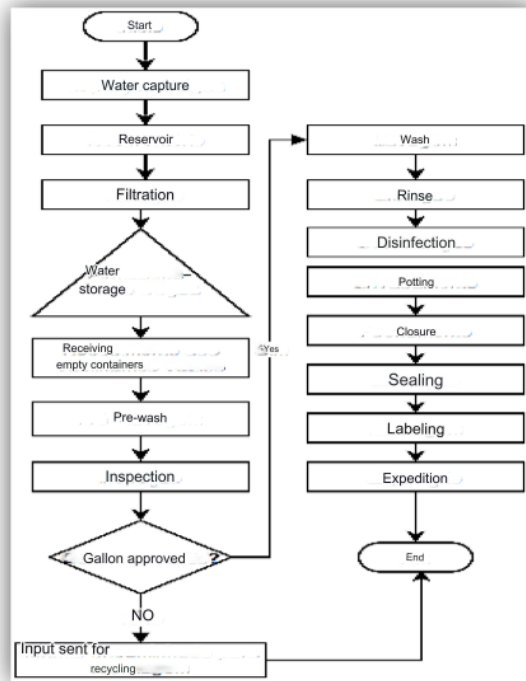
Pre-washing quality control is carried out by inspection verifying the smell; if the bad smell persists, the container is discarded, and the remaining containers that are in good condition are taken to another conveyor belt, where the second and third washes are carried out with 11 water and bactericidal jets. These inspections are carried out in shifts, so that there is no wear and tear on employees.

Once cleaning is complete, the gallons go through the filling and sealing process, using lids and seals and, finally, labels are added and the products are released for shipping, returning to the distributors' trucks.

Furthermore, in terms of quality, every three months, analyses are carried out to ensure that the properties of the water are adequate, these being carried out by Technological Analysis Center (CETAN)/ES, with the issuance of reports. In addition to this, the food-chemical engineer monitors the internal studies carried out by the unit on a daily basis, such as: physical-chemistry, pH meter, conductivity meter and microbiological-colilert method.



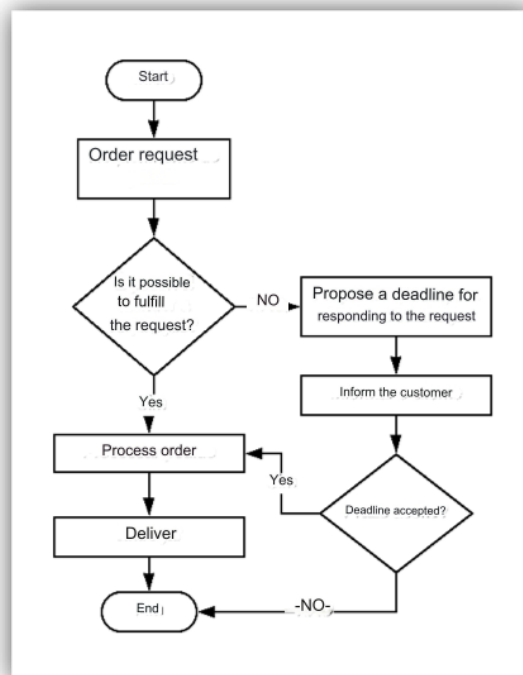
Figure 1. Production line flowcharts



Source: Authors (2020).

The company's expenses are concentrated on the payroll of 30 employees and electricity. And its revenue comes from orders, through requirements filled out by customers that are later analyzed, processed and delivered. In Figure 2 the flowchart shows how this process is carried out.

Figure 2. Order request



Source: Authors (2020).



