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WESLEY DOUGLAS OLIVEIRA SILVA

DECISION-MAKING AND NEGOTIATION MODELS TO SUPPORT BRAZILIAN TRANSITION TOWARDS A CIRCULAR ECONOMY

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Concentration Area: Production Management

Advisor: Profª. Drª. Danielle Costa Morais.

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ABSTRACT

The linear economy model used around the world (resource extraction – production-consumption-disposal) has placed an enormous burden on the environment and hampered its self-recovery capacity, having environmental negative implications, and also economic and social negative impacts. In this sense, the circular economy model (production-consumption – reintroduction) figures as one of the attempts to slow down the impact that the linear model has on the world. Despite the advances experienced in developed countries, developing countries like Brazil face difficulties in making a shift to the circular economy model, either due to lack of structure or knowledge, or because several decisions need to be taken, decisions that may involve different decision-makers, their conflicting perspectives, and criteria. Thus, the objective of this thesis was to propose models to support decision-making and negotiation that would help various sectors in Brazil to make the transition to a circular economy more assertively. In chapter 3, a group decision model is proposed to help segments of society to identify and allocate responsibilities and costs for solid waste management. A case study in the packaging sector is presented to validate the model. Therefore, in chapter 4, a multi-criteria model of the individual decision is presented to help company managers to define which strategies should be outsourced and which should be kept in-house as they were their responsibilities. Two case studies in circular economy textile companies' adopters and incumbents were used to validate the model and to compare what the main nuances can emerge from these two different business models, and, thus, generating insights that help adopters to make better decisions about outsourcing strategies. Afterward, as many economic activities are developed through the indiscriminate use of water that is a finite natural resource, in chapter 5, a negotiation model is proposed to resolve conflicts in river basin committees on the identification and allocation of circular strategies to minimize the pollution and water scarcity. This model was also validated in a case study. The results of the application of the models showed that the circular economy is an umbrella topic and that, regardless of the sector, size, and/or activity in Brazil, this new model can be implemented bringing environmental, economic, and social benefits.

Keywords: circular economy; Brazil; decision-making; negotiation.

RESUMO

O modelo de economia linear empregado mundo afora (extração de recursos – produção-consumo-descarte) tem colocado o meio ambiente sobre um enorme fardo e dificultado sua capacidade de autorrecuperarão, tendo implicações negativas, também, em termos econômicos e sociais. Nesse sentido, o modelo de economia circular (produção – consumo – reintrodução) figura como uma das tentativas de frear ou desacelerar o impacto que o modelo linear causa ao mundo. Apesar dos avanços experimentados em países desenvolvidos, os países em desenvolvimento como o Brasil enfrentam dificuldades de realizarem uma mudança para o modelo de economia circular, seja por falta de estrutura ou conhecimento, ou ainda porque várias decisões precisam ser tomadas, decisões estas que podem envolver diferentes tomadores de decisão, suas perspectivas e critérios conflitantes. Dessa forma, o objetivo desta tese foi de propor modelos de apoio à decisão e negociação que auxiliassem diferentes setores do Brasil a realizarem a transição para economia circular de forma mais assertiva. No capítulo 3 um modelo de decisão em grupo é proposto para auxiliar segmentos da sociedade a identificarem e alocarem responsabilidades e custos para o gerenciamento de resíduos sólidos, um estudo de caso no setor de embalagens é apresentado para validar o modelo. Por conseguinte, no capítulo 4, um modelo multicritério de decisão individual é apresentado para auxiliar gestores de empresas a definirem quais estratégias devem ser terceirizadas e quais aquelas que devem ser realizadas em suas plantas uma vez que elas eram de suas responsabilidades, dois estudos de casos em empresas têxteis adotantes e incumbentes da economia circular são utilizados para validar o modelo e para comparar quais as principais nuances podem surgir desses dois modelos de negócio diferentes e, assim, gerar insights que auxiliem as adotantes a tomarem melhores decisões quanto à terceirização ou não. Depois disso, como muitas atividades econômicas são desenvolvidas através da utilização indiscriminada da água que é um recurso natural finito, no capítulo 5 um modelo de negociação é proposto para resolver conflitos em comitês de bacias hidrográficas sobre a identificação e alocação de estratégias circulares para minimizar a poluição e a escassez de água. Esse modelo foi validado, também, em estudo de caso. Os resultados das aplicações dos modelos mostraram que a economia circular é um tema guarda-chuva e, que, independentemente do setor, tamanho e/ou atividade do Brasil, esse novo modelo pode ser implementado trazendo benefícios ambientais, econômicos e sociais.

Palavras-chave: economia circular; Brasil; tomada de decisão; negociação.

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CONTENT

1 INTRODUCTION

The intensive use and inadequate management of natural resources have negative consequences with serious consequences for countries all over the world, whether they be developed or developing nations. These consequences include, but are not limited to, pollution which has reached inordinate levels, an increase in social inequality and issues to do with economic deficits (ALVARADO et al., 2021).

In this perspective, the orientation of the traditional production-consumption model, commonly known as the linear economy model, is towards the single use of goods. Thus, natural resources are extracted without planning, the production process of goods is disorderly, and, after consumption, the residues of these goods are irresponsibly discarded without evaluating what the impact on the environment will be (HASEEB et al., 2021).

Furthermore, all around the world, the linear economy model is powered by the use of water in economic activities that do not take into account that water is a finite resource. Added to this is the fact that pollution caused by economic activities contaminates groundwater and alters the natural hydrological cycle, thus resulting in this cycle being interrupted, thereby water becomes scarce, and this intensifies the struggle for survival of the poorest in society (STUMPF et al., 2021).

Hence, this has direct impacts on the soil. For example, there is a reduction in the availability of healthy and arable land that is suitable for economic activities such as agriculture. It must be borne in mind that these activities contribute greatly to the economic composition of the gross domestic product of many countries, thus causing economic problems when these activities are interrupted (DONG et al., 2021).

At the same time, in the linear economy model, economic activities have processes that are put into practice that use non-renewable energies which, in most cases, release many greenhouse gases and have an adverse impact on the quality of the air. Consequently, the consumption of goods from these processes increases the carbon footprint worldwide (SUÁREZ-EIROA et al., 2021).

Thus, the linear economy model has placed an enormous burden on the environment, as it manifests itself frequently and in a very short time span, and this further limits the chances that the environment can self-recover, thus militating against present and future generations being able to meet their needs from natural resources (MIES; GOLD, 2021).

Regarding the linear economy model, a lot of waste is generated during the production process, before products are consumed because they do not meet retailers' minimum quality requirements. Then, after products have been consumed or have reached the end of their useful life, they are often simply dumped as waste. Consequently, the previously mentioned negative impacts on the environment and on society in general are verified. Thus, adequate management of waste is needed that covers all phases of the life cycle of products (BRAZIL, 2010).

Adequate management of natural resources (i.e., water, soil, and air), and adequate solid waste management is in line with the principles of circular economy (CE), which seeks to develop strategies for decrease natural resource negative impacts by the systematic reintroduction of waste into the production and/or business cycle in order to partially or completely recover its value (SNELLINX et al., 2021).

However, despite advances related to the circular economy, developing countries such as Brazil face difficulties in identifying and implementing practical issues that enable them to make the transition to the circular economy model, as interconnected decisions need to be taken at different levels (SILVA; MORAIS, 2021).

In this sense, chapter 3 puts forward a discussion on how circular strategies are identified and allocated in the packaging sector due to the 25 thousand tons/per day in Brazil that go to the dumping ground and to its enormous potential of pollution to the soil and groundwater observed. So, this is an alternative approach to comply with the sectoral agreement established in Law 12,305.2010 – National solid Waste Policy (SILVA; FONTANA, 2020).

Next, since in chapter 3 we identify and allocate the circular responsibilities among the segments, in chapter 4 we have a look at how the segments put into practice these responsibilities. More specifically, we analyze the decision-making process about outsourcing or not the circular responsibilities in different companies to generate insights that support others to make the transition. The focus is on the textile and fashion industry which is the fourth largest polluter in the world and in Brazil it has a huge contribution to the gross domestic product (ROSSI et al., 2020).

Moreover, most of the economic, social, and public activities are based on the intense use of water and this is a natural but limited resource. So, the pollution and drought of water in Brazil cause problems in the community activities. Especially, in chapter 5 we have a look at the process of circular water resources management in watershed committees due to its potential to have conflicts (REZENDE et al., 2019).

Thus, this thesis explores how decision-making and negotiation models can help Brazil make the transition to the circular economy and get environmental, economic, and social benefits. More specifically, first this thesis proposes a group decision model to support Brazil in the to identify and allocate circular strategies among society segments in the packaging sector. Secondly, the thesis proposes a multicriteria decision-making model to outsource circular economy strategies in textile and fashion industry. Finally, this thesis develops a negotiation model to support water resources management in watershed committees following the basis of circular economy.

1.1 Objectives

1.1.1 Main objective

The main objective of this thesis is to propose decision-making and negotiation models to support the Brazilian transition towards a circular economy in packaging sector, textile and fashion industry, and regarding water resources management.

1.1.2 Specific objectives

To achieve this main objective, the following objectives are set in this thesis:

- To propose a group decision-making model to resolve conflicts in the identification of circular economy strategies and fair allocation of costs and responsibilities to segments in relation to the management of solid waste;
- To develop a multicriteria decision-making model for textile industry managers to classify which of their circular strategies will be outsourced and which will be carried out in house;
- To deploy an integrative negotiation model to assist watershed committees to set circular strategies and responsibilities in relation to the appropriate management of water resources; and
- To assess the impact of the circular economy model on the environmental, economic, and social dimensions in multiple case studies by implementing the proposed models.

1.2 Motivation and Justification

The rapid growth of the urban population, especially in developing countries like Brazil, and the level at which waste is generated is also growing rapidly (KINOBE et al., 2015). Hence, what is perceptible is that there are concerns about preserving the environment and about the negative impact that its poor conservation will have on the quality of life of future generations (MAHNOUDI; FAZLOLLAHTABAR, 2014).

Veiga (2013) states that in Brazil, for example, the generation of waste has grown at a rate that is three times faster than that of the population, with most of its municipalities unable to find suitable places for disposal such as landfills. Therefore, Farel et al. (2013) argue that the capacity of landfills has become more limited and are expensive to manage, which restricts their use. Moreover, they have open-air dumps to release waste and they bring several inconveniences such as contamination of water courses and the soil.

On the other hand, OtengAbabio et al. (2013) point out that authorities, scholars, practitioners and societies around the world are studying ways to explore possibilities for a paradigm shift in production-consumption relations. The aim is to recover the material considered as waste, and so, in addition to making gains in environmental terms, there will be economic gains and social benefits. The circular economy model is one means of tackling this.

The main features of the circular economy are the fundamental rethinking of how to make use of virgin natural resources, which is diminished; what renewable and/or cleaner energies to invest in; and how to minimize the amounts of waste generated by changes in production processes. These latter ranges from choosing the raw material to be used, and designing the product to planning its final destination, which probably includes reintroducing the product in some stream, whether into its original supply chain or a different one (KAZANCONGLU et al., 2020).

From this perspective, in Brazil, the National Policy for Solid Waste (NPSW) was sanctioned and regulated by LAW No. 12305/2010, which brings together a set of guidelines for the appropriate management of solid waste (BRAZIL, 2010).

Coming from the NPSW is the concept of shared responsibility for the product's life cycle, which establishes cooperation between the different spheres of government, the business sector, and other segments of society, here called stakeholders, for the integrated management of the whole of the life cycle of the product, especially at the end of its useful life, when it is presented in the form of solid waste (GUARNIERI et al., 2016).

In addition, there is the National Plan for Water Resources (NPWR) set out in LAW No. 9433/1997, which establishes a democratic, participatory decision-making process for the appropriate management of water, which is a natural and public asset, but a limited one (BRAZIL, 1997).

However, with regard to decision-making for the management of both solid waste and water resources, problems occur with the various segments of society that have difficulties in establishing mutually acceptable decisions about identifying circular strategies, defining responsibilities and allocating them. This can weaken actions aimed at preserving the environment (SILVA; FONTANA, 2021).

This occurs because each segment has interests, perspectives and goals that conflict with those of other segments. Thus, in order for this decision-making not to fail, approaches must be developed that manage to coordinate the different perspectives in order to seek an accommodating atmosphere so that collaborative relationships can be built into the decisions taken.

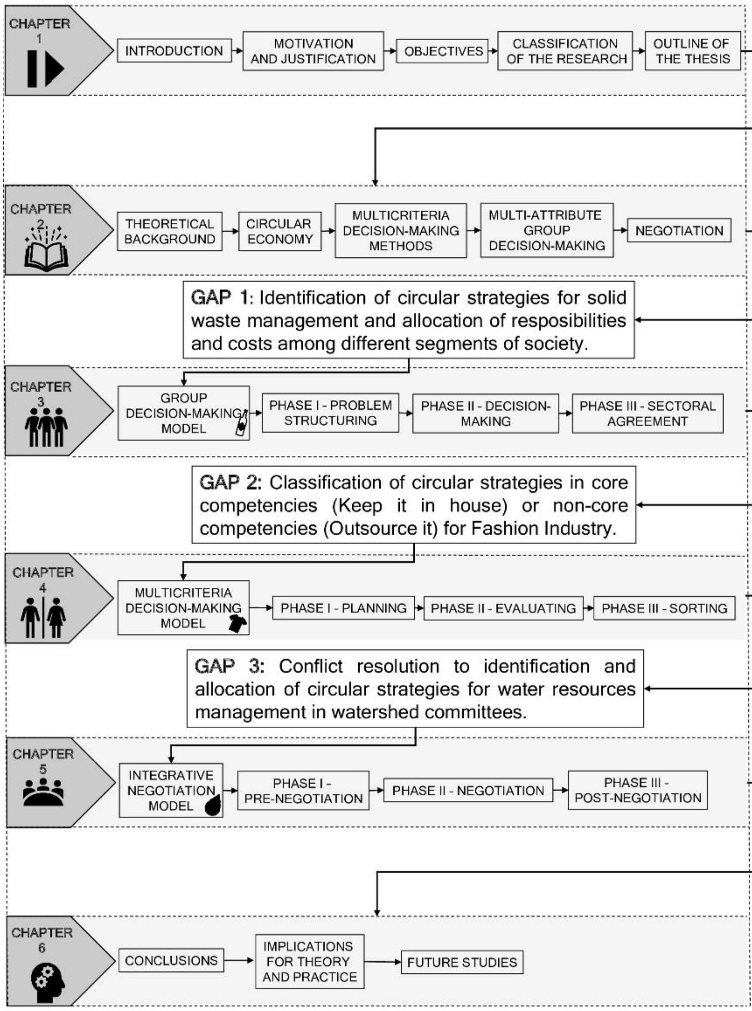
Another important problem in this context is that when responsibilities are defined, pressures are created between the segments so that the implementation of defined circular strategies may actually be put into practice. In this respect, of these often arbitrarily choose to outsource their CE responsibilities without realizing the advantages of carrying out their planning in line with their current activities (GUARNIERI et al., 2015). This can hinder the transition to a circular economy in Brazil.

Thus, decision-making models, group and/or individual, and negotiation models can be useful to assist in this transition, since it supports decision-makers on thinking clearly and in a structured way about their possibilities, thus reaching satisfactory decisions for circular economy transition in Brazil.

1.3 Outline of the thesis

In addition to this introductory chapter, this thesis has five additional chapters that are briefly described below and summarized in Figure 1.

Figure 1 - Outline of the thesis



Source: The Author (2022)

- Chapter 2 - Presents the theoretical framework on which the development of the models of this thesis is based (i.e., Circular Economy, Multicriteria Decision-Making Models, Multi-attribute Group Decision-Making, and Negotiation);
- Chapter 3 - Presents a multicriteria group decision model to support segments of society in identifying circular strategies, and to distribute responsibilities and costs for the management of solid waste;
- Chapter 4 – Provides a multicriteria model of individual decision to support managers of incumbent companies and adopters of the circular economy in classifying their strategies between those that should and should not be outsourced;
- Chapter 5 - Develops an integrative negotiation model for river basin committees with regard to defining circular strategies for the appropriate management of water resources; and

- Chapter 6 - Contains the main conclusions arising from applying the models in case studies, contributions to theory and practice, and suggestions for future lines of research.

In the applications of the three models presented as case studies (i.e., Chapter 3, Chapter 4, and Chapter 5) various methodologies, methods and techniques are used to develop specific questions for each situation presented as shown in Table 1.

Table 1 - Methodologies used in the chapters

Chapter	**Model**	**Methodology**
Chapter 3	Multi-attribute Group Decision Model	- Valued Focused Thinking -FITradeoff for the Ranking Problematic -FITradeoff for Group Decision -Shapley Value
Chapter 4	Multicriteria Decision-Making Model	- Cognitive Mapping - BSI 8001:2017 -FITradeoff for the Sorting Problematic
Chapter 5	Integrative Negotiation Model	-Valued Focused Thinking for a Group Context - Multi-Objective Linear Programming Models -FITradeoff for the Choice Problematic - The Global Criterion Method

Source: The Author (2022)

These methodologies, methods and techniques are presented in more in-depth details in chapter 2.

2 THEORETICAL BACKGROUND AND LITERATURE REVIEW

This chapter is divided into two parts. The first part of this chapter presents definitions and explanations of the fundamental topics of this thesis: Circular Economy, Multicriteria Decision-Making Methods, Multi-attribute Group Decision-Making, and Negotiation. The applications set out in chapters 3, 4, and 5 use these concepts. The second part presents the literature review and the gaps addressed in this thesis.

2.1 Theoretical Background

2.1.1 Circular Economy

The development of economic activity in the world has for many years been based on a linear business model, which extracts natural resources, transforms them into goods, after which they are used and disposed of (BRAUNGART et al., 2013).

Although fundamental for the growth and development of societies, this model has been shown to be fragile, given the limited availability of natural resources. In the context of the linear economy, actions focus on minimizing negative impacts through reduction, i.e., continuing to produce in the same way, but with less intensity, without changing perspective, and only postponing problems for the future (POTTING et al., 2017).

Moreover, the central principle of linear economy is reduction, the linear flow of the consumption of resources is maintained for which a cradle-to-grave approach is used. This is only concerned with products until the end of their useful life, which is regarded as their destination. Furthermore, it allows a deceleration of the moment at which natural resources will run out (BRAUNGART; MCDONOUGH, 2002). However, there has been an increasing demand for actions that bring radical changes in the way that resources are used, such as in the circular economy model.

According to the Ellen MacArthur Foundation (2012), the Circular Economy model can be defined as a model of the economy that has restorative and regenerative intentions and aims to keep products, parts from them, components, and materials at the highest level of utility and value during their entire life cycle.

Furthermore, to be implemented, the circular economy distinguishes two types of cycle under which its actions can be focused (SNELLINX et al., 2021):

- The Biological Cycle: circular economy strategies act to recover and regenerate the biosphere by managing the flow of renewables and using them in cascade;

- The Technical Cycle: reserves of natural resources must be managed and recovered, since they are limited and finite, by means of closed-loop supply chain strategies.

In a report from the Ellen MacArthur Foundation (2012), three principles that guide the circular economy are pointed out:

- To preserve and enhance natural resources by controlling their finite reserves, and balancing this with the flows of renewable resources;
- To maximize the yield from resources, thus making products, components and materials in use circulate, both in their biological and technical cycles;
- To encourage the effectiveness of the system by revealing and excluding negative externalities from the start.

Furthermore, Webster (2015) points out the main differences between a linear economy model and a circular economy model. These differences are described in Table 2.

Table 2 - Differences between linear and circular economy model

Linear Economy Model	Circular Economy Model
Externalizes costs with a view to reducing production costs.	Internalizes costs to increase quality, performance and reduce risks in the production process.
Product Liability extends to the sale of the product.	Producer responsibility extends throughout the product's lifecycle.
It standardizes products to facilitate economies of scale, the efficiency of the process and the use of the product.	Standardizes components to promote their reuse, remanufacture and recycling.
Promotes a linear, production-sale-use-disposal system based on a competitive market.	Promotes collaboration without losing competitiveness with differentiated markets and regions, and offers products on demand.

Source: Adapted from Webster (2015)

Thus, it is important to make a transition to the circular economy model, thereby changing the way of thinking, understanding, acting and managing business from the simple to the complex, from linearity to circularity, from predictive to adaptive, from independent to interdependent, from efficient to effective, from constructing win-lose relationships to entering into win-win relationships and from competition to collaboration (DONG et al., 2021).

2.1.1.1 British Standard for Circular Economy

The BSI 8001:2017 is a maturity standard for the development of circular economy principles in an organization. This maturity standard aim is to guide any organization, regardless of its location, sector, size and type of business, in circular economy to develop practical guidelines to reap easily realizable benefits, requiring only modest investments. At the same time, it can also assist different users with different levels of experience with circular economy to rethink the use of resources, combined with an increasing in their financial, environmental, and social performance by (BSI, 2017).

The analysis according to the standard BSI 8001:2017 works on 6 fundamental principles and uses a symbology to indicate the degree of intensity with which the circular economy principles are met is shown in Figure 4 (ROSSI et al., 2020).

Figure 2 - BSI 8001:2017

Principles proposed by the standard BSI 8001:2017

Systems Thinking	Holistic approach to understand the interactions between individuals and activities within the wider systems they are part of.
Innovation	Continually innovate to create value by enabling the sustainable management of resources through the design of processes, products/services and business models
Stewardship	Manage the direct and indirect impacts of their decisions and activities within the wider systems they are part of;
Collaboration	Promote collaboration internally and externally through formal and/or informal arrangements to create mutual value
Value Optimization	Keep all products, components and materials at their highest value and utility at all times
Transparency	Organizations are open about decisions and activities that affect their ability to transition towards a more circular and sustainable mode of operation and are willing to communicate these in a clear, accurate, timely, honest and complete manner

Symbols used to represent the intensity levels based on BSI 8001:2017

✓	Indicates that the criterion is **very efficient** at achieving the requirements of the principle, evaluating ways for doing business and creating additional circular values.
+	Indicates that the criterion has a **median efficiency** at achieving the requirements of the principle, and is limited in doing the evaluation of circular solutions for processes.
✕	Indicates that the criterion has a **weak efficiency** at achieving the requirements of the principle, but should be used in the initial stages of CE journey to explore opportunities.

Source: Adapted from BSI 8001:2017

Consequently, it is an important methodology to be used in circular economy decision-making model.

2.1.2 Multicriteria Decision-Making Methods

A multicriteria decision problem is one in which there are at least two alternatives and a set of objectives, which, in most cases, conflict with each other. Furthermore, there are criteria, attributes or dimensions associated with the objectives that measure the performance of each alternative (ROY, 1996; DE ALMEIDA, 2013).

Moreover, multicriteria methods support structuring, synthesizing information and determining a satisfactory solution for situations that involve one or more decision-makers

(DMs) (ZELENY, 1986). In the decision-making process, there may be some important actors, among whom are those whose roles are as follows: (ROY, 1996):

- A decision-maker: responsible for the decision and its consequences;
- An analyst: responsible for providing methodological support to the DM;
- A specialist: has in-depth knowledge of issues or systems inherent in the decision-making process; and
- *Stakeholders*: who influence the DM by exerting pressure.

From this perspective, the satisfactory solution found in the multicriteria decision problem is aligned with the nature of its problematic. The most basic are (VINCKE, 1992):

- The Choice Problematic (P.α): from within a set of available alternatives, choose a subset;
- The Classification Problematic (P.β): categorizes a set of available alternatives according to certain pre-established classes and profiles;
- The Ranking Problematic (P.γ): order, preferentially in descending order, a set of available alternatives.

Added to these problematics are the proposals by Belton and Stewart (2002), which are: the portfolio problematic which is responsible for establishing a subset of alternatives and for evaluating their individual characteristics and their interaction with other alternatives; and the design problematic, which works on the creation of new alternatives based on the objectives of the decision problem.

In order to analyze decision support problems, some elements are important. Among them, the DM's preference structure stands out, which is defined by binary relations that allow comparisons between alternatives (VINCKE, 1992). Suppose then, the comparison between two alternatives A and B, according to Roy (1996) the following preference relations can be used:

- Indifference (I): *AIB*, there are clear reasons that justify the similarity between alternatives A and B;
- Strict Preference (P): *APB*, there are clear reasons that justify a significant preference in favor of alternative A;
- Weak Preference (Q): *AQB*, corresponds to the non-existence of clear reasons that justify the indifference or strict preference between alternatives A and B;
- Incomparability (R): *ARB*, corresponds to the absence of clear reasons that justify the option for any of the three preceding relationships.

De Almeida (2013) points out that the DM's rationality should be considered. This can be compensatory or non-compensatory. Compensatory rationality means that the poor performance of an alternative in one criterion is compensated by the good performance of that same alternative in other criteria. Non-compensatory rationality means that the poor performance of an alternative in one criterion is not compensated by the good performance of that same alternative in other criteria.

In order to solve multicriteria decision problems, there are Multicriteria Decision-making Methods (MCDM/A) that can be classified in several ways. However, the classification that is most used is that of Roy (1996):

- Single Synthesis Criterion Methods: they are based on compensatory aggregation of preferences and do not permit incomparability.
- Outranking Methods: are based on non-compensatory rationality and accept incomparability.
- Interactive Methods: these are based on problems the solution of which is found based on learning of the DM's preferences over time.

The Flexible and Interactive Tradeoff (FITradeoff) used in this thesis is part of the Single Synthesis Criterion Methods.

2.1.2.1 Flexible and Interactive Tradeoff

Additive aggregation models are based on the Multi-attribute Value Theory (MAVT) that has the same structure as in Equation 2.1(DE ALMEIDA et al., 2013).

$$v(a) = \sum_{j=1}^{m} w_j v_j(a) \tag{2.1}$$

Where m is the number of criteria, $v(a)$ is the value of one alternative a for a DM, w_j is the scale constant of criterion j, and $vj(a)$ is the value of the consequence for criterion j, given its scale constant w_j $\forall$ j ≥ 0 and $\sum_{j=1}^{z} w_j = 1$.

The scale constants in the additive aggregation model means more than the level of importance, it also means the substitution rate for loss compensation in one criterion and the gain in another. Thus, for facilitate, the scale constants will be named here as weights (DE ALMEIDA, 2013).

The Flexible and Interactive Tradeoff (FITradeoff) proposed by De Almeida et al. (2016) method for eliciting the DM's scale constants uses the MAVT. It forms part of the compensatory rationality methods and is classified as a single-criterion synthesis method.

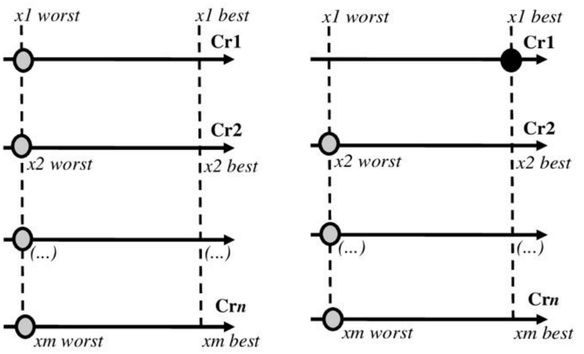
In this context, the traditional Tradeoff procedure is a scale constant elicitation procedure to support multicriteria decision problem-solving (DE ALMEIDA et al., 2016). Scale constants are related to the tradeoffs that the DM makes between consequences, that is, the value by which the decision-maker is indifferent between two consequences, as they bring him/her equal utility. In this sense, when these scale constants are obtained, it is possible to robustly evaluate the alternatives presented by the decision-making problem (MENDES et al., 2020).

However, in the traditional Tradeoff procedure, for the process of eliciting the scale constants to happen the decision-maker is asked to give complete information about the consequences, in other words, the decision-maker is required to identify the exact points where the indifference between the consequences occurs (FREJ et al., 2021). This process is more cognitively demanding for the decision-maker. Nevertheless, the decision-maker is not always able to precisely identify these points of indifference, which may bring inconsistencies to the decision-making process leading to more time in the elicitation of scale constants, thereby taking more time to come to a decision (PERGHER et al., 2020).

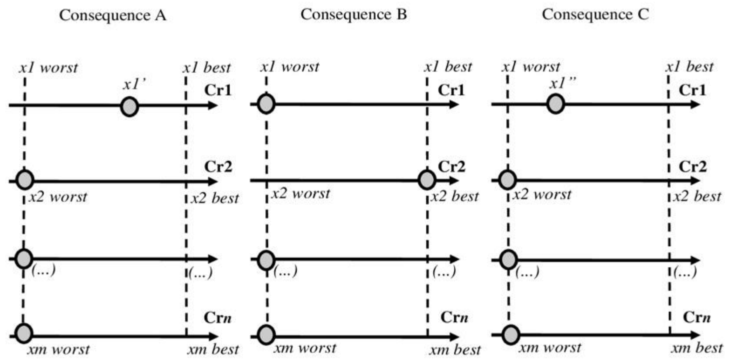
On the other hand, Flexible and Interactive Tradeoff (FITradeoff) is an alternative method for eliciting scale constants developed by De Almeida et al. (2016). In this sense, to elicit scale constants FITradeoff uses partial information, which emerges in situations where the decision-maker is either not able to express the exact points of indifference or does not wish to do. Furthermore, the assessment of consequences in FITradeoff is done through strict preference relations, which instead of the exact point of indifference FITradeoff algorithm identifies ranges of values in the consequences that may contain the exact indifference points. Thus, FITradeoff requires less cognitive effort from the decision-maker leading in fewer inconsistencies and less time for the decision-making process (FREJ et al., 2019).

Furthermore, to apply FITradeoff for the choice problematic the first step is to order the criteria weights (w_j) as in Figure 2(a). The DM must choose among the j criteria (Crj) one by one, the criterion that he/she would like to level up its performance from the worst consequence ($vj(xi)worst$) to the best consequence ($vj(xi)best$) while all others are kept constant, and this will be done until $j-1$ criteria are ordered. Then, the elicitation process will continue as in Figure 2(b).

Figure 3 - FITradeoff elicitation procedure



(a) Ordering the criteria



(b) Evaluation of the consequences

Source: Adapted from De Almeida et al. (2016)

In order to exemplify the elicitation process, let us suppose that the DM must evaluate the Consequences A, B and C with strict preference statements (P) which are cognitively easier to evaluate. Let us also suppose that the DM stated initially that his/her criteria order was ($w1 > w2$) and then, that Consequence A is better than Consequence B (APB), and Consequence B is better than Consequence C (BPC).

Next, since FITradeoff works with partial information, the evaluation of consequences made by the DM does not try to find an exact indifference point, but, instead, FITradeoff creates intervals of the consequences (x_i' and x_i''), which may be around the exact indifference point (x_i)(Equations 2.2-2.4). This interval is explored with more evaluations of consequences until the exact values of $w1$ and $w2$ are found.

$$w_1 > w_2 > \cdots > w_m | \sum_{j=1}^{m} w_j = 1 \qquad (2.2)$$

In Equation 2.2 the first term represents w_m weight criteria ordered, and the second term represent the weights normalized with a total sum equal to one.

$$w_j v_j(x_i') > w_{j+1} \quad j = 1\ to\ m-1 \tag{2.3}$$

Equation 2.3 represents the first point of consequence $w_j v_j(x_i')$, which is better than the consequence w_{j+1}, elicited from decision-maker preferences to create the interval range of consequences that may contain the exact indifference point.

$$w_j v_j(x_i'') < w_{j+1} \quad j = 1\ to\ m-1 \tag{2.4}$$

Equation 2.4 represents the second point of consequence $w_j v_j(x_i'')$, which is worse than the consequence w_{j+1}, elicited from decision-maker preferences to create the interval range of consequences that may contain the exact indifference point.

To support the elicitation process the FITradeoff algorithm tries to find a solution using a linear programming problem (LPP). Thus, by using Equations 2.2-2.5 of FITradeoff for the choice problematic, it tries to maximize the global value of the alternative.

$$Max\ v(a) = \sum_{j=1}^{m} w_j v_j(a) \tag{2.5}$$

Equation 3.4 represent the Objective Function that is used in the LPP model of FITradeoff to obtain the maximum overall value alternative. If the algorithm does not find out the solution or the DM is not willing to accept it so quickly, then, the elicitation process is continued and the search for solutions is made in the possible weight vector space considering that w_j are non-negative (Equation 2.6).

$$w_j \geq 0, j = 1 \dots m \tag{2.6}$$

Additionally, FITradeoff was originally developed for the choice problematic, later the FITradeoff was extended to embed other problematic issues such as the ranking problematic and the sorting problematic.

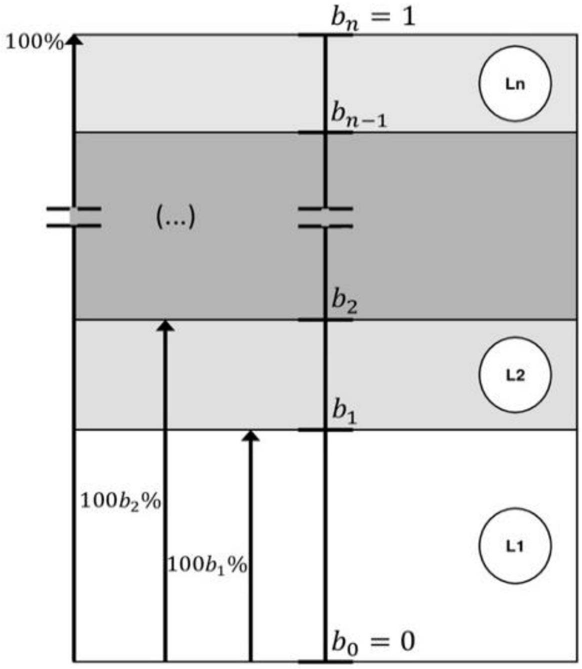
- FITradeoff for the ranking problematic intends of allocating alternatives in ascending order of preferences. One of the differences in FITradeoff for the ranking problematic is in the objective function of the LPP run in the algorithm, it also have differences in the LPP constraints. The objective function aims to find the difference (d_{jz}) between the global values of two alternatives, starting from which a pairwise comparison matrix is inserted alongside the dominance relations obtained (FREJ et al., 2019). See Equation 2.7.

$$d_{jz} = \sum_{j=1}^{m} w_j v_j(x_{ij}) - \sum_{j=1}^{m} w_j v_j(x_{iz}), j = 1, \dots, m; = 1, \dots, m; \neq z \quad (2.7)$$

Equation 2.7 represents the Objective Function (d_{jz}) that is used in the LPP model of FITradeoff to generate the ranking of the alternatives considered. Moreover, $\sum_{j=1}^{m} w_j v_j(x_{ij})$ represents the global value of one alternative j, and $\sum_{j=1}^{m} w_j v_j(x_{iz})$ represents the global value of one alternative *z*. Moreover, for the ranking process, the method uses a tool like the Hasse diagram that supports the DM to visualize the progress and the DM may stop the process as soon as he/she feels satisfied with the partial results obtained.

- FITradeoff for the Sorting Problematic intends of allocating alternatives to certain predefined classes (KANG et al., 2020). Consider a set of alternatives A. The problematic sorting consists of supporting the DM to assign alternatives $a_k \epsilon A$ to n pre-established classes ($L_1, \dots, L_r, \dots, L_n$) where the class L_1 includes the most desirable alternatives and L_n includes the less desirable alternatives (ROY, 1996). According to Kang et al., (2020) to Apply FITradeoff for the Sorting Problematic, the DM must follow the same first step of FITradeoff for the Choice Problematic. To proceed with the classification process, the DM must establish lower and upper limits b_n that limit the problem classes as shown in Figure 3. To establish these values, the DM needs to consider percentages between 0% - 100%, which represent, respectively, the worst and the best value that an alternative can have.

Figure 4 - Classes of the problem



Source: Adapted from Kang et al. (2020)

To assign the alternatives $k \in A$ to n pre-established classes, FITradeoff runs the two Linear Programming Problems (LPP) and explores the space of weights φ^n formed by the inequalities pointed out in Equations 2.8-2.9 and looks for the optimal ones (s_1 and s_2) that respectively minimize and maximize the values of the alternatives. These optimal values are compared with the limits of the classes to assign these alternatives to one of the classes.

LPP1:

$$
\begin{aligned}
&s_1 = \text{Min Z} = v_j(x_i^{a_k}) = \sum_{j=1}^{m} w_j v_j(x_i^{a_k}) \\
&w_j v_j(x_i') + \varepsilon \geq w_{j+1} \quad j = 1 \; to \; m-1 \\
&w_j v_j(x_i'') + \varepsilon \leq w_{j+1} \quad j = 1 \; to \; m-1 \\
&w_1 > w_2 > \cdots > w_j | \sum_{j=1}^{m} w_j = 1 \\
&w_j \geq 0, j = 1 \ldots m
\end{aligned}
\tag{2.8}
$$

LPP2:

$$s_2 = \text{Max Z} = v_j(x_i^{a_k}) = \sum_{j=1}^{m} w_j v_j(x_i^{a_k})$$

$$w_j v_j(x_i') + \varepsilon \geq w_{j+1} \quad j = 1 \; to \; m-1$$

$$w_j v_j(x_i'') + \varepsilon \leq w_{j+1} \quad j = 1 \; to \; m-1 \tag{2.9}$$

$$w_1 > w_2 > \cdots > w_j | \sum_{j=1}^{m} w_j = 1$$

$$w_j \geq 0, j = 1 \ldots m$$

It is important to point out that ε represents a constant that makes inequalities computationally treatable. As more preferential information is given by the DM throughout the decision-making process, the weight space and inequalities are updated.

2.1.2.2 Multi-attribute Group Decision-Making

Multi-criteria decision problems for a single DM can also be extended to multiple DMs, where each of them has a different value system, interests, and perspectives. The focus of this type of problem is on how to aggregate the preferences of these multiple DMs.

De Almeida et al. (2013) indicate two main ways of aggregating preferences:

- Aggregate the DMs' initial preferences: in this case, the DMs act together and are willing to be more flexible in relation to their preferences to find a better result for the group. This type of aggregation is generally used to aggregate experts' preferences;

- Aggregate the DM's final preferences: in this case, each DM acts according to his/her preference structure and value system and the results are aggregated using a group function which is given by Equation 2.10.

$$v(a) = \sum_{j=1}^{m} w_j v_i(a) \tag{2.10}$$

where w_j is the weight of each criterion for each DM for the evaluation of the group and $\sum_{i=1}^{m} w_j = 1$ and $w_j \geq 0$.

2.1.2.3 Negotiation

For Kersten (2001), negotiation can be defined as an interactive process of interpersonal relationships and the search for mutually acceptable agreements from a perspective of conflicting objectives. Furthermore, ethical, cultural, political, and economic factors have a great influence on what the relationships of stakeholders with each other will be like in the negotiation process.

Group decision processes and negotiation are commonly associated as synonyms. However, Dias and Clímaco (2005) state that they are not and point out some characteristics that distinguish them as presented in Table 3.

Table 3 - Differences between group decision-making and negotiation

Group Decision-Making	Negotiation
It is a decision involving two or more DMs, who will take responsibility for the choice.	It is a process in which two or more independent DMs interact to reach or not to reach a common decision.
It involves using analytical procedures to aggregate the preferences of a group of DMs.	The concern is with interaction, communication, contact and learning between DMs.
In the use of analytical procedures, there is a great concern for the DMs' rationality and the paradoxes.	Some analytical procedures are used so as to respect the issues of rationality in order to obtain more efficient results for the parties involved.

Source: Adapted from Dias and Clímaco (2005)

Carter et al. (2004) presented some postures that can be identified in negotiations:

- Competitive Win-Lose Posture: participants seek to satisfy their own interests at the expense of the interests of other participants, which are normally opposed;
- Collaborative Win - Win Posture: participants seek to satisfy the interests of all parties in the negotiation process;
- Competitive Lose-Lose Posture: Participants do not mind losing as long as the others do too.

According to Medeiros et al. (2017), the mediator also has an important role in the negotiation processes. In addition to explaining and monitoring the process, the mediator must also see to it that all representatives take part in the discussions, must observe their degree of commitment and must mediate any situations of conflict.

Thus, some important concepts in negotiation need to be defined, such as the reservation value, the zone of possible agreement and the final negotiated value:

- Reservation Point: this represents the least favorable point at which the parties will accept an agreement, i.e., the precise values of the attributes they are willing to negotiate (DE SOUZA et al., 2010);
- Zone of Possible Agreement (ZOPA): this can be defined as the distance between the parties' reserve prices. Each point within the ZOPA represents an agreement which both parties consider profitable (KOROBKIN, 2000);
- Target Point: this represents the highest absolute result or the best result that both parties would like to achieve (SCHAERER et al., 2016).

As an analytical representation of such concepts, consider the case of a seller and a buyer in a negotiation process, then:

- $x1$: seller's reserve value;
- $x2$: buyer's reserve value;
- x: final negotiated value, where $x1 < x < x2$;

The ZOPA will exist if and only if $x1<x2$ and the ZOPA is between the interval [$x1$, $x2$].

According to Stoshikj (2014), the case of there being no zone of agreement between the parties in question does not necessarily mean that negotiations will end with a situation in which no agreement is reached. The parties may be willing to complete the deal and try to broaden the whole picture by including additional factors relevant to them. To reach the final negotiated value (x), several strategies can be used, one of which is the tradeoff strategy.

In fact, Faratin et al. (2002) demonstrates the tradeoffs strategy by making use of the concepts of indifference curves. These are convex curves that represent the indifference that an agent feels about increasing/decreasing the utility of a decision variable versus a simultaneous decrease/increase in the utility of the other variable.

In this sense, the Pareto curve is the curve formed by the points where convex parts of each stakeholder's indifference curves intersect. This curve is the site of possible joint assessments, none of which can be considered better or worse, i.e., the subset that is not dominated by the set of possible consequences for all alternatives (SILVA; URTIGA; MORAIS, 2021).

Any alternative that is under the Pareto Curve balances the utilities between the two interested parties, and there is, therefore, no better alternative than this one. The trade-off strategy can be used on alternatives that lie outside this area and it can consider the exchange of the gain in utility in the decision variables so that the final value negotiated between the parties can be reached (FARATIN, 2002).

Hence, for Stoshikj (2014), establishing an overview and gaining insights about the negotiation process and the variables that influence its result and degree of efficiency lead to recognizing that there are two types of negotiation: distributive and integrative.

Negotiation is distributive, according to Thompson et al. (2010), when negotiators are primarily concerned with their own results and not with the joint results of all parties involved.

Distributive negotiations have less exchange of information as there is a zero-sum, win-lose focus, with less concern for creative thinking or problem solving about how the other party can also get more. The more one party receives, the less the other party gains - one of them loses what the other has gained. In other words, each concession is automatically a loss for one of the parties and an equivalent gain for the other party (HÜFFMEIER et al., 2014).

According to Ogliastri and Quintanilla (2016), in this case, the negotiation is based on a fixed value that the parties involved distribute during the negotiation. However, the focus on distributing a fixed value has inefficiencies, hampers the negotiation relationship and complicates the creation of value in the negotiation.

Integrative negotiation is different from distributive negotiation. According to Kersten (2001), here the negotiation context into which the agreement is inserted is usually friendly and cooperative in nature. Therefore, it values the integration of the points of interest of the parties involved.

For Barnaud et al. (2013), the concept of integrative negotiation describes a process in which interested parties reformulate the problem to try to "make the cake bigger"; it is an interesting way to explore synergies between ecological, social and economic participations.

According to Chapman et al. (2017), integrative negotiations require greater exchange of information due to multiple points being negotiated and the parties involved are focused on seeking opportunities for mutual gain. As several points are involved, the main focus is to find an optimal configuration of these problems. The resources have different values for each party involved, and the optimal configuration assigns the resources to the party that places the greatest value on the resource in exchange for trade-offs on other issues.

The integrative approach emphasizes the need for trust, mutual understanding, openness and a sense of empathy. As such, the integrative approach tries to capture synergistic advantages in the form of mutual gains and therefore believes in win-win relationships. They start by creating mutual value. Once the parties create value, they must distribute that value through objective criteria, rather than by bargaining or imposing, a process that the parties use in the distributive negotiation strategy model (OGLIASTRI; QUINTANILLA, 2016).

Furthermore, Kersten (2001) identified four characteristics of integrative negotiations that allow them to be distinguished from distributive negotiations:

- Value creation;
- Focuses on interests and not positions;
- Being open about and exchanging relevant information; and
- Learning and restructuring problems.

Thus, Stoshikj (2014) considered that to use the integrative approach, the characteristics of the situation dealt with must show an integrative potential. Hence, when the parties have different priorities, for example, the integrative potential is higher.

The integrative negotiation model proposed in chapter 5 for conflict resolution about the definition and allocation of circular economy strategies in watershed committees uses some methodologies that are presented in the following subsections (2.1.4.1 - 2.1.4.3). The FITradeoff elicitation process, which is also used in this model, was already presented in c

2.1.3 Problem Structuring Methods

According to Durugbo (2020), Problem Structuring Methods (PSM) are sets of Operations Research procedures commonly used to carry out interventions to investigate and capture problems of a multidimensional and complex nature based on structured-intuitive processes, whose results are unique underlying innate circumstances that present themselves to decision-makers in the context of the problem.

Moreover, the focus of the PSM is on representing the problem to clarify issues that would not be so easily perceived without their support. Consequently, PSMs can stimulate creativity to support the decision-making process both reactively by identifying existing but underexplored solutions and proactively identifying and creating opportunities and solutions that were not thought of previously (WHITE et al., 2016; SMITH et al., 2019). One of the most popular PSMs is Value Focused Thinking (VFT), and a tool used in another PSM is Cognitive Mapping.

2.1.3.1 Value Focused Thinking

In this respect, Value Focused Thinking (VFT) (KEENEY, 1992) is a technique that goes against the logic of other PSMs. Instead of focusing on alternatives, the VFT initially focuses on the DM´s values and on identifying what he/she wants so as the alternatives are used as a means of achieving a DM's values.

Likewise, another important point about VFT is that it provides a DM with a systemic framework for decision-making to structure objectives suitable to the problem situation since the DM wants to reach desirable consequences based on his/her preferences (CARVALHO et al., 2018).

In group decision situations, VFT is commonly used before the decision-making process. As the structuring of the problem evolves in its successive representations, VFT prompts decision-makers to have participatory-consultative positions, leading to a deepening that has not been observed so far. Thus, VFT is more efficient in collecting unknown information, which intends to support DMs to come to a situation where they share an understanding of a complex and unstructured problem so as they may decide about what strategies to put into effect (MATEO et al., 2017; POLETO et al., 2020).

In this respect, the five main steps of applying the VFT in the decision-making process with the support of an analyst are summarized as follows (KEENEY, 1992).

In Step 1, a list of all concerns, considerations, and issues that are related to the decision-making process should be drawn up. To do so, several techniques can be used, ranging from informal conversation with people who have faced similar situations to considering the worst and best consequences that could occur in that scenario.

In addition, concerns must be turned into objectives in Step 2. Even though many of the objectives generated are redundant, it is desirable that they are contained in the final list of objectives and, thus, can be combined and/or grouped. These redundancies may be an indication of the importance of these objectives for the DM and, therefore, considerable attention should be paid to them.

Moreover, Step 3 is concerned with arranging the objectives hierarchically so that those considered fundamental can be identified as also the mean objectives. Thus, a list of questions developed by Keeney (1996) will be used.

Thereafter, the DM needs to clarify the meaning of each objective in Step 4. In this respect, the analyst questions the DM as to the real meaning of the objective. Consequently, aspects that are part of the objectives can be identified and better understood, and so the most appropriate and precise way to achieve them can be established.

Finally, in Step 5, the objectives must be tested to see if they really reflect the DM's preferences by evaluating the actions generated. It should be checked whether the results are consistent with this assessment.

VFT was initially developed for a single DM and its main characteristic is that it proactively identifies decision opportunities (KEENEY, 1992).

Once these opportunities are identified what must guide them are the DM's values. From these values, the DM's objectives and goals are recognized and hierarchized and thus the relations between them are demonstrated. Subsequently, DM analyzes the objectives and goals and tries to find alternatives that accurately meet these objectives (KEENEY, 1996).

In this context, Urtiga and Morais (2015) proposed an approach using VFT for group contexts. They expanded it to multiple DMs in a negotiation process, specifically focusing on the pre-negotiation phase. The steps proposed by Urtiga and Morais (2015) are summarized below and will be applied in this model with the support of an analyst:

- Step 1: The actors involved in the process are identified. DMs and the analyst are of special interest;
- Step 2: The objectives are identified and structured individually by all DMs. They must think about their own interests in order to create value; in other words, about what they want to achieve from that situation;
- Step 3: The objectives must be hierarchized so that their relationship with each other can be identified and so that they can be classified into fundamental objectives (central reason of the situation), and main objectives (ways to achieve the fundamental objectives). This step will result in individual trees of objectives from all DMs;
- Step 4: The analyst has to aggregate the individual trees into a single tree for the group. To do so, the analyst will try to identify common values, objectives, and relations between them. Thereafter, in a workshop, the analyst will discuss with the DMs the group tree and develop it until the DMs feel the situation is well-represented. This step will result in a final single tree for the group;
- Step 5: The analyst will analyze the objectives addressed in the final single tree and assign issues (attributes) to them, which will be discussed by the DMs in a workshop until DMs reach unanimous agreement on a list of issues. Moreover, with these attributes, a DM is able to assess how the offers made by other DMs may achieve his/her objectives. This step will result in a single list of issues (attributes) to be negotiated; and
- Step 6: The DMs can generate alternatives for the situation by analyzing the objectives.

2.1.3.2 Cognitive Maps

According to Eden and Ackermann (2004), a cognitive map is basically formulated by hierarchical constructs that are connected by arrows and are drawn up, as described below.

The constructs represent the DM's value system and his/her perceptions about the problem under study. Thus, to elaborate the map, first, a label for the problem is formulated. This label is a short statement that fully conveys the idea that will be explored in the cognitive mapping process.

The constructs of the map are made up of present poles and opposite poles. The present poles must be formulated from Primary Elements of Assessment (PEA) which are words given by the DM and indicate general thoughts about the defined label.

The DM complements the PEAs by forming phrases about the importance of that PEA for the development of the problem. These phrases form the present poles of the constructs. The DM is then asked about the possible consequences of not being able to meet the present pole of each construct and produces phrases that indicate these possible consequences. These phrases are the opposite poles of the constructs.

Therefore, the DM is provoked sequentially with questions such as: what is important? Why? How can you attend to the constructs? And he/she draws up a network of other constructs that are distributed in different areas of the map.

Finally, the DM is asked how each construct in the map relates to the others and the construct relates to arrows that show these connections. This process is repeated until DM fell satisfied with the representation of the problem situation.

2.1.4 Shapley Value

The Shapley value is an approach to cooperative games developed by Shapley (1953). Games are decision problems with multiple players (decision-makers) whose decisions affect each other (SHAPLEY, 1953; SADEGH et al., 2010).

Shapley Allocation incorporates the fairness concept as it considers the idea of earnings egalitarianism, which is when the gain of a given player is proportional to the gain of other players when they are present in the same coalition. Coalitions can be considered as a group of players who have the institutional structure to plan and execute actions, including the fair allocation of the costs generated among their members (PEREA; PUERTO, 2019).

Thus, according to Zheng et al. (2019), the Shapley value represents the average marginal contribution of each player when they participate in all the different coalitions, which can be formed randomly in a game. Thus, the Shapley fair allocation will be used to share the costs of strategies defined in the proposed approach.

According to Shapley (1953) the Shapley value for cooperative games $\langle N_P, C\rangle$ can be calculated by Equation 2.11:

$$\pi_i^{SH} = \sum_{i\in S} \frac{(N_P - |S|)!(|S| - 1)!}{N_P\,!}[C(S_j) - C(S - i)] \tag{2.11}$$

In Equation 2.11, π_i^{SH} is the Shapley value for player i, which represents the percentage of the costs allocated to a player, based on all the sequences of participation of the n possible players in the coalition. Where i represents n possible players, Np is the number of players, Sj is the number of players in a coalition j, $C(S_j)$ is the characteristic function that is the gain for the coalition.

Since the Shapley value considers the bargaining power of players. Equation 2.11 must comply with the following conditions:

Condition 1: $\pi_i \geq C_{(i)} \forall\, i = 0,1, \dots, n$. The player's Individual Rationality in condition 1, where the individual gain obtained from the cost allocated to each player is at least equal to the gain of each player who does not participate in the coalition.

Condition 2: $\sum_{i\in S} \pi_i \geq C_{(Sj)} \forall\, i = 0,1, \dots, n$.The Coalition Rationality in condition 2, which implies that no subgroup of the grand coalition will lose its gain due to the formation of another coalition.

Condition 3: $\sum_{i\in S} \pi_i = C_{(Np)} \forall\, i = 0,1, \dots, n$. The Collective Rationality condition implies that the gain for all players must be equal to the gain for cooperation.

Condition 4: $C_{(Sj)} = \sum_{j\in Np} P_k \ \forall\, i = 0,1, \dots, n$. Condition 4 represents the value created by a S_j subset of interacting players.

The fulfillment of Conditions 1, 2, and 3 presupposes the existence of an important concept in cooperative games, the Core, which is defined as a series of imputations that satisfy these equations, thus making the allocation of costs possible.

2.1.5 Multi-objective Optimization and the Global Criterion Method

According to Alves et al. (2015) a multi-objective linear optimization problem consists of linear objective functions (Equation 2.12) that must be optimized in a viable region defined by a set of linear constraints (Equation 2.13) and weights (Equation 2.14).

$$\text{Max}\, z = f(x) = \varphi D x \tag{2.12}$$

$$x \in X = \{x \in \mathfrak{R}^{\mathrm{n}} : x \geq 0, C_X = e, e \in \mathfrak{R}^{\mathrm{m}}\} \tag{2.13}$$

$$w \in \varphi = \{(w_1, w_2, \dots, w_n) | w \in \mathfrak{R}^{\mathrm{n}} : \sum_{i=1}^{n} w_j = 1, w_1 > w_2 > \cdots > w_n \} \tag{2.14}$$

Where x is the viable solution, and X is the viable solution space. Moreover, D is the coefficient matrix of the objective function, C is the constraint matrix, and e the limit of the constraints. Additionally, φ is the weight space and $\mathrm{w_j}$ are the scaling constants referred to here as weights for simplification purposes.

Optimizing all objectives simultaneously so as to obtain efficient solutions might not be possible since the multiple objectives are conflicting (ALVES et al., 2015). Therefore, one of the techniques used to tackle this problem was the one proposed by Boychuk and Ovchinnikov (1973), called Global Criterion Method (GCM), which will be used here.

The GCM combines all the objective functions of the problem into a single global criterion function $G(x)$ that will be minimized and represents a measure of how close $Min\ G(x)$ is to the ideal solution f_i^o which is the optimum for each separately considered ith objective. Thus, the single global criterion function can be solved using the Simplex method because it enables the sensitivity analysis. Also, the Simplex method gives an economic interpretation of the problem and provides more information for DM in the bargaining process. The most common form of the GCM function is (Equation 2.15).

$$G(x) = \sum_{i=1}^{m} \left(\frac{f_i^o - f_{i(x)}}{f_i^o} \right) \tag{2.15}$$

Where m is the number of objectives and $f_{i(x)}$ is the objective function for objective i.

2.2 Literature review

This section puts forward a discussion of the literature review presented in circular economy regarding the National Solid Waste Policy, the Textile and Fashion Industry, and circular economy and Water Resources Management. After that, this thesis positions the contribution of this work in relation to the state of the art

2.2.1 Circular Economy and National Solid Waste Policy

The constant growth in population and the production-consumption patterns of society in profit-oriented economies makes an unrestrained generation of solid waste, which is especially related to the current linear model practiced (extraction of natural resources-use-landfilling) and can lead to eco-and-waste disposal systems collapsing with serious environmental, economic and social consequences (RIBA et al., 2020; MARTIN et al., 2021). Therefore, concerns about environmental preservation have been prompting researchers and practitioners around the world to study and develop systems to reduce the generation of solid waste, and to promote the value recovery of its materials to benefit society as a whole (FAGNANI; GUIMARÃES, 2017).

In this sense, the global attention has shifted to more sustainable production-consumption models as the circular economy model, which consists of resources being reintroduced and kept in various supply chains to recover as much value as it is possible of the goods, thereby being properly disposed of, and consequently resulting in lower pollution rates (KUAH; WANG, 2020).

Additionally, we can shed light on several benefits for circular economy model adoption such as to promote opportunities to discussions that strengthen solid waste management in an environmentally friendly manner, to redesign products to improve its disassembly and reintegration into the productive-business cycles of other supply chains reducing its inadequate disposal in the environment and fostering the emergence of new businesses and job vacancies (CHEN, 2021).

Nevertheless, several developing countries still seem to be stuck in the linear model, but some of them are trying to find means to make a migration to the circular model. In Brazil, for example, the mean found was the National Solid Waste Policy (NSWP) (Law No. 12,305/2010), which establishes guidelines for adequate and integrated management of solid waste (BRAZIL, 2010; DE SOUZA et al., 2016). Accordingly, some studies have been developed on the NSWP perspective and its impact for solid waste management (SWM) in Brazil.

Maier and Oliveira (2014) studied the main effects of the NSWP on the viability of waste management, especially from an economic perspective, and criticized the limitation of the NSWP in terms of the lack of mechanisms to guarantee its implementation.

Jabbour et al. (2014) carried out a similar study and concluded that, among the challenging mechanisms for implementing the NSWP, the main ones are economic issues related to investments in cleaner technologies, issues of organizational strategies, product design for an adequate end-of-life destination and extending educational issues to include everyone in society.

Additionally, Guarnieri and Cerqueira-Streit (2015) pointed out the lack of government incentives in relation to waste-pickers, who are the main workforce in solid waste management in Brazil. They argued how the correct application of the NSWP when properly encouraged by the government could contribute to formalizing employment and income generation for waste-pickers, who generally live in a situation of social vulnerability in Brazil.

Another important point mentioned by Rodrigues et al. (2020) is that the NSWP indicates reverse logistics (RL) strategies as instruments for adequately operationalizing the solid waste management process, since RL refers to the way that materials return to the business environment and/or the productive process in order to recover their value partially or fully (HAMMES et al., 2020).

In studies related to evaluating ways to create strategies to promote RL in order to effectively implement the NSWP and the transition to a circular economy, Ferri et al. (2015) considered that recycling is the main way to achieve the NSWP goals and developed a model to assess the quantity and location of solid waste collection points.

Guarnieri et al. (2015) suggested the outsourcing of reverse logistics processes as a way to properly manage solid waste coming from companies, based on the argument that companies should focus only on their core competencies as a way to add value to their business and to generate competitive advantage. However, they did not carry out any previous analysis to verify whether, in fact, the operations related to reverse logistics are not core competencies of the companies, which can lead to serious problems in companies’ competitive advantages.

Then, Caíado et al. (2016) developed, similarly to the existent carbon credit market, a proposal for the reverse logistics credit market for the management of solid waste in Brazil.

Moreover, the Brazilian transition to a circular economy model is centered on the concept of shared responsibility for the product's life cycle, which is a cooperation between different segments of society, such as government, manufacturers, and others to manage the product's life cycle at the waste level through RL strategies (BRAZIL, 2010).

Furthermore, the definition of RL strategies to manage solid waste in Brazil is made by a group of public agents who are the decision-makers (DMs). Thus, group decision-making involving public participation is more challenging because it presents different preferences, levels of aspirations, and the points of view of several DMs as a result of which many conflicts may arise (SOLTANI et al., 2015; WIBOWO et al., 2015). Consequently, the decision-making process for defining RL strategies is more likely to fail (DE ALMEIDA; WACHIWICKZ, 2017).

From this perspective, Polzer and Person (2016) argue that in order to minimize the risk of group decision-making failing, it is necessary to understand the different perspectives of the different segments of society so that everyone's perspectives are covered and, thus, conflicts over solid waste management may be resolved.

Thus, Guarnieri et al. (2016) used the Problem Structuring Method (PSM) Strategic Options Development and Analysis (SODA) to understand the perspectives of the different segments involved in solid waste management in Brazil and to develop viable alternatives. However, they have not advanced in the formalization and sharing of these alternatives among the various segments.

Finally, Garnett et al. (2017) give some directions that help the decision-making about formalization and sharing of the alternatives in NSWP to be effective towards a circular economy transition, by stating that what is needed is one authority to put the strategies proposed in the table to be evaluated, to know how the DMs are going to share information and interact with each other, and to establish a valid mechanism to aggregate the preferences in terms of the decision to be made. Consequently, the collaboration among circular economy stakeholders' plays an important role to make de transition viable (VAN LANGEN et al., 2021).

2.2.2 Circular Economy in Textile and Fashion Industry

The textile and fashion industry is extremely important for the economy of developed or developing countries, and its contribution has increased even more over time throughout the world, as it is essential for the dynamics of trade, and generates jobs and income for large numbers of people (MAJUMDAR et al, 2020).

Hence, according to Shirvanimoghaddam et al. (2020), in the last twenty years, the global capacity of production of the textile and fashion industry has doubled and reached an average consumption of approximately 13 kg per user with an index of 100 million tons consumed per year worldwide.

Furthermore, in the textile and fashion industry, simultaneously to the growth of its production, consumption and economic contribution, the negative environmental impact of its activities and processes has also been growing (BUKHARI et al., 2018). Therefore, due to its intensive use of resources such as water, energy and chemical components, the textile and fashion industry is considered the fourth largest polluter in the world, after the civil construction, transport and food industries (RIBA et al., 2020).

Estimates show that two-thirds of textile fiber production in processes such as dyeing, printing and finishing clothes use mostly energy from fossil fuels and petrochemical components, resulting in large emissions of greenhouse gases, in addition to increasing the footprint of carbon (SHEN et al., 2010; TERINTE et al., 2014).

The other fibers, including textiles that come from plantations such as cotton, require large amounts of water, arable land and pesticides. This alters the natural cycle of water, the soil and biodiversity because of the amount this industry consumes and the contamination it causes, thus impairing the availability of water and arable land (BEVILACQUA et al., 2014).

Furthermore, the consumption of Fast-fashion, which is the throw-away culture imposed by shortening the life cycle of clothing in the textile industry, causes large amounts of clothing to be incinerated or even dumped, which is harmful to the environment and limits its self-recovery capacity (YOUSEF et al, 2020).

In addition, the textile industry brings up important humanitarian issues for reflection, such as the devaluation of the payment of manual labor or even the use of slave labor in its production processes (TURKER; ALTUNTAS, 2014).

In this sense, the alleged inability of the textile industry to reduce global levels of the excessive use of natural resources becomes less and less acceptable as an excuse when alternatives such as the circular economy emerge. These slow down the generation of waste, close and narrow the loops between materials, energy used and production. Moreover, we can observe in the literature some studies related to the circular economy in the fashion industry.

Regarding the opportunities and barriers of the circular economy, Wilson (2015) empirically assessed the challenges and opportunities of introducing the circular model into Scottish textile industry companies, in which several initiatives were taken to make this introduction, such as the zero-waste concept from the perspective of a closed-loop supply chain. However, some researchers and practitioners consider that the concept of zero waste in the value chain is questionable.

Surveys of circular business models, such as that by Mukendi and Henninger (2020), conducted interviews with consumers to identify their perceptions of hiring clothes so that companies could develop new CBMs. The interviews revealed that hiring clothes is perceived by consumers much more in relation to the focus on awareness of the environmental issue than taking pleasure in this type of clothing. However, since the size of the sample used in the study was only 20 participants, 17 women and 3 men, the conclusions drawn need to take account of this limitation.

With regard to indicators in the Circular Economy, Virtanen et al. (2019) developed indicators to measure the circularity of materials at the regional level. On the other hand, the authors highlighted the limitations in relation to obtaining data on the flow of materials only at the national level, which may not necessarily reflect, statistically, the results at the regional level.

Consumer behavior in the circular economy is evaluated in studies such as the one by Vehmas et al. (2018) who carried out interviews to identify consumer expectations about circular fashion and also explore what form the communication process between company and consumer should take with regard to the remanufacturing of products. The results showed that consumers expect to be communicated about this process at the time of purchase. Their study also displays the limitation regarding the size of the sample.

New technologies used to put circular economy strategies into practice are presented in studies such as by Maattanen et al. (2019) who developed a method for recycling cotton fibers and carried out tests to verify whether, in the recycling process, the original color would or would not be maintained in the cotton. The study highlighted the need to develop more specialized software to make a more robust estimation of recycled and recovered fibers.

Issues of collaboration in the circular economy for the textile and fashion industry are highlighted in studies such as by Fischer and Pascucci (2017) who evaluated the elements of how the transition from a linear model to a circular economy model creates organizational forms of collaboration between companies that include the circular model. The main elements identified were coordination of the supply chain, contracts and financial mechanisms that stimulate the generation of new companies and their collaborating with each other. Despite allowing for an understanding of this theme, the results indicated that additional studies are needed to assess the circular effect on the consumption of collaborative fashion.

Decision support models in the circular economy of the fashion and textile industry are validated by Paras et al. (2019) who identified reverse logistics options such as reuse, upcycling, downcycling, incineration and landfill disposal so as to implement the circular economy for the fashion industry and used the multicriteria Analytic Hierarchy Process (AHP) method to select one of the options.

Furthermore, Riba et al. (2020) developed a machine learning model to assist in classifying post-consumer textile wastes so that they can be directed to the correct production cycle, thus minimizing their inappropriate disposal. However, the results of these studies are limited to fiscal and cost issues for the countries studied.

Finally, in relation to outsourcing decisions in the circular economy for textile wastes, only two studies were identified in the period analyzed. The first study by Stal and Corvellec (2018) explored how textile companies amortize circular market demands using outsourcing. The results show that depending on the type of demand that clothing companies have, they can opt for outsourcing strategies or keep circular activities in-house. However, their study did not propose any approach that considers how regulatory, normative and cognitive issues of managers encourage companies to adopt one strategy at the expense of the other.

The second study by Kühl et al. (2020) evaluated the effect of outsourcing on the circularity of several supply chains, including textiles, and identified that outsourcing improves the level of circularity in supply chains. However, their study is limited to deducing the results presented only from the qualitative analysis of a small set of papers available in the literature.

2.2.3 Circular Economy and Water Resources Management

There are several contributions to the literature that investigate different approaches to assisting decision-makers to solve conflicts in water resources management (WRM). The most widely used are scenario analysis, the use of multi-criteria decision analysis methods for group decision-making, game theoretical approaches, the development of decision and/or negotiation support systems, and participatory approaches.

Over the years, scenario analysis has become a valuable technique for WRM. Vieira and Ribeiro (2007) make a strategical analysis about Brazilian secondary scenarios that may come from conflict resolution of water resources management in first-tier scenarios.

Liu et al. (2011) proposed a mixed-integer linear programming model to optimize the annual costs of alternative scenarios (e.g., the desalination of seawater and the recovery and treatment of water and sewage) evaluated for bringing water to regions lacking potable water.

Shirmohammadi et al. (2020) analyzed scenarios of land use and their impact on the flow of water in arid and semi-arid regions that are more vulnerable to environmental changes.

Mehrparvar et al. (2020) applied the WEAP simulation model with GMCR II for conflict resolution in water allocation scenarios due to demand-supply disparities presented in the Zayandehroud basin.

However, one important limitation inherent in scenario analysis approaches is that they may not comprehensively consider all possible scenarios, both due to the human limitations of the analysts who prospect such scenarios, and the computational limitations of processing data for many scenarios simultaneously (VIEIRA; RIBEIRO, 2007).

Furthermore, some studies have quantitatively modeled conflict resolution using multi-criteria decision analysis methods (MCDA) to support group decision-making in the context of WRM. Monte and de Almeida-Filho (2016) developed a model based on Multi-Attribute Utility Theory (MAUT) to define maintenance policies for water resource transmission systems in locations that concentrate low-income populations. Srinivas and Singh (2018) developed a model that uses the Fuzzy Delphi process to consider the uncertainties arising from DMs' opinions to support group decision-making in a WSC.

Dowlatabadi et al. (2020) included AHP and DEMATEL MCDA methods within GMCR to eliciting DMs relative preferences in the Hawizeh/Hoor-Al-Azim Wetland Conflict.

Nonetheless, the methods used to develop the models required DMs to make many assessments and to be knowledgeable about specific decision-making concepts, which can significantly increase the cognitive effort that DMs need to make, and consequently, might increase inconsistencies in the decision-making process (DE ALMEIDA et al., 2016).

In addition to these quantitative approaches, many studies have adopted Game Theory concepts to address issues that concern conflict resolution in WRM. Wang et al. (2009) used the Cooperative Water Allocation Model (CWAM) to make a fair, efficient, and equitable allocation of water among users who compete for water resources at the basin level.

Mehrparvar et al. (2016) used CWAM for the same purpose but in the context of the Zayandehrood River basin and also applied a stability index to assess stakeholder satisfaction with the allocation made using the alternatives generated.

Ahmadi et al. (2019) analyzed the conflict resolution between different stakeholders in a water transfer process and they used cooperative and non-cooperative games to compare how these influenced outcomes. Ahmadi et al. (2019) concluded that when stakeholders decide to cooperate, the results show that they benefit more from the formation of coalitions than by acting individually or by engaging in non-cooperative games.

Nevertheless, a limiting aspect of game theory-based approaches is that many of them may not be able to deal with the asymmetry of stakeholders' power and knowledge

(MEHRPARVAR et al., 2016). In other words, when the approaches can deal with this asymmetry, they can lead to consensual decisions to overcome the conflicts that may arise in democratic water resources management. Also, these approaches tend to focus only on the economic effects of the decisions (FIGUEIREDO; PERKINS,2013).

On the other hand, some studies have designed generic support systems that can be used in conflict resolution situations that have different characteristics. Malta et al. (2005) applied the Graph Model for Conflict Resolution (GMCR) to deal with issues related to water use in the Lima Campos Brazilian reservoir. Madani and Hipel (2007) have advanced in GMCR use, demonstrating that it may also cover social-politic issues about the Jordan River.

Moreover, Hipel et al. (2008) presented GMCR II in which its use is not limited to water resources conflicts, but also to other conflicts (e.g., political conflicts and international trade). Kronaveter and Shamir (2009) proposed a support system based on the Analytic Hierarchy Process (AHP) for negotiation to assist stakeholders in the process of allocating water between users.

Ma et al. (2013) used GMCR and identified some solutions to deal with a conflict over transboundary water resources due to pollution caused by sediment in a lake in the region. Hipel et al (2014) used GMCR II to resolve conflicts over the Euphrates River, which involved Iraq, Syria, and Turkey.

Recently, Yang et al. (2021) presented a dynamic evolutionary GMCR to simulate the different behaviors of water users throughout time in a transboundary water conflict in China. Nevertheless, a critical limitation in this type of approach is that it may not be able to capture subjectivities present in real situations, whether ideological or preferential (KRONAVETER; SHAMIR, 2009; YANG et al., 2021).

Finally, there are participatory approaches for negotiating WRM actions. Ali et al. (2019) applied an attitudinal-based negotiation strategy to mitigate military conflicts that may pose environmental and hydrological risks between India and Pakistan.

Moreover, participatory approaches may be intertwined with problem structuring methods (PSM) and MCDA methods and are used to seek consensus between representatives of a WSC. Particularly, the study by Medeiros et al. (2017) proposed a bargaining approach to help conflict resolution with a WSC in a basin using Strategic Options Development and Analysis (SODA). They also included the Additive Scoring System (ASS) to enable the bargaining process between representatives and the selection of the best alternative.

Despite its substantial contribution, the model by Medeiros et al. (2017) is limited in some ways: First, SODA is an approach focused on identifying available alternatives rather than generating alternatives based on DMs' values (SILVA; FONTANA, 2021). Thus, applying SODA may result in DMs being offered weaker alternatives than could be obtained if DMs' values were to be used (KEENEY, 1992). Another important limitation to be mentioned is that although the ASS enables the bargaining process between the representatives of the WSC to take place, ASS selects only a single alternative of the greatest global value and this alternative may not be enough to bring the problem situation to the surface, and this limitation can be a determinant aspect of the extent to which the WSC engages in implementing the alternative selected (KEENEY, 1992).

2.3 Synthesis of the state of the art and positioning of this work

The circular economy presents itself as an alternative so that different segments of society may change their paradigm in relation to issues of production and consumption. Therefore, the circular economy model is an umbrella topic that covers the entire supply chain and, in this way, presents opportunities for action at various points in it.

Therefore, studies are needed that cooperate with advances in the literature, especially in developing countries like Brazil which are still in the early stages of the transition process to the circular economy model.

In this way, as observed in subsection 2.2.1, the literature review of circular economy and National Solid Waste Policy indicates a main gap:

- The absence of any work related to Brazil that present a holistic picture considering a structured mechanism to promote the transition to a circular economy focusing on collaboration, fairness, and preference aggregation strategy.

Thus, the objective of chapter 3 is to propose a group decision model to assist DMs involved in the solid waste management process to define reverse logistics strategies, allocating responsibilities and costs between them in a fair manner so as to the transition to a circular economy happen.

Moreover, in subsection 2.2.2, the literature review of circular economy in textile and fashion industry shows another gap in literature:

- The outsourcing decision-making model to put circular economy processes into practice still underestimated.

Consequently, the model proposed in chapter 4 fills the gap of the literature and innovates in some points when compared to other models that have been published in the literature.

Moreover, as economic activities use a huge amount of water resources and this is a natural and finite resource, circular water resources management is also an important topic.

Furthermore, in subsection 2.2.3, we have addressed the problem of circular economy and water resources management and identified another gap in the literature:

- We have a look on the conflicts that emerge from watershed committees' members when deciding about their circular strategies in watersheds. Again, the literature lacks in innovative contributions approaches to this topic.

Thus, chapter 5 proposes an integrative negotiation model to assist WSCs in Brazil to solve the conflicts regarding the definition of circular economy strategies to water resources management.

3 GROUP DECISION MODEL TO SHARE RESPONSIBILITIES FOR SOLID WASTE MANAGEMENT IN BRAZIL

This chapter proposes a group decision model to share responsibilities for solid waste management in Brazil to support the transition to a circular economy. It is important to mention that the results of this chapter were published in the Journal of Cleaner Production by Silva and Morais (2021).

3.1 Context

The National Solid Waste Policy (NSWP) promulgated by the Brazilian Ministry of the Environment (Law Number 12,305/2010) was an attempt to demonstrate that the Brazilian government authorities are concentrating efforts to ensure the environment is being preserved in circular economy logic. Thus, it has defined solid waste management as one of its central concerns since the generation of waste in developing countries such as Brazil is increasing exponentially (DIAS et al., 2018). Therefore, through the concept of shared responsibility for the product during its life cycle, the NSWP emphasizes the need for the various segments of society (i.e., government, private initiative, waste-pickers) to work together in the proper management of solid waste (FUSS et al., 2021).

To do so, one important point of the NSWP is related to sectoral agreements, which represent acts of contractual nature in which the segments of society signal their responsibilities in the management of solid waste (BRAZIL, 2010). Sectoral agreements are also explored in some studies.

Deus et al. (2017) studied the characteristics necessary to carry out this type of agreement between private and public initiative. Pin et al. (2018) focused on the municipal sphere and evaluated some scenarios for achieving the sectoral agreement. However, the authors point out the need for greater government engagement to encourage the realization of the NSWP, ranging from the municipalities to the national level.

Dias et al. (2018) advanced in this direction and showed that there is a lack of commitment in the private sphere, since most companies perform only one pre-processing step for the recovery of solid waste. Da Paz et al. (2018) contributed to this by assessing the environmental risks arising from poor management of construction and demolition waste, which are also included in the NSWP.

Finally, the most recent study by Guarnieri et al. (2020) evaluated the first phase of implementing the sectoral agreement for reverse logistics in the packaging sector. According to the perception of the segments highlighted in the NSWP, the authors observed that the most critical problems in Brazilian sectoral agreement implementation were:

- The way of identifying and selecting suitable RL strategies;
- The ineffectiveness of the sectoral agreement as an instrument for defining responsibilities among DMs as it is currently conceived and,
- The lack of trust between the groups that participate in the sectoral agreement, since how costs are allocated is not made clear, which undermines the consensus on the fairness of the process and jeopardizes engaging in implementing the RL strategies.

These three problems have not been adequately tackled in the literature of circular economy and this reaffirms the originality of the model. The proposed model has these three problems embedded in it and the model is presented in the next section.

3.2 Proposed Model

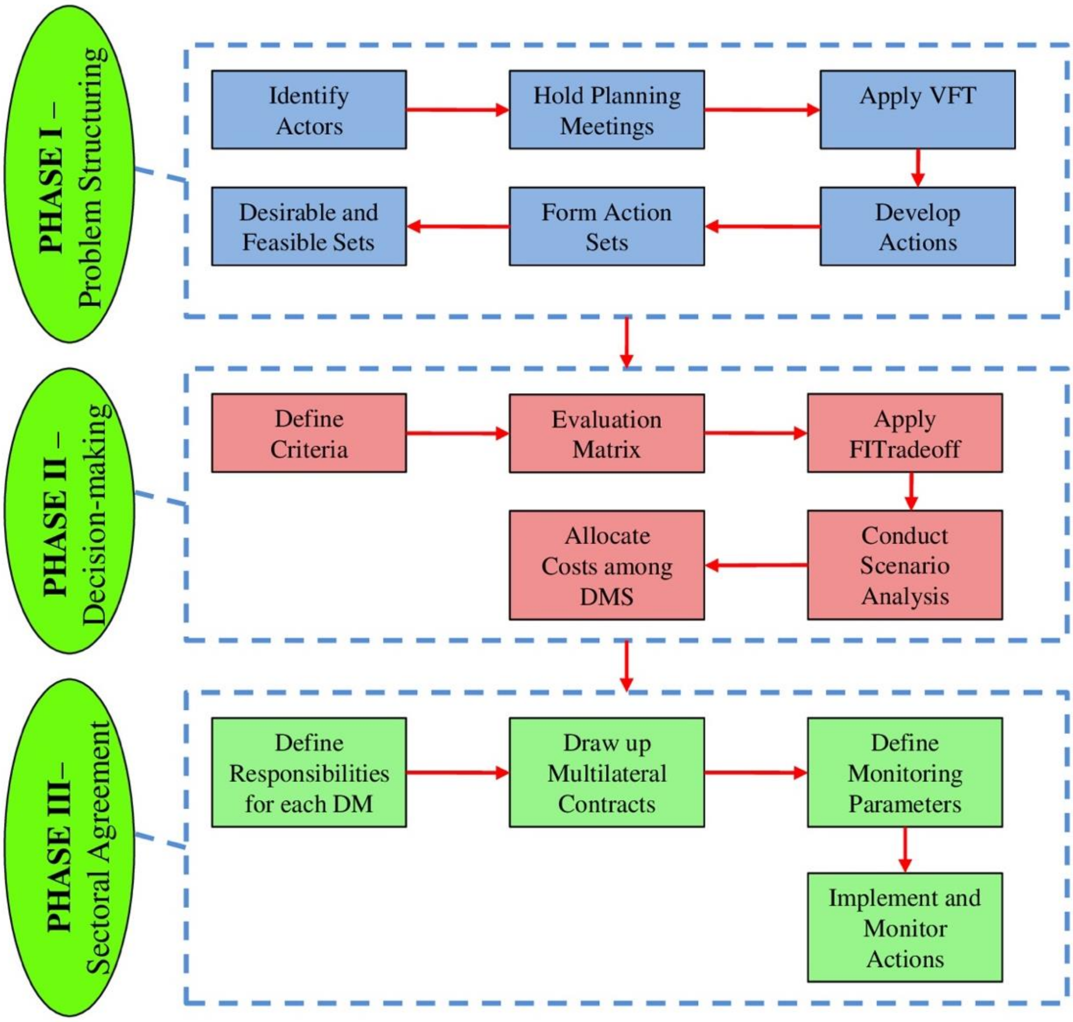
Value Focused Thinking (VFT) (KEENEY, 1992) is used to stimulate the DMs to think creatively about their own and each other's perspectives, objectives, and values to develop strategies to deal with the conflicts about solid waste management, which may be more consistent than the strategies identified with other PSMs such as SODA since SODA does not focus on the DM's values and objectives. Moreover, the VFT structure may aid the DMs to adjust their perspectives and strategies that they have defined to cope with the NSWP law, thereby resulting in fewer inconsistencies in the migration to a circular economy.

Next, the approach proposes the use of the Flexible and Interactive Tradeoff (FITradeoff) multi-criteria method for the ranking problematic (FREJ et al., 2019) to elicit the DMs' preferences using partial information which is easier to assess because this requires less cognitive effort from DMs so that inconsistencies in the decision-making process are decreased and so DMs may come to a mutually acceptable decision more easily. Furthermore, whether there is no consensus, DMs' final preferences may be aggregated using the FITradeoff for Group Decision to select a single mutually acceptable decision (DE ALMEIDA et al., 2019).

Also, the Shapley Value (SHAPLEY, 1953) is proposed to allocate the costs of the alternatives fairly between the DMs involved to manage solid waste, because this is a point of dissonance and causes mistrust in the NSWP. Finally, the proposed approach uses multilateral contracts to guarantee the DMs' engagement in putting the alternatives into practice.

A summary of the proposed model is shown in Figure 5 and more in-depth details about the phases of the proposed approach are given as follows.

Figure 5 - Proposed Model



Source: The Author (2022)

3.2.1 Phase 1 – Problem Structuring

Initially, the actors must be identified. To do so, it is recommended that a planning meeting be held in order to clarify the purposes of the process, as well as to verify the DMs' availability and their interest in participation.

Therefore, the VFT must be applied individually with each DM identified. This will generate individual objective trees for each DM. Then, the trees will be unified with the support of one analyst. This will result in final single objective trees for each DM and also their related actions to manage solid waste by the analysis of the final single objective tree.

Next, in a workshop, the DMs will discuss the formation of the sets of the actions. Forming them will take place in such a way that the DMs bear in mind the concept of the alternatives of solid waste management provided by the NSWP to a circular economy transition (Law No 12,305/2010), i.e., non-generation, reduction, reuse, recycling, treatment of solid wastes and environmentally appropriate final disposal, which is a priority order that has to be followed. In this respect, DMs must verify how the actions developed in the VFT process for each of them can be used to put these alternatives into practice. Thus, a list with the sets of possible actions that make the alternatives feasible should be generated.

3.2.2 Phase 2 – Decision-Making

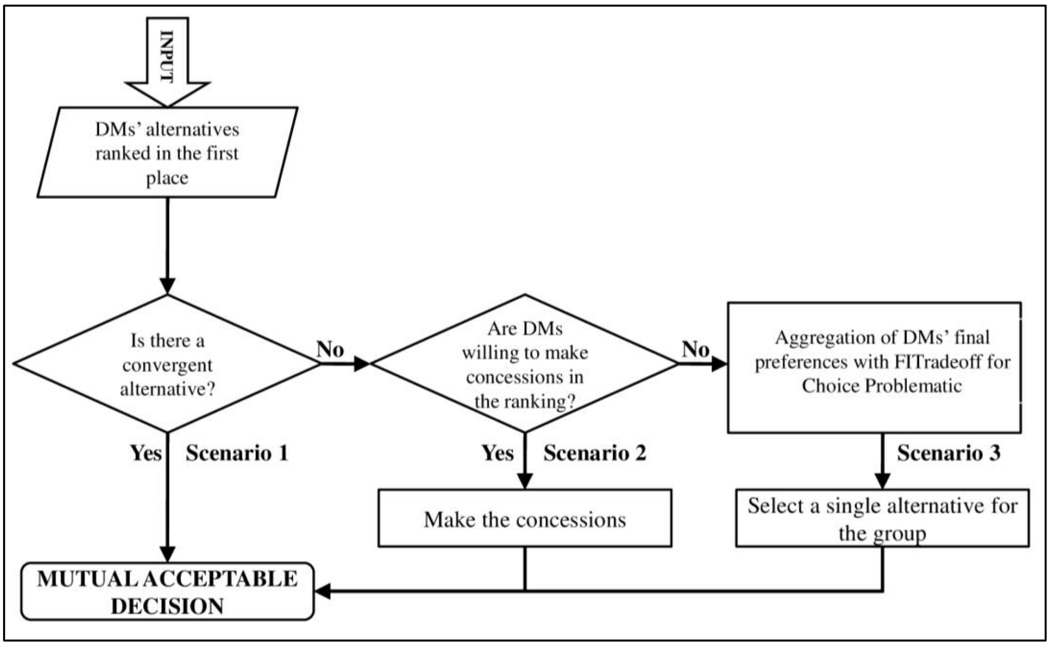
Then, each DM must individually define the criteria on which to evaluate the sets of actions formed in Phase 1. These criteria are those derived from the VFT developed with each DM by the analysis of their individual objective trees. However, an assumption of the model is the use of the cost criterion, which will be common to all DMs, for economic analysis on its sharing. This process will result in a list of criteria for each DM, with or without similarities.

Next, evaluation matrices formed by the sets of actions (alternatives) versus the evaluation criteria have to be drawn up for each DM. Thus, each DM will have a different evaluation matrix. Later, we will apply the Flexible and Interactive Tradeoff (FITradeoff) for the ranking problematic.

Moreover, after entering the evaluation matrices into the FITradeoff software for ranking problematic available for download on fitradeoff.org, the elicitation process will be conducted with each DM.

Thus, for each DM, an individual list of ranked alternatives will be generated. A check should then be made to determine if there is a convergence between the results. Consequently, the three possible scenarios, shown in Figure 6 are visualized in this context.

Figure 6 - Scenario Analysis



Source: The Author (2022)

- Scenario 1 – Optimistic: The alternative ranked in the first place in the results obtained for all DMs involved in the elicitation process using FITradeoff for the ranking problematic is the same so that the Shapley cost-allocation is made;

- Scenario 2 – Reasonable: The alternative ranked in the first place in the results obtained for all DMs involved in the elicitation process using FITradeoff for the ranking problematic is not the same but DMs are willing to make concessions to reach a mutually acceptable decision so that the Shapley cost-allocation is made; and

- Scenario 3 – Pessimistic**:** The alternative ranked in the first place in the results obtained for all DMs involved in the elicitation process using FITradeoff for the ranking problematic is not the same and DMs are not willing to make concessions. In this case, it is necessary to aggregate the DMs' preferences. To do so, this study proposes to aggregate DMs' outcomes and final results using FITradeoff for group decision (DE ALMEIDA et al., 2019). Additionally, the rankings of each DM will be used as inputs as long as the same criteria previously defined are used. These should form a single evaluation matrix for the elicitation process while the

FITradeoff for group decision will be used to aggregate DMs' preferences. This additional evaluation will be made with all DMs simultaneously. However, if the DMs do not want to make some evaluation of a certain criterion, this criterion may be easily blocked without losing information. This process runs until a single alternative that simultaneously meets the preferences of all DMs is reached (DE ALMEIDA et al., 2019). In this sense, the objective function of the LPP from FITradeoff for group decision tries to maximize the value of the alternative as in Equation 3.1.

$$\text{Max Z} = \sum_{j=1}^{m} w_j v_j(x_{ij}) \tag{3.1}$$

In Equation 3.1Max Z represents the Objective Function that will be used in the LPP of FITradeoff for group decision to select a single alternative with the best value $\sum_{j=1}^{m} w_j v_j(x_{ij})$ for the group.

Then, with a single alternative that represents the set of actions selected by the group, it is necessary to allocate its cost among the DMs. For this, the Shapley value approach (SHAPLEY, 1953) for allocating costs fairly will be used.

Afterwards, the agreement between the DMs is formalized.

3.2.3 Phase 3 – Sectoral Agreement

In this phase, the responsibilities, in terms of costs and actions for each DM, should comprise the agreement between them. In this agreement, multilateral contracts will be used that balance the benefits associated with the set of actions defined by the DMs and that reinforce the commitment to the proposed objectives.

Thus, the implementation of the actions of the selected alternatives will be the responsibility of the DM who had the action in question identified in his VFT. In addition, the costs allocated to each DM must be included in the contracts.

The process is finalized by implementing the selected actions, and deadlines, performance levels, monitoring and evaluation must be met, under penalty of fines for performance below the established or, in extreme cases, by revoking the agreement (BRAZIL, 2010). Consequently, the decision-making process about circular economy definition is completed.

3.3 Application

A case study was carried out in a craft brewery in northeastern Brazil and the results are presented in this section.

3.3.1 Phase 1 – Problem Structuring

The beer of the company is sold in two main channels: selling in its own store, which requires direct contact with consumers, and reselling it through wholesalers. The company has a truck that delivers to wholesalers. However, when there is extra demand, the delivery service is outsourced.

At the end of its supply chain, post-consumer beer glass bottle packaging is generated as solid waste. The company needs to comply with the NSWP, with respect to the sectoral agreement for packaging, and therefore, it contacted the authors of the present study via e-mail to develop ways to deal with at least 75% of the total amount of the beer glass bottle packaging because this percentage is established in the NSWP.

Subsequently, the representatives of each segment foreseen in the NSWP were identified in a planning meeting: the company manager (decision-maker 1 - DM1), a government authority (decision-maker 2 - DM2), and a representative of the waste-picker's association (decision-maker 3 - DM3). For the application of the proposed model, the presence of an analyst was necessary.

Initially, the VFT method was applied with each DM individually. To do so, the support of the analyst was requested. Then, the analyst used the VFT questioning technique proposed by Keeney (1996) to support eliciting the DMs' objectives. The results from questioning DM1, DM2 and DM3, respectively are shown in Tables 4, 5 and 6.

Table 4 - DM1 interview (The company manager – private sector representative)

Question	**Answer**
What is wrong with your organization?	The consumption of my beer products generates a large amount of solid waste, which is being inappropriately disposed of.
What are the consequences of improper disposal?	It causes environmental pollution, increases the complexity to manage my production process, damages the corporative image of my company and increases my costs of buying new packages.
How did you notice this problem?	When I was doing benchmarking with other beer companies.
How could you solve this problem?	I have to implement sectoral agreement for packaging.
What are your interests with regard to the sectoral agreement?	To increase profit and for our company to have an image that my customers value.

Source: The Author (2022)

Table 5 - DM2 interview (The government authority representative)

Question	**Answer**
What are the benefits that this company brings to the city?	This beer company is a source of job vacancies so that their productive activity helps to boost our economy.
What is wrong about this company?	The beer consumption causes pollution because packaging is disposed of improperly.
What could be done to solve this problem?	To pay waste-pickers to collect the beer packaging, to invest in facilities to inspect and sort the packaging, to invest in educational campaigns to make the population aware of the environmental consequences of improper disposal.
What are your responsibilities to solve this problem?	To implement policies to prevent solid waste pollution.
Why?	To guarantee the citizens' well-being and to have social approval.

Source: The Author (2022)

Table 6 - DM3 interview (The waste-picker association representative)

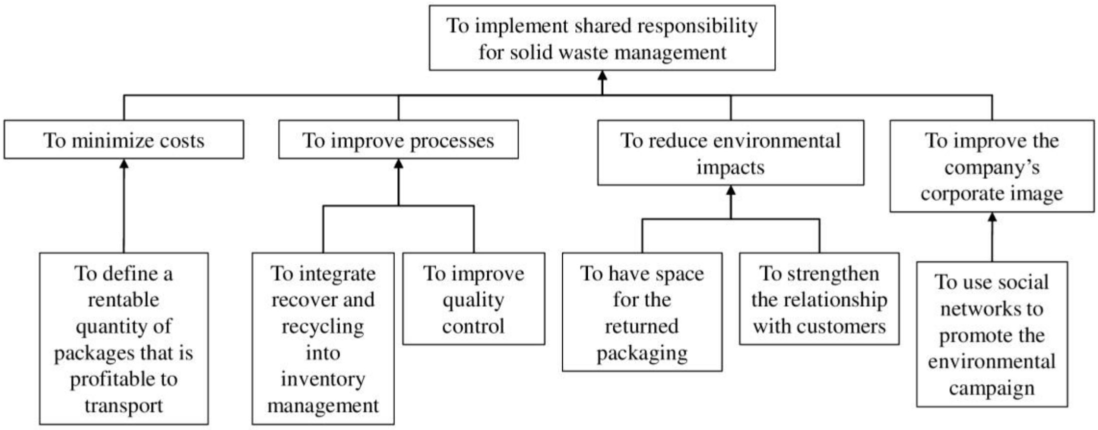
Question	Answer
What are your interests in the proper disposal of beer packaging?	To generate jobs vacancies for waste-pickers.
Why?	To generate income for waste-pickers who live in social vulnerability situations.
What could be done to solve this problem?	We should be contracted to collect, sort and inspect the beer packaging and give it back to the company.
What are your responsibilities to solve this problem?	To train the waste-pickers to support the reverse packaging logistic process.
Why?	To guarantee that our work will be effective in solid waste management.

Source: The Author (2022)

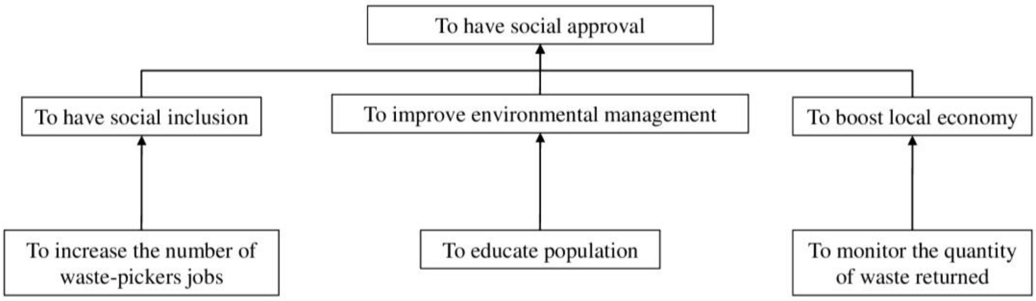
Next, the analyst guided the DMs into creating individual hierarchies of values. The results are shown in the individual objective trees of each DM in Figure 7. The most general fundamental objective for DM1 was to implement shared responsibility for solid waste management post-consumer beer packaging by means of reverse logistics actions, which is shown at the top of Figure 7(a).

Subsequently, DM1 defined his most specific fundamental objectives which were: to minimize costs, to improve processes, to reduce environmental impacts and to improve the company's corporative image. Then, DM1 defined the main objectives: To define a quantity of packages that is profitable to transport, to use social networks to promote the environmental campaign, to strengthen the relationship with customers, to improve quality control, to have space for the returned packaging and to integrate recover and recycling into inventory management. A similar analysis can be done for the objective trees of DM2 and DM3.

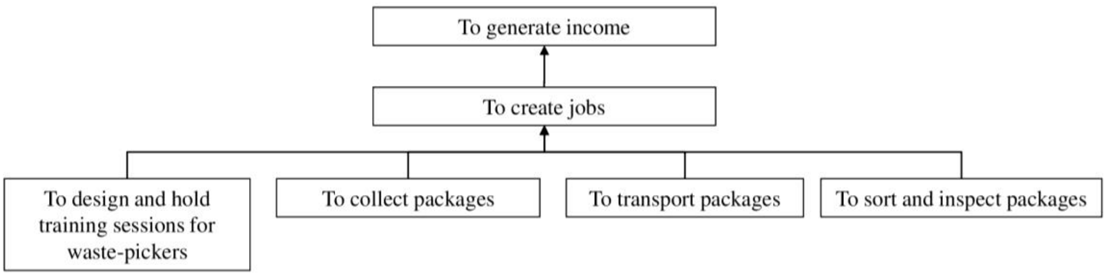
Figure 7 - DMs objective trees



(a) DM1 objective tree



(b) DM2 objective tree



(c) DM3 objective tree

Source: The Author (2022)

Subsequently, each DM analyzed their objectives comprehensively and exhaustively as a result of which, based on this analysis, they developed actions to meet them. Table 7 shows the actions and their respective costs, obtained after completing the VFT.

In a workshop, the DMs were asked to identify the sets of actions to be developed for the management of solid waste, based on the order of priority provided in the NSWP, i.e., non-generation, reduction, reuse, recycling, treatment of solid waste and environmentally appropriate final disposal.

Consensually, the DMs discarded the possibilities of non-generation, reduction, and treatment of solid waste, as these alternatives would directly impact the main activity of the brewery company. Counting only with reuse, recycling, and final disposal, the actions and sets of actions were defined and are presented in Table 8.

Table 7 - Actions and respective costs

DM	Action	ID	Cost (R$ - Reais Brazilian Currency)
DM1	Define a lucrative quantity of packages to be collected	a_1	250,00
	Routing problem for collect waste	a_2	350,00
	Give discounts on new beers bought if the consumers bring empty packaging in the return	a_3	20,00
	Spread awareness campaigns on Instagram, Facebook, and Tik Tok	a_4	417,00
	Develop an app to communicate with consumers	a_5	7000,00
	Develop and implement a managerial integrated system	a_6	7000,00
	Provide space for the packaging returned	a_7	400,00
	Set specification limits for inspection	a_8	450,00
	Provide tags to identify reused packaging	a_9	1,00
	Develop and implement an inventory management technique	a_{10}	200,00
DM2	Give lectures to schools on environmental preservation	a_{11}	37,00
	Define collection point within the city	a_{12}	250,00
	Drive media campaigns in communication vehicles	a_{13}	400,00
	Monitor the quantity of beer packaging returned	a_{14}	200,00
	Provide buckets for collect waste in collection points	a_{15}	450,00
DM3	Provide bicycles to transport waste	a_{16}	400,00
	Transport beer packaging to waste-pickers facility	a_{17}	7,00
	Transport beer packaging to the focal company	a_{18}	4,00
	Count and notify waste quantity returned	a_{19}	3,00

Source: The Author (2022)

Table 8 - Action sets

Action Set	Actions	Description
S1 – Reuse	$a_1, a_2, a_3, a_4, a_5, a_6, a_7, a_8, a_9, a_{10}, a_{12}, a_{14}, a_{15}, a_{16}, a_{17}, a_{18}, a_{19}$	Reuse of packaging in the production process with the necessary treatments to guarantee the same quality of the product to the consumer,
S2 – Recycling	$a_2, a_3, a_4, a_6, a_8, a_{11}, a_{12}, a_{14}, a_{15}, a_{16}, a_{17}, a_{18}, a_{19}$	Transformation of the characteristics of the waste with physical, chemical and/or biological changes so that it becomes a raw material again, whether from the same supply chain or another,
S3 – Final disposal	$a_4, a_6, a_7, a_8, a_{12}, a_{13}, a_{14}, a_{15}, a_{16}, a_{17}, a_{18}, a_{19}$	Orderly distribution to landfills without damage or risks to public health or the environment,

Source: The Author (2022)

From this process, the action sets desired by the DMs and that are feasible from the point of view of the law were obtained.

3.3.2 Phase 2 – Decision-making

Initially, DMs were asked to identify the criteria against which the action set should be evaluated. Likewise, the actions for SWM emerged from VFT analysis, the criteria were also identified. Table 9 shows the criteria defined by each DM.

Table 9 - Criteria defined by each DM

DM1				
ID	**Criterion**	**Description**	**Optimization Direction**	**Scale**
C1	Cost	Total cost of adopting the action set	Minimize	Financial Resources (In thousand of R$)
C2	Operationalization	Refers to the difficulty in implementing the action set in the company	Minimize	1-Very easy to 5-Very Difficult
C3	Benefit	Refers to the benefits brought about by implementing the action set with internal and external customers	Maximize	1-Very little to 5-Very Large
C4	Environmental Impact	Refers to improvements in the environment brought about by adopting the action set	Maximize	1-Very Small to 5-Very Large
DM2				
ID	**Criterion**	**Description**	**Optimization Direction**	**Scale**

C1	Cost	Total cost of adopting the action set	Minimize	Financial Resources (In thousand of R$)
C2	Level of pollution	Refers to the level of pollution generated by implementing the action set	Minimize	1-Very little to 5-Very large
C3	Environmental awareness	Refers to the environmental awareness brought about by implementing the action set	Maximize	1-Very Small to 5-Very Large
C4	Job vacancies	Refers to the number of jobs generated in the local community	Maximize	1-Very Small to 5-Very Large
DM3				
ID	**Criterion**	**Description**	**Optimization Direction**	**Scale**
C1	Cost	Total cost of adopting the action set	Minimize	Financial Resources (In thousand of R$)
C2	Job vacancies	Refers to the number of jobs generated for the waste-pickers	Maximize	1-Very Small to 5-Very Large
C3	Quantity of waste collected	Refers to the environmental awareness brought about by implementing the action set	Maximize	1-Very Small to 5-Very Large

Source: The Author (2022)

Subsequently, the DMs individually developed their evaluation matrices which are shown in Table 10.

Table 10 - DMs' evaluation matrices

DM1's Evaluation Matrix				
Action Set	Criterion			
	C1	C2	C3	C4
S1	17,40	4	5	5
S2	9,59	2	5	4
S3	9,98	3	1	2
DM2's Evaluation Matrix				
Action Set	Criterion			
	C1	C2	C3	C4
S1	17,40	1	5	5
S2	9,59	1	5	5
S3	9,98	5	1	2
DM3's Evaluation Matrix				
Action Set	Criterion			
	C1	C2	C3	
S1	17,40	5	5	
S2	9,59	5	3	
S3	9,98	2	1	

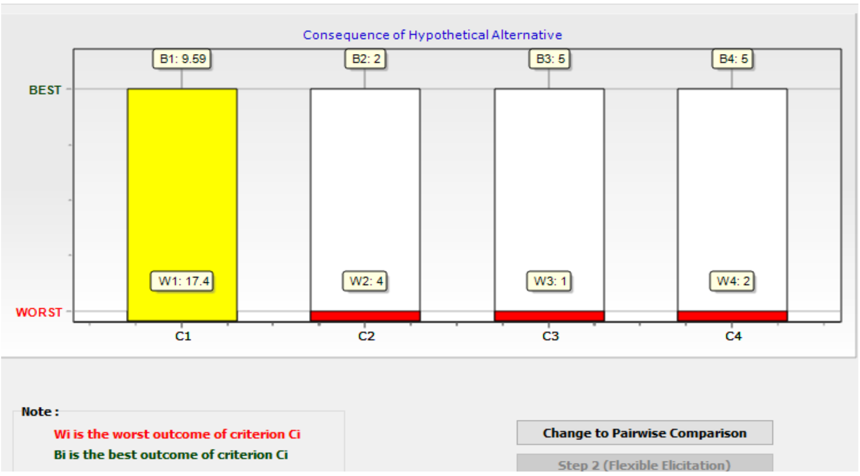
Source: The Author (2022)

The evaluation matrices were used as input in the FITradeoff software for the ranking problematic and each DM made their elicitation process in different moments based on their own evaluation matrices. The elicitation process into the software begins by the DMs being asked to order the evaluation criteria as it is shown in Figure 8(a). For DM1, the ordering of the criteria was C1> C2> C3> C4. For DM2, the order was C1> C4> C2> C3 and, for DM3, the order was C2> C1> C3. After ordering the criteria, the software proceeded with the elicitation process. In this respect, questions were presented so that each DM could assess the hypothetical consequences related to the action sets, as exemplified in Figure 8(b) referring to DM1.

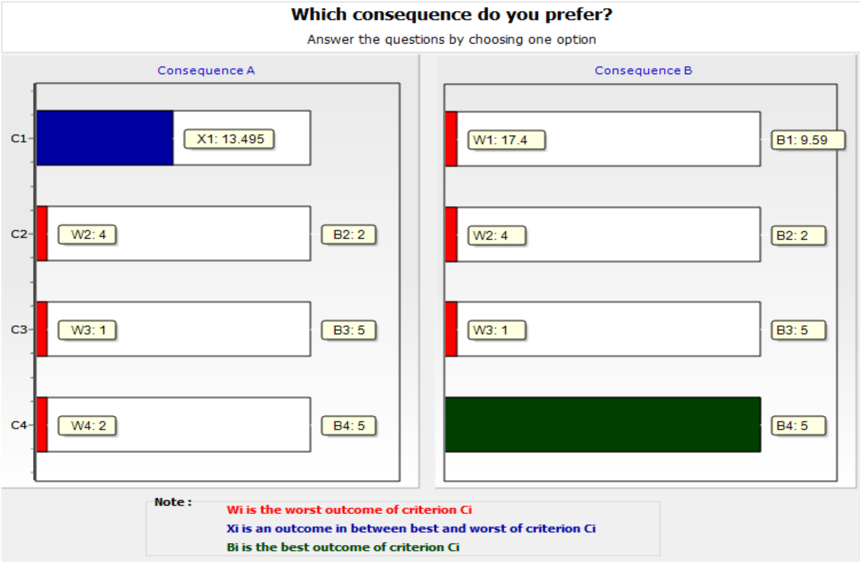
After each cycle of questioning, the software compiles dominance matrices alongside the alternatives. Simultaneously, Hasse diagrams were constructed and made available so that the DMs could check the progress of the rankings of the sets of actions. The DMs could stop the elicitation process at any time if they were satisfied with the partial results obtained.

Furthermore, for DM1, DM2 and DM3 2 cycles of questions were necessary to find the final ranking of the sets of actions.

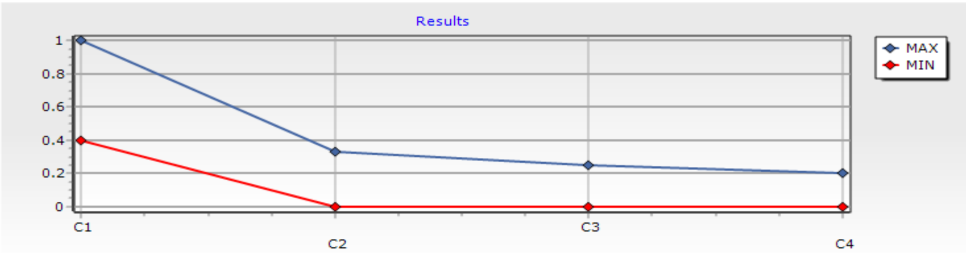
Figure 8 - FITradeoff elicitation procedure



(a) Criteria ordering



(b) Consequence evaluation



(c) Possible range of weights
Source: The Author (2022)

Afterward, the action set final ranking for DM1={1^{st} – S1, 2^{nd} – S3, 3^{rd} – S2}, DM2={1^{st} – S2, 2^{nd} – S1, 3^{rd} – S3}, and DM3={1^{st} – S1, 2^{nd} – S3, 3^{rd} – S2}.The analyst evaluated the final rankings in order to identify the existence of a mutually acceptable decision on the first placement of the action sets. As for DM2 the action set ranked first did not coincide with the action set of the other DMs, and DM2 was asked whether he would be willing to make a concession to the group since the difference between the global value of his action set in 1^{st} place was very small when compared to his 2^{nd} place action set, which coincided with the action set of the other DMs. Next, DM2 made the concession, accepting the alternative ranked in 1^{st} place by the group (S1 - Reuse). Thus, the scenario 2 fit the situation regarding the DMs' results. Then, DMs gave positive feedback on the best-ranked alternative and, thus, the model continued to be applied.

Then, the costs of the action set were allocated among the DMs, i.e. the total cost of the S1 (R$ 17,400.00). The number of coalitions according the DMs entrance order is defined, as a rule by n!, where n is the number of DMs; therefore, for 3 DMs, we have 3!, which results in 6 possible coalitions. The cost of each coalition formed is shown in Table 11(a).

The coalition cost in column 1 of Table 11(a) represents the total costs of each DM implementing by their own the actions provided in their individual VFT. The penalty/subsidy cost in column 2 of Table 11(a) refers to the charges foreseen in the NSWP, which are passed on to the coalitions. After determining the costs, the coalition value functions were calculated considering the savings made by forming a coalition, which are also shown in Table 11(b).

The Shapley value was calculated using Equation 2.11 for each DM and indicates the costs allocated to the alternative for each of them as it is shown in Table 11(c).

Table 11 - Shapley cost-allocation

Coalition	**Coalition Cost**	**Penalty/ Subsidy Cost**	**Total Cost**
{DM1}	11,61	1,20	12,81
{DM2}	4,14	1,20	5,34
{DM3}	1,65	1,20	2,85
{DM1,DM2}	15,75	2,00	17,75
{DM1,DM3}	13,26	2,00	15,26
{DM2,DM3}	5,79	2,00	7,79
{DM1,DM2,DM3}	17,40	2,10	19,50

a) Coalition Costs

Coalition	**Value Function**
{∅}	0,00
{DM1}	12,81
{DM2}	5,34
{DM3}	2,85
{DM1, DM2}	17,75
{DM1, DM3}	15,26
{DM2, DM3}	7,79
{DM1, DM2, DM3}	19,50

b) Value Function

Coalition Entrance Order	**DM1**	**DM2**	**DM3**
{DM1, DM2, DM3}	12,81	4,94	1,75
{DM1, DM3, DM2}	12,81	4,24	2,45
{DM2, DM1, DM3}	12,41	5,34	175
{DM2, DM3, DM1}	11,71	5,34	2,45
{DM3, DM1, DM2}	12,41	4,24	2,85
{DM3, DM2, DM1}	11,71	4,94	2,85
Shapley Value (10^3)	12,31	4,84	2,35

c) Shapley Value

Source: The Author (2022)

Thus, the costs allocated to each DM were: R$: 12,310.00 for DM1, R$: 4,840.00 for DM2, and R$ 2,350.00 for DM3.

3.3.3 Phase 3 – Sectoral Agreement

The formalization of the results of the decision-making process took place based on the terms of the sectoral agreement provided for in the NSWP, which was proposed to DM1, DM2, and DM3, each being a representative of a segment of society, as provided for in the principle of shared responsibility for that law.

In addition, formalization was carried out contractually between the DMs. However, it is important to note that DM2, who is the government's representative, has limited autonomy in relation to bureaucratic issