Pesquisa Operacional (2023) 43(spe1): e263604 p.1-15
doi: 10.1590/0101-7438.2023.043spe1.00263604

Printed version ISSN 0101-7438 / Online version ISSN 1678-5142
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ARTICLES

APPLICATION OF THE FITRADEOFF METHOD IN A PORTFOLIO PROBLEM IN THE CONTEXT OF REVERSE LOGISTICS FOR WHOLESALE

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Received April 30, 2022 / Accepted September 29, 2022

ABSTRACT . The study investigates options to support the reverse logistics for wholesalers in a company. This big company, which do not have the name presented in this paper aims to improve the process of returning unsold items. At the moment, the process contained several rework-related losses. Hence, in this study two methodologies have been applied. The VFT has been used to structure the problem considering the multiple objectives presented by the Decision-Maker, in special those that are considered by sporting multinational. Also, the FITradeoff method has been used to identify the alternatives that should compose the portfolio of options concerning the reverse logistics. The portfolio problematic has been applied since it has been desired to obtain the subset of option to support the problem, constrained by monetary resources. Using the VFT, ten alternatives which were evaluated in ten criteria have been defined, and support by the FITradeoff method. As result, the alternatives five alternatives have been selected to compose the portfolio.

Keywords: portfolio problematic, FITradeoff Method, Value Focus Thinking, Multi-Criteria Decision-Making/Aiding (MCDM/A), reverse logistic process, wholesalers, sport company.

1 INTRODUCTION

With the increase in the complexity of processes, companies began to face problems that involves different factors, usually guided by conflicting objectives – such as cost and quality, an famous example is the Supplier Selection problem (Barla 2003, Chai et al. 2013, Xia & Wu 2007). In this context, studies related to Multi-Criteria Decision-Making/Aiding (MCDM/A) problems emerged, leading to the development of MCDM/A methods (Keeney & Raiffa 1976, Belton & Stewart 2002, de Almeida et al. 2015), which aims to assist in its resolution in order to guarantee results that are consistent with the Decision Maker (DM) preferences.

For the study in question, two different methodologies have been applied to support the reverse logistics for wholesalers in a company. The process of returning unsold items at the end of the

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season from wholesalers to the distribution center in Monza, Italy, contained several rework-related losses.

Hence, the Value-Focused Thinking, proposed by Keeney (1992), was used to structure the problem considering the objectives presented by the (DM), in special those that are considered by sporting multinational. The VFT has used to identify the objectives for decision makers and determine the available alternatives.

Moreover, the FITradeoff method (de Almeida et al, 2016; de Almeida et al., 2021) for portfolio problematic, idealized by Frej et al., (2021), has been used to identify the alternatives that should compose the portfolio of options concerning the reverse logistics. The multicriteria decision problem of the portfolio problem is composed of several alternatives, among which those that maximize the objective function should be selected, guided by the preferences of the decision maker and subject to investment restrictions (de Almeida et al., 2015). It uses concepts of combinatorial optimization problem which seeks to accommodate a certain number of items in a backpack of limited capacity (Karp 1972). However, in MCDM/A approach the decision-maker's objectives must be considered. And from that arises the main difficulty of the decision-making process: the need to evaluate the multiple objectives in an integrated way.

The paper is divided as follows. Section 2 presents the FITradeoff method. Section 3describes the use of the VFT to structure the problem. Section 4 describes the application of the FITradeoff method to solve the problem. Finally, Section 5 remarks the conclusions and future studies.

2 FITRADEOFF METHOD FOR PORTFOLIO PROBLEMATIC

The FITradeoff method (de Almeida et al, 2016; de Almeida et al., 2021) is a method to elicit scaling constants for problems in the context of Multi-Attribute Value Theory (MAVT – Keeney & Raiffa 1976). This method is based on the Tradeoff procedure to elicit scaling constant. In the Tradeoff procedure (Keeney & Raiffa 1976), the DM have to compare two consequences, and define indifference between them, allowing to make an exchange between them. However, it is not an easy task, which deals to 67% of inconsistences in results obtained using the Tradeoff procedure (Weber & Borcherding 1963).