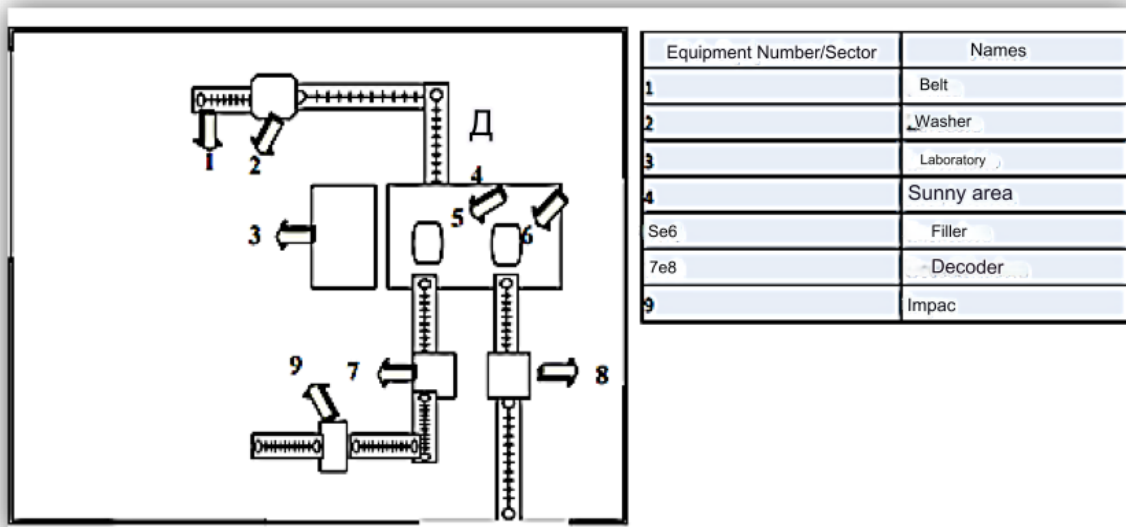
When analyzing the flowcharts discussed previously, it can be seen that the company produces sequentially and in line; this system allows it to operate with 100% of what is permitted by the supervisory bodies discussed at the beginning of the text. Due to this, the company works with orders, as it must be analyzed whether the source extraction limit will not be exceeded with the increase in new requests. If it is not possible to meet the customer's order, a deadline that can be met is proposed.

Furthermore, it can also be seen that electricity consumption is among the factory's highest costs, due to the equipment that makes up the automated production line, with emphasis on Impac, which is responsible for approximately fifty percent of the company's entire energy consumption.

Gallons that do not reach the expected standard after cleaning or have any damage are destined for the company Zimermann, located in São Mateus/ES, to be recycled and reused.

To complement the analysis of the organization's production processes discussed so far, a change in its layout was prepared and suggested as an improvement for the company. Figure 3 illustrates the current layout, and in Figure 4 the proposal is presented, in which it is possible to visualize in greater detail how the factory's production line is structured.

Figure 3. Layout by company product

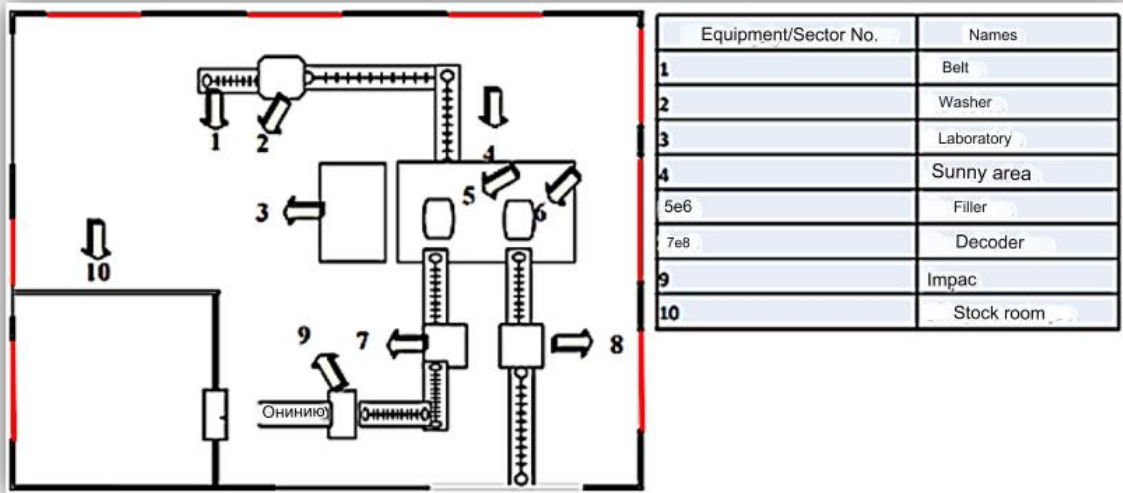


Source: Authors (2020).

Note that all equipment and processes involved are organized in sequence, in such a way that the product follows a production line. Thus, according to the study conducted by Neumann (2015), the layout adopted by the company is the product layout.



Figure 4. Layout by modified product



Source: Authors (2020).

In general, the organization of the company's production structure is satisfactory, as it can meet the maximum production level allowed by the DNPM. However, it is worth highlighting that the factory would be able to operate at higher extraction levels, but this would exceed the level permitted by supervisory bodies.

Due to this limitation, improvement proposals had a smaller field of action. Therefore, as illustrated in Figure 4, improvements were suggested in the company's layout, aiming to gain brightness through the addition of windows (highlighted in red) in the environment, so that the equipment is closer to them, in order to provide greater ventilation and to improve the natural lighting of the place. It is important to note that no financial feasibility studies were conducted to implement the proposals.

Furthermore, it was recommended to build a room for temporary storage of 500 mL products until they reach the desired batch size. These actions contributed to improving the quality of product storage and will avoid future rework, for example, due to crushed packaging. It is worth noting that the representations of the layout in Figures 3 and 4 are a macro view of the process, and details of dimensions in the project are not considered.

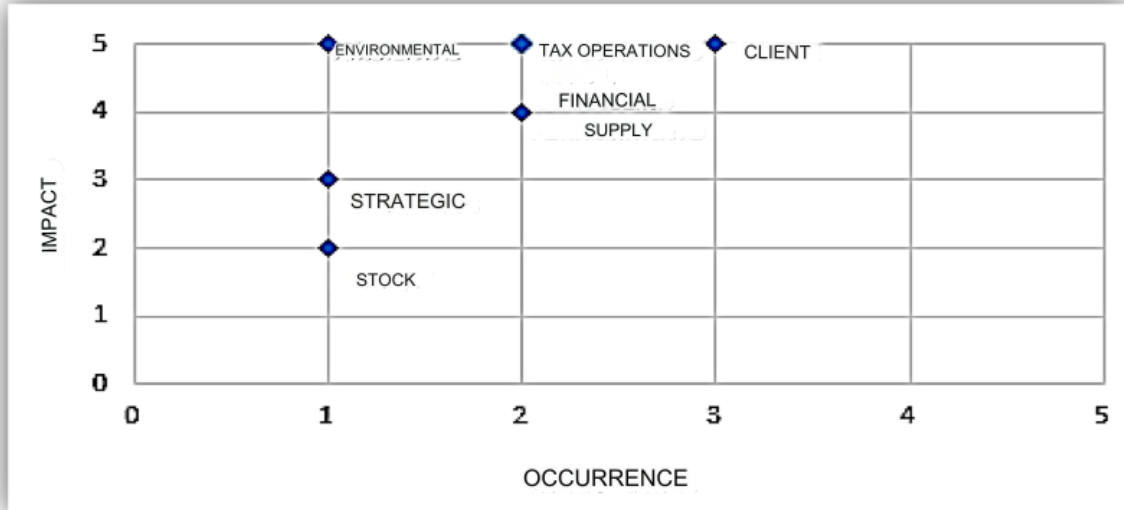
After analyzing the company's production processes, the risks to which it is exposed were studied using the FMEA tool. The risks were organized and applied according to application in the company; they are related to the Environmental, Strategic, Operational, Supply, Tax, Financial, Customer and Stock areas.

The risk assessment was carried out through the answers obtained through a questionnaire given to the company's interviewee, who received a brief conceptual explanation about the items covered. This assessment consisted of analyzing the levels of impact and occurrence, so that it was possible to classify the risks using a scale, to later prioritize them. The scale used ranged from 1 to 5, with the following characteristics: 1 - remote risk; 2 - small risk; 3 - moderate risk; 4 - high risk; and 5 - very high risk.



The results obtained by the adopted scales are presented in Figure 5, using the Occurrence x Impact graph. This facilitated the visualization of the main risks to which the company is exposed.

Figure 5. Occurrence x Impact Graph



Source: Authors (2020).

Analyzing the data graphically, it stands out the risk linked to customers as the one with the greatest impact on the company, due to payments via check that were not honored by some clients. From this point onwards, improvement measures were developed for this impact, through the use of FMEA. In Figure 6 the use of the tool is illustrated.

In the FMEA table present in Figure 6-a and 6-b, the details of the process, description, function and type of failures stand out, as well as their causes, occurrence and detection, which vary on a scale from 1 to 5, with 1 being minimal failure and 5 being very high.

As a solution to the highlighted risk, it was suggested that the company limit payment methods to credit and debit cards, payment apps or bank notes, with the financial department being responsible for standardizing the aforementioned payment methods.

Figure 6. FMEA table (A) and (B)  
(A)

Nome do processo			
Data: 01 de junho de 2020			
Folha Nº 1 de 1			
Descrição do processo	Funções do processo	Tipo de falha potencial	Efeito da falha potencial
A partir do número de galões que foram entregues para o cliente, o mesmo se desloca para o escritório e efetua o pagamento dos produtos adquiridos	Recebimento do valor referente aos produtos vendidos	Não pagamento dos produtos posteriormente comercializados	Endividamento da empresa por não receber o valor referente ao que foi vendido





(B)

FMEA DE PROCESSO	X	FMEA DE PRODUTO	ÍNDICES				Ações recomendadas					
Causa da falha potencial	Controles atuais	S	O	D	R	Ações recomendadas	Responsável/Prazo	Medidas implantadas	ÍNDICES ATUAIS			
									S	O	D	R
Recebimento do valor a ser pago pelos clientes por meio de cheques	Diminuição do número de cheques recebidos pelos clientes como forma de pagamento	4	3	2	24	Não recebimento por meio de cheques, mas sim nas outras formas já recebidas (dinheiro, cartões de crédito e débito e também por meio de aplicativos de pagamento)	Departamento financeiro da empresa	Recebimento do valor referente aos produtos comercializados somente por meio de cartões de crédito e débito, dinheiro e aplicativos de pagamento.	4	1	2	8

Source: Authors (2020).

Considering that the organization applies the suggested improvements, the severity, occurrence and detection indices would be, respectively, 4, 1 and 2. In this way, the result of multiplying the indices would be 8 -16 less than the company's current scenario, which is twenty-four. Therefore, the proposed actions mitigate risks and impact profits for the company.

#### 4. CONCLUSION

As discussed, the mineral water industry is booming in Brazil, with the country emerging as one of the largest bottled water producers in the world. With this accelerated growth, the market becomes increasingly competitive, making it essential for companies to find ways to stand out among their competitors. In this context, it is essential that the company has in-depth knowledge of its entire production process.

Therefore, as demonstrated in the study, mapping the production process, combined with the analysis of the company's layout, is one of the means to obtain a broad view of the production system as a whole. This allows the identification of possible improvements and opportunities for optimization. In the case in question, a change in the layout was proposed, aiming to allocate the final products in a more suitable location, in order to avoid unnecessary rework.

Given this, there are several ways in which a company can stand out in the market, and it is up to the manager to choose the model that best adapts to the production and available investment, according to their reality. Furthermore, it is essential to emphasize the importance of risk analysis in all production processes, together with the use of a quality tool, such as FMEA, which was applied in this study, to facilitate the identification of possible problems and acting for their resolution.

With the implementation of the suggested improvements, the occurrence rate was reduced from 3 to 1, demonstrating a reduction in the probability of failures. This highlights the importance of the FMEA tool for studying and mitigating risks in processes, making it necessary to review it whenever there are changes in one of the factors that make up the phases in the execution of the service.

Finally, it is important to highlight that, as in other sectors of the industry, improvements in the production line are increasingly necessary so that the organization can stay ahead of its competitors.





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