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# Big Bags Reverse Logistics using Business Intelligence and Multi-Criteria Analysis

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**Abstract**

The present work aimed to apply Reverse Logistics using Business Intelligence and the SAPEVO-M, a Multicriteria Analysis Method. For this purpose, On-site visits were carried out during the period from April to August 2022. During this period, data were collected from unstructured interviews, Gemba walks, photos and videos. The result showed that 83% of the Big Bags discarded by the company could be reused through Reverse Logistics. Then, SAPEVO-M was applied to select the best provider of the Reverse Logistics service for the Bigs analyzed.



*Keywords:* Reverse Logistic; Big Bag; Business Inteligence; SAPEVO – M; SADEMON.

## 1. Introduction

The logistical life of a product does not end with its delivery to the final consumer. In this way, products that have become obsolete, have been damaged, or are not fully functioning, can follow the 3R sustainability policy: reduce,

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reuse and recycle. In addition, with an eye on the benefits of Green Engineering, companies have sought to develop mechanisms to reduce environmental risks, acting directly in the life cycle of products, enabling their processes and operations to be aligned with sustainability.

One of the mechanisms used for companies to know themselves, and to define the best way to strategically position themselves in the market in the face of new opportunities, is precisely through the analysis of extreme data. In this sense, Business Intelligence, through the Power BI software, allows the production of versatile and dynamic dashboards, enhancing and facilitating the analysis of data from small, medium, and large companies, organizing them, and presenting relevant information for decision-making by institutions.

Decisions are made all the time and under different conditions in business environments. According to Santos et. al. [1], multicriteria decision support methods take into account both a scientific and subjective character, encompassing quantitative and qualitative characteristics, thus becoming powerful tools for business support.

The present work aims to apply Reverse Logistics (RL) in Big Bags using the Power BI tool and the SAPEVO-WEB multi-criteria decision-making support method.

## 2. Theoretical Framework

### *2.1. Data Analysis*

Data analysis is the process of giving order, structure, and meaning to data, including transforming the collected data into useful and reliable conclusions and/or lessons. Based on established themes, the data are processed to seek trends, differences, and changes in the information obtained, using processes, techniques, and tools that are based on certain premises and, therefore, have limitations.

Statistical analysis is about the discovery process. Scientific development requires the generation of a method to systematically examine objects of interest. This process often requires evidence to support an argument. One of the best ways to build evidence is to examine numbers related to study subjects. This examination is performed through statistical analysis [2].

### *2.2. Business Intelligence*

Business Intelligence (BI) is a set of tools that create, access, and manipulate data interactively and provide managers and business analysts with sufficient analysis to serve as a basis for improving and improving current decisions [3].

Laudon et. al. [4] Business Intelligence is a term used by hardware and software vendors and information technology consultants to describe the infrastructure for storing, integrating, reporting, and analysing data from a business environment.

For Sezões et. al. [5], Business Intelligence is a production process whose raw material is information and the final product is knowledge. So, it's all about collecting, archiving, exploring, and granting data, turning it into information and knowledge. Its role is to help managers make better business decisions and provide more accurate, valid, and expressive information.

According to Costa et. al. [6], "The use of Business Intelligence (BI) tools, bring sharpness in the look about reading data, enabling the monitoring and display of key indicators".

### *2.3. Multicriteria Decision Concepts*

The Multicriteria Decision Marking (MDCM) approach plays an important role in the selection of non-dominant alternatives among several viable alternatives evaluated against multiple criteria in real-life decision making, involving questions of uncertainty [7]. The following aspects should be involved in quality decision-making (DM) ([8];[9]):

- A perception of the DM regarding the necessity and appropriateness of the decision, considering marketing, operational, technological, strategic, financial variables, etc;

- The adoption of a methodology or combination of methodologies, enabling the identification of the variables and a rational analysis of the information;
- The assessment of the necessity and feasibility of sharing the decision-making process to ensure the required engagement in the deployment of the chosen alternative.

According to Pereira et. al. [10], "Despite the diversity of MCDM approaches, methods and techniques, the essential ingredients of MCDM are a finite or infinite set of actions (alternatives, solutions, courses of action, etc.), at least two criteria, and at least one DM".

For Drumond et. al. [11], "It is essential to use a Multi-Criteria Decision Support (AMD) method to support the classification process".

The decision-making process must meet the important objective according to which, whatever the option chosen, the best must be made of the opportunity, without damaging the strategic position of the decision agent [12]. Innovation is seen as a complex, uncertain and risky phenomenon. Innovation is the implementation of a good, a new process or a significantly improved service, or a new marketing or organizational method. Is necessary understanding of the dynamics associated with technological innovation [13][14].

### *2.4. Method SAPEVO-M*

The Simple Aggregation of Preferences Expressed by Ordinal Vectors – Multi Decision Makers – SAPEVO – M - method represents a new version of the original SAPEVO ordinal method that enables the evaluation of only one decision-maker. This evolved version extends the method to multiple decision-makers, in addition to introducing a process of standardization of evaluation matrices, increasing the consistency of the model [15].

According to Teixeira et at. [15], the SAPEVO-M method unfolds the decision-making problem from three basic steps, namely:

1. Transforms the ordinal preferences of the criteria into a vector of criteria weights;
2. Transforms ordinal preferences from alternatives to a given set of classification criteria into partial weights of alternatives and;
3. Determines the overall weights of the alternatives.

From the SAPEVO-M Method, the computer system SApevo-m: DEcision Making ONline (SADEMON) [16], was developed, whose function is to present a dynamic and interactive tool for decision-makers, with the adjustment of the treatment of exception.

## 3. Methodology

It is based on qualitative-quantitative research, of exploratory character, based on the multicriteria structure for decision making and business intelligence. Data collection occurred between April and August 2022 on-site in the Mining Factory. The methodological chart can be seen in Figure 1.

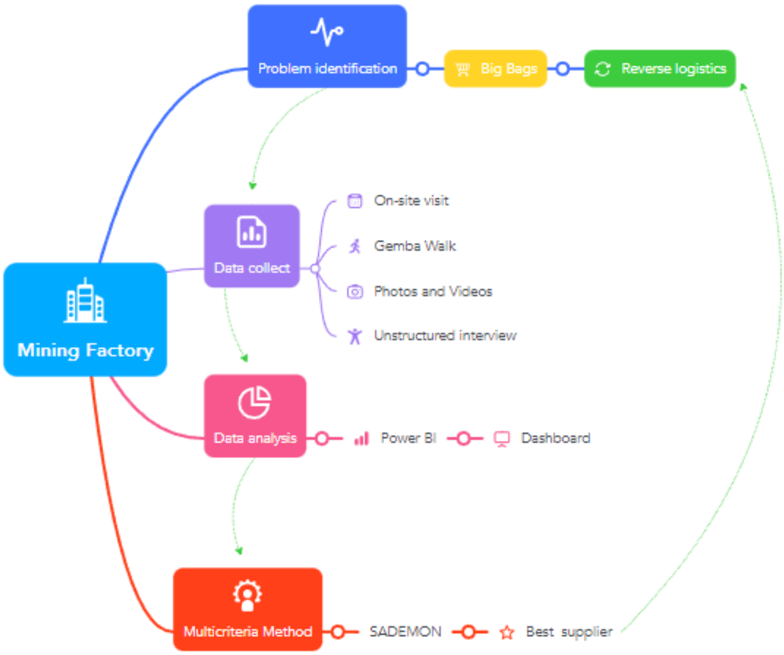


Fig. 1. Methodological scheme of the research

A problem related to the waste of Big Bags was identified throughout the mining company's production process during Gemba Walk. From there, data were collected on the types of defects that related to the Big Bags, the sectors of the factory where they were, the quantities by sector, as well as the total. Then, unstructured interviews were conducted to know the reasons for the waste of the Big Bags, complemented with photos and videos of the loss process, as well as the criteria to be used in the input of the Modelling process of SADEMON to determine the best supplier of recycled Big Bags.

Data analysis took place using Microsoft Power BI. It generated a Dashboard with performance indicators about the waste of Big Bags. Then, using the SADEMON Multicriteria Decision Method, the problem for selecting the best supplier of recycled Big Bags for the company was modelled.

For the application of the SAPEVO -WEB method, the following criteria were used in 4 pre-selected companies:

- Price: Characterized by the unit value that the packaging will return to the company after the entire cleaning process;
- Lead Time: Criterion evaluated in the number of days in which the product is taken to the company, the entire process is carried out and returns;
- Reliability: This point is marked by the measurement of the quality of the services provided, such as the finishing of the sewing, cleaning and replacement of parts. This criterion was qualitatively evaluated by assigning scores from 0 to 5, where 0 is the worst level of reliability and 5 the best level.

## 4. Results and Discussion

### *4.1. Business Intelligence*

Figure 2 shows the overview of the Dashboard developed in Power BI. It is possible to verify the total amount of Big Bags, the possibility of revenue from the sale, opportunity cost with the Big Bags destroyed, the percentage according to the opportunity cost x revenue generated, defective Big Bags found by sector of the company, Graph Treemap with the division by type of defect, Pareto Chart of the amount of Big Bags x Sector. In addition, it is possible to filter according to the sector and type of defect.


Fig. 2. Dashboard overview

From the data analysed in Figure 2, it can be seen that of the 166 Big Bags considered as environmental liabilities, 29 were destroyed (17% of the total). Therefore, 137 (83%) were able to be recovered for reuse in the production process, through Reverse Logistics.

It is still possible to attest that the biggest defect found in the Big Bags was no "skirt", followed by valve problems, destroyed and tear, holes and dirt. Regarding the division by sector, most of them were scattered throughout the factory, followed by the cargo, sand, oven, and mills sector.

### *4.2. SAPEVO-M*

To select the supplier of recycled Big Bags, the SAPEVO-M method was used, through the SADEMON platform. Table 1 shows the characterization of the companies about the price, lead time, and reliability criteria.

Table 1 - Characterization of companies

| Company | Price (R$) | Lead time (days) | Reliability |
|---|---|---|---|
| **A** | 18,00 | 7 | 3 |
| **B** | 22,00 | 5 | 4 |
| **C** | 9,00 | 20 | 2 |
| **D** | 9,50 | 19 | 1 |

After modelling the problem in SADEMON, the weight of the criteria can be visualized in Figure 3.

From Figure 3 it can be seen that the most important criterion is reliability (1,00), followed by price (0,71) and lead time (0,01).


Fig. 3. Weight of criteria

Figure 4 shows the modelling result. The winning supplier to perform the Big Bags Reverse Logistics service was company D (1.71), C (1.53), A (0.37) and B (0.17).

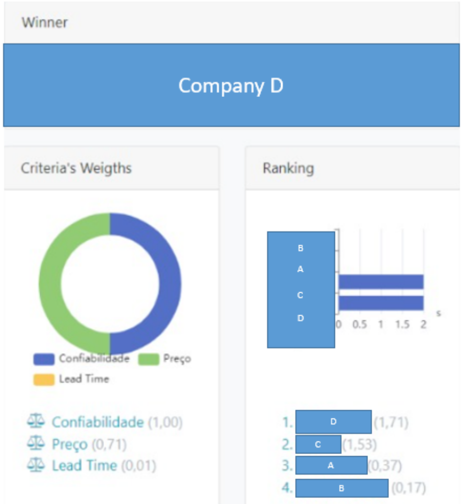

Fig. 4. Final Result

## 5. Final Considerations

This work aimed to apply Big Bags Logistics using Business Intelligence and the SAPEVO-M Multicriteria Analysis Method. With the help of Power BI, it was possible to generate a dashboard with key performance indicators about the object of study.

From the analyzed metrics, it was possible to verify that 83% of the Big Bags discarded by the company could be reused through Reverse Logistics. From then on, SAPEVO-M was applied, using the SADEMON platform, in 4 pre-selected companies for modeling the problem. The criteria selected for the problem were price, lead time, and reliability. Company D had the highest score, followed by C, A, and B, thus being the winner to provide the Reverse Logistics service for Big Bags.

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