In this context, the FITradeoff method does not requires that DM defines indifference relations for consequences if they do not want to do that. On the other hand, this method uses partial information concepts, requiring only strict preferences for DMs. Among the benefits associated, the use of incomplete information should be highlighted, which allows the analysis of partial results obtained with less cognitive effort by the decision maker

The FITradeoff method also combines the two perspectives for preference modeling: the elicitation by decomposition, which is performed in the traditional method, special the Tradeoff procedure, and the holist evaluation (de Almeida et al. 2021). This feature provides more flexibility for the method, since the DM can use the perspective that judges most adequate to express preferences. During the elicitation by decomposition the DM compares consequences, and express stric preferences for them, as illustrated in Figure 1. In addition, during the holistic evaluation, the DM compares alternatives, and can define a dominance relation between them.

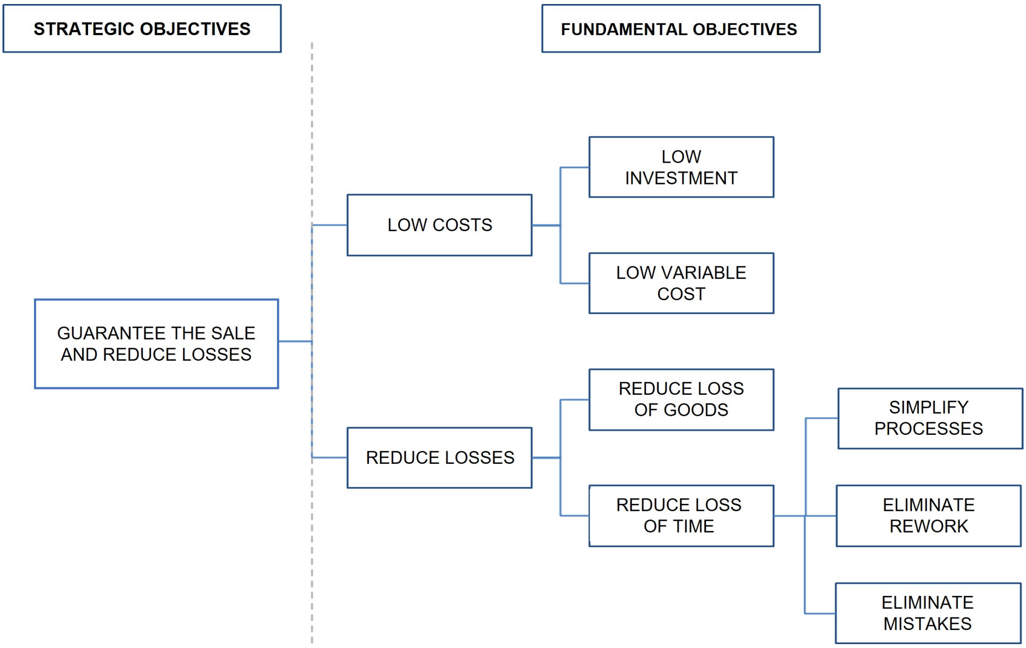

Figure 1 – Problem objectives and criteria.

The FITradeoff method has been proposed to solve several types of problematic, such as choice problematic (de Almeida et al., 2016), ranking problematic (de Almeida et al, 2019), sporting problematic (Kang et al., 2020), and portfolio problematic (Frej et al, 2021). In this context, several applications using this method are presented in the literature (Roselli & de Almeida 2021; Camilo et al. 2020; Pergher et al., 2020; Santos et al., 2020; Fossile et al., 2020; Kang et al., 2020; Kang et al., 2018; Carrillo et al., 2018; Frej et al., 2017).

The FITradeoff method for portfolio problematic has been proposed by Frej et al. (2021). This method uses the cost-benefit ratio to select the most appropriate project portfolio. Hence, it considers the rank of alternatives in descending order according to the cost-benefit ratio, based on the computational methodology presented in Frej et al. (2019). After that, selected the projects that fit the budget. In this way, it was possible to find a solution with a reduced computational effort, eliminating the need to evaluate all possible portfolios. In addition, the model allows to choose a set based on partial information, minimizing the decision maker's difficulties throughout the process.

An application concerning a portfolio of development and research projects in a renowned Brazilian electricity company is considered. At result, it was concluded that the proposed model has several advantages that encourage its application, such as the possibility of analyzing partial results throughout the process, as well as using the graphic visualization to support the decision (Frej et al., 2021).

3 USING THE VFT TO STRUCTURE THE PROBLEM

3.1 Problem Description

The company, founded in July 1924, started its business with the manufacture of sports shoes and, in 1936, it consolidated itself as a reference brand among the most famous athletes in the world. In the late 1990s, the organization continued to expand its business by acquiring a French group specialized in ski apparel, enabling it to compete with the market leader. In 2005, after acquiring a competitor, the German company established itself as one of the largest groups in the market, currently having a turnover of US$ 24 billion (2017) and more than 53 thousand employees (2014).

Despite its worldwide presence, it was considered the problem of reverse logistics for wholesalers in Europe. The multinational faces problems in its reverse logistics process for wholesalers, an operation in which unsold items are allowed to return to the distribution centers in exchange for a credit to the stores. Such difficulties lead to a great loss of time when the goods arrive at the distribution center. Especially when it comes to out-of-season products that are returned and will be sold with a discount, the time to make them available is essential to guarantee their sale. Hence the need to redefine the process.

The goods refund process begins as the multinational is contacted by e-mail or telephone. In this moment, the returned goods are detailed to obtain an authorization to dispatch them. Once the request has been approved, customer service must contact the store again, with details regarding the request. Subsequently, the instructions will be sent along with the barcode that has the return permission. Then, the packaging phase starts, in which the approved goods are placed on boxes that must have the printed authorization bar code pasted on one side.

The boxes will be collected by the carrier and marked with the company's own management code. Upon arrival at the distribution center, orders will be identified through the authorization number and will pass in a quality inspection process. Finally, items in appropriate conditions will be added to the inventory and displayed for sale at a reduced price and a credit associated with the return will be given to the store.

In this process, however, there are several problems. Among which we can mention:

- The long process of requesting the return of goods, which depends on direct contact between a wholesaler employee and the company's customer service.
- A time-consuming and labor-intensive packing process, which requires the authorization to be placed on every box sent back.
- The fragility of the paper that contains the authorization, that is often damaged along the supply chain and leads to complications to identify the request number.

- The incompatibility between the code used by the sports company and the carrier. The inclusion of the carrier's bar code is sometimes pasted on top of the one containing the return information, this way hampering to identify it.
- The impossibility of tracking returned goods.

All these issues directly affect the process and delay the moment that the returned goods will be displayed for sale, generating rework and time loss along the chain. In this study, the DM is an important employee of the company who is responsible to select the portfolio of alternatives that best solved their difficulties, considering monetary constraint, as well as the other strategic objectives of the company.

3.2 Define Objectives

According to Keeney (1992), the identification of objectives is not carried out properly, either due to lack of understanding by decision makers, pressure and lack of time or lack of knowledge about problem structuring approaches.

Hence, in this study, the VFT device has been used – the list of problems and deficiencies existing in the process, in order to stimulate the determination of objectives. Briefly, it can observe that:

1. The slowness of the request process.
2. The reliance of the request process on the immediate availability of the sports company's attendants (on requests made over the phone).
3. The long time taken to pack all returned goods, according to the instructions.
4. The laborious packing process, which requires authorizations to be glued to each of the returned boxes – a number that can vary between a few and hundreds of units.
5. The inefficiency of the packing process, which is usually not carried out correctly – given that many wholesalers do not paste the authorization on every box – and because of the fragility of the paper – which is often damaged during the trip.
6. Lack of unification of information between the carrier and the sports company, which results in more than one code in the same return box and may result in difficulty in identifying it.
7. The impossibility of tracking returned goods.
8. The loss of time to identify boxes without the authorization code.
9. The inefficiency of managing items in the distribution center.

Moreover, another device has been considered, the list of desired consequences:

1. Fast and standardized return request process, to facilitate the analysis and approval by the sports company.
2. Greater ease in the identification process of returned goods, to reduce the time of identification of these when they arrive at the distribution center.
3. Increased agility in the quality control process, so that goods are placed in stock more quickly.
4. Improvement in the management of items in the distribution center, to ensure speed in the processes.

Once, stimulated by these devices, the decision maker's set of fundamental objectives has been determined, as illustrated in Figure 1. These objectives have been well-defined in order to establish the attributes to measure them.

3.3 Define Attributes

The objectives can be described as the performance in some of the stages of the process, which can be measured by the following criteria:

1. **Time to Create a Devolution Request:** It consists of the average time that a wholesaler takes to make the return request.
2. **Packing Time:** It is the average time that the wholesaler takes to pack the goods in a box, accordingly to the instructions of the return process.
3. **Time to Pass the Quality Control:** It consists of the average time to carry out the quality control of the returned goods.
4. **Time Managing the Returned Items:** It consists of the average time to carry out management activities, such as adding the product to the system and taking it to the respective location in the distribution center.
5. **Time Spent Analyzing Unidentified Boxes:** Boxes that arrive at the distribution center without the authorization bar code must be analyzed by a store team, in order to determine from which store those goods came and what is the authorization number of the return order. Thus, it consists of the average time used to determine to which store the unauthorized boxes belong.
6. **Time to Identify Returned Goods (Inside Boxes):** This is the average time required to match goods in a returned box with the items listed in the return request.
7. **Item Tracking:** Determines whether or not the alternative allows tracking of returned goods throughout the supply chain.

8. **Variable Cost:** Consists of the estimated monthly cost for the implementation of the alternative, which will require a continuous investment and not just at the beginning.

9. **Logistical Complexity:** Consists of the degree of difficulty to attend the wholesalers and collect their returns.

10. **Alternative Implementation Time:** Consists of the estimated time to implement the chosen alternative.

Table 1 presents the description of these criteria.

Table 1 – Criterion Classification.

Criteria	Classification	Scale	Increasing / Decreasing
C1: Time to Create a Devolution Request	Natural	Numeric: Minutes	Decreasing
C2: Packing Time	Natural	Numeric: Minutes	Decreasing
C3: Time to Pass the Quality Control	Natural	Numeric: Minutes	Decreasing
C4: Time Managing the Returned Items	Natural	Numeric: Minutes	Decreasing
C5: Time Spent Analyzing Unidentified Boxes	Natural	Numeric: Minutes	Decreasing
C6: Time to Identify Returned Goods (Inside Boxes)	Natural	Numeric: Minutes	Decreasing
C7: Item Tracking	Constructed	Verbal: Inexistent (1), On stages (2), On real time (3)	Increasing
C8: Variable Cost	Natural	Numeric: Thousands of Euros	Decreasing
C9: Logistical Complexity	Constructed	Verbal: (1) Very High, (2) High, (3) Moderate, (4) Low, (5) Very Low	Increasing
C10: Alternative Implementation Time	Natural	Numeric: Months	Decreasing

3.4 Action Space and Problematic

New technologies in the management of distribution centers and in logistics processes were raised, to determine the set of investment options for the company.

The first alternatives concern to the design of an area on the multinational's website for wholesalers. Its main objective would be to facilitate the interface between the sports company and the sellers, bringing this connection closer and integrating their processes. Among its features, it would be possible to request a return, find the step-by-step instructions for preparing the shipment of goods, generate the QR code that will be used throughout the entire logistics chain, track orders and contact different branches to make the exchange. of products among wholesalers certified by the multinational.

RFID, known for airport applications for tracking luggage, was another technology considered. Using the tag, it would be possible not only to automatically recognize returned items, but also to track them along the supply chain.

Regarding the distribution centers, the use of AR (Augmented Reality) has become more frequent to increase productivity. Augmented reality consists of a technology that connects virtual tools with the physical world, through mobile devices such as smartphones, tablets, and glasses. In this sector, its main purpose is to help on management and decision-making processes, facilitating inventory counting and movement procedures. As a result, it is possible to increase the accuracy and agility of management.

The increase of investments in robots in the logistics sector has brought greater visibility to the technology that can generate savings of up to 40% in distribution centers. The robotic warehouse is organized and managed using machines, automatic systems, and specialized software, which reduce manual processes, verticalize storage and optimize employees' resources and time. For the current context, it could be used in the process of identification and separation of goods, to facilitate quality control, and inventory management, through the transport to their respective location in the distribution center.

Another innovation that proves to be an important reducer of logistical costs are the establishments used to store orders from different customers so that they can come and collect them – the so-called lockers. For the context of the problem, a way to minimize the complexity of attending wholesalers would be to leave the returned order in a locker, used to serve nearby establishments. In this way, the number of stops would be reduced, and the route would become more standardized, factors that would guarantee a lower cost.

Given globalization and the increasing complexity of supply chains, greater integration of different parts is essential to achieve better results. In this sense, the union of e-commerce and carriers through digital transformations represents an important advance. This way, it would be possible to offer the distribution center and wholesalers more accurate information about the stages of the order, facilitating the planning of both parties.

The use of a system whose purpose is to assist the driver during deliveries – or, in the case of reverse logistics, the collection of returns – can bring great efficiency to the process. The logistics cockpit consists of an interface for smartphone or tablet that offers functions such as viewing the best route, monitoring of completed and pending deliveries, digital proof of delivery, sending updates to the company and the possibility of reporting occurrences that affect the progress of deliveries.

From the implementation of the Internet of Things (IoT) in sensors and devices, it is possible to create a flow of information with real-time monitoring of the location and status of deliveries that facilitate decision-making in case of accidents and unforeseen events. Unlike the logistical cockpit, the technology does not depend on the active participation of the driver. This process is ensured through the integration of systems and the use of geolocation, in order to facilitate the control of the logistical stages and increase the agility of response.

Inventory management efficiency is directly associated with cost reduction and sales guarantee, since it will ensure that products are available at the desired time. In this way, the implementation of a system that allows the automation of management processes is advantageous, since it will result in improvements in the execution of activities, reducing the rate of errors and rework, while increasing safety, productivity and reliability. of information.

With the advancement of transport technologies, new modalities have become available in the market. Among them, the advancement of autonomous vehicles and drones is notorious.

In summary, the set of alternatives evaluated are:

1. Inclusion of an area for wholesalers on the company's website.
2. Use of RFID in their products.
3. Implementation of augmented reality technologies in distribution centers.
4. Automation of processes in the distribution center, through robotization.
5. Use of lockers as collection points for return orders.
6. Integration of e-commerce and carriers.
7. Application of the logistic cockpit to assist the driver during order picking.
8. Application of the Internet of Things (IoT) in logistics processes, through so-called smart trucks.
9. Use of an automated inventory management system.
10. Hire of drones for returns of small orders that require speed.

Based on the information found regarding the technologies, as well as the times provided by the distribution center operators and the approximate value of the company's billing for the region, it was possible to estimate the consequences of each of the alternatives, as illustrated in Table 2.

In line with it, the cost of each of the projects are illustrated, which is the constraint used in the portfolio problem. The budged is 75 million of euro.

4 USING THE FITRADEOFF METHOD

In this study, it has been observed that DM presents a compensatory rationality since he prefers to wait more to implement a measure that could guarantee less time spent identifying goods. i.e., better performance in the Time to Identify the Returned Goods compensated for a worse performance in Time to Implement the Alternative.

Hence, the FITradeoff method has been considered to be used. Intra-criteria and inter-criteria evaluations will be carried out based on this method (de Almeida et al. 2016, de Almeida et al., 2021).

Table 2 – Decision Matrix.

Alt. / Cr.	Cr.1	Cr.2	Cr.3	Cr.4	Cr.5	Cr.6	Cr.7	Cr.8	Cr. 9	Cr.10	**Cost**
Alt. 1	5	7	10	15	30	12	0	1	0	1	18
Alt. 2	15	5	5	10	0	0,5	2	76	1	6	2
Alt. 3	15	10	3	10	30	4	0	6	0	12	300
Alt. 4	15	10	1	6	30	2	0	10	0	18	1000
Alt. 5	15	10	10	15	30	12	1	0,2	4	3	25
Alt. 6	15	10	10	15	15	12	1	12	2	2	10
Alt. 7	15	10	10	15	30	12	0	8	3	1	7
Alt. 8	15	10	10	15	15	12	2	10	3	4	50
Alt. 9	15	10	7	10	30	7	0	7	1	1	7
Alt. 10	15	10	10	15	30	12	2	5	2	12	27

The intra-criteria evaluation strongly depends on the way in which the criteria were established in the previous stages, considering aspects such as: the evaluation scales, whether the consequences are probabilistic or deterministic and whether their functions are linear or not. For the study, the value functions were elicited by the decision makers, and it was concluded that a linear approximation of preferences was reasonable. Therefore, all value functions were considered as linear – an outcome usually seen, accordingly to what was presented on SMARTS/SMARTER (Edwards & Barron 1994).

The inter-criteria evaluation was carried out jointly with the DM. the FITradeoff method has been developed to elicit scaling constants in problems in the context of MAVT.

Using the FITradeoff Decision Support System, the DM rank the scaling constant. The inequality (1) presents this order of scaling constants related to each criterion.

$$k_{C5} > k_{C6} > k_{C4} > k_{C10} > k_{C8} > k_{C3} > k_{C9} > k_{C7} > k_{C1} > k_{C2} \qquad (1)$$

After that, the DM proceeds in flexible elicitation process, in which two pairs of consequences were compared in order to establish strict preferences between consequences, as illustrated in Figure 2. After answering five questions, the decision maker obtained a ranking of six levels, in which there were still alternatives evaluated at the same level (Figure 3).

Although the decision maker had the chance of stop the process at this point, he chose to proceed with the elicitation until the end, obtaining the complete ranking of the projects. The following recommendation: implement the alternatives 2, 9, 6, 7 and 1 and consume 44 million of euros (Figure 4).

The FITradeoff DSS provides a sensitivity analysis for DMs. The sensitivity analysis aims to determine the robustness of a solution, from varying certain parameters of the model in order to guarantee that the result obtained would not be altered. In this sense, consequences of the first five criteria which had higher values of scaling constants (Time Spent Analyzing Unidentified Boxes, Time to Identify Returned Goods, Time Managing the Returned Items, Alternative Im-

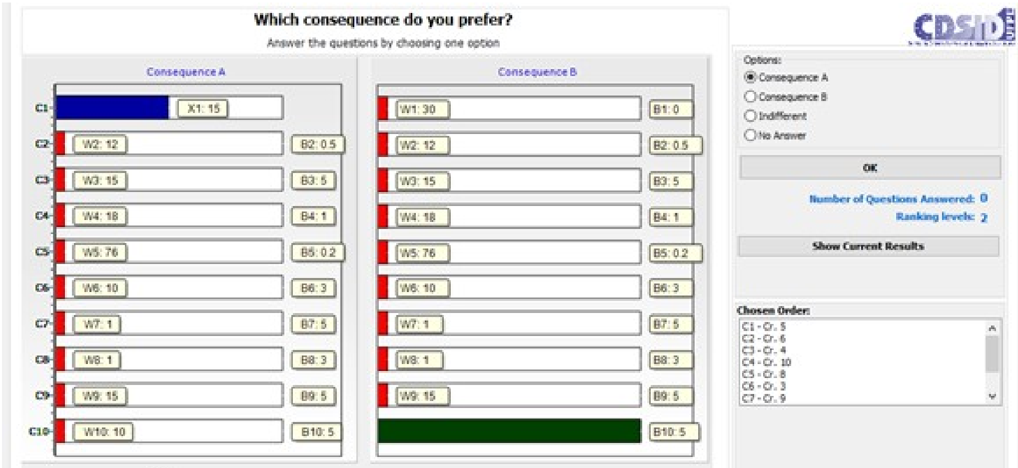

Figure 2 – Elicitation by Decomposition in FITradeoff DSS.

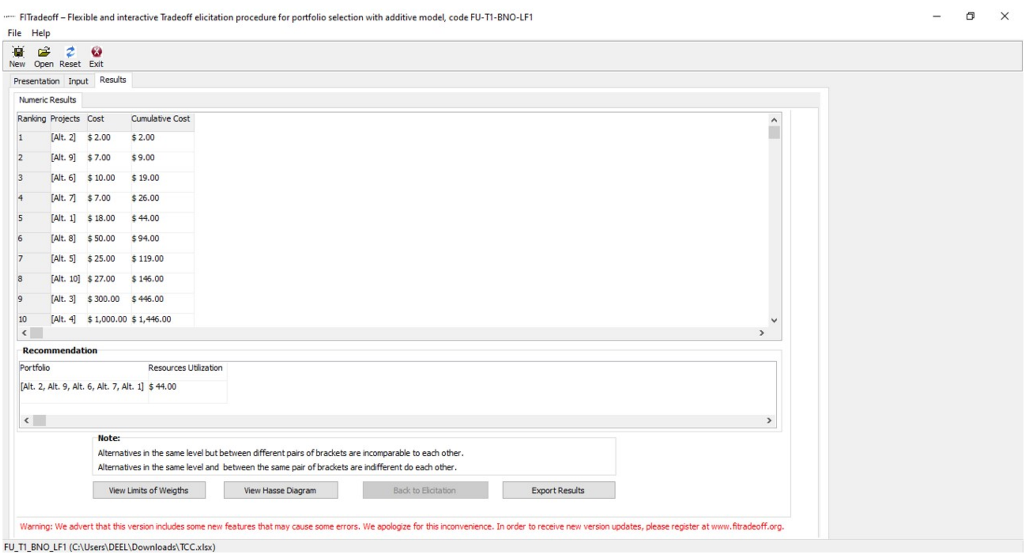

Figure 3 – Ranking of six levels.

plementation Time and Variable Cost) vary by 10%. At the end, it was noticed that the results remained the same, demonstrating that there is a certain robustness in the solution.

5 CONCLUSION

In this work, a problem in the context of reverse logistics for wholesalers of a sporting goods company was considered, whose proposed alternatives consisted of technologies that could be grouped to solve existing flaws in the process. Once the set of available projects was determined, it was decided to select a portfolio to maximize the return obtained by the decision maker, de-

Figure 4 – Complete Ranking.

scribed according to his preferences. To this end, the FITradeoff method was applied to the portfolio problem proposed by Frej (2021), based on a cost-benefit approach.

Among the benefits associated with the application, the use of incomplete information should be highlighted, which allows the analysis of partial results obtained with less cognitive effort by the decision maker. Despite the desire to continue with the elicitation process, the decision maker was able to analyze his options after 5 questions, obtaining a ranking of 6 levels that was very close to the final ranking.

In this research, it is reasonable to assume that the criteria are deterministic. Because, despite the possibility of variation in the criteria of return request time, time to pack, time to carry out quality control, time spent analyzing unidentified boxes and time to identify the returned merchandise, these processes are standardized, so that the expected variability is small. The same can be said for the criterion of time to implement the solution, whose forecast was made considering the acquisition times of necessary technologies, process changes, software development, etc. This way, although it is possible to have a variation of a few days in the total time used, the estimation considered the possibility of delays. The cost criteria (Investment for Implementation and Variable Cost) can also be considered deterministic because, despite the possibility of variation of these values depending on the period, the change is not considered significant for a short period of time.

Regarding the limitations of the study, it was needed to make a few estimations to compose the matrix of consequences. Given the lack of a study regarding the times of the processes. In addition, it was not possible to obtain a detailed budget for the implementation of the technologies.

Another issue was the estimation of the impact of technologies on each of the processes, which could not be precisely determined since it was not possible to carry out tests with them. In addiction the implementation of the alternatives must be carried out in line with the multinational's project team, the sector responsible for managing new investments. Since the DM is not part of the team, he will not be directly involved in the installation of new technologies.

Acknowledgments

This work had partial support from the Brazilian Research Council (CNPq).

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How to cite

CYRENO MW AND ROSELLI JLRPR. 2023. Application of the FITradeoff Method in a Portfolio Problem in the Context of Reverse Logistics for Wholesale. *Pesquisa Operacional*, **43** (spe1): e263604. doi: 10.1590/0101-7438.2023.043spe1.00263604 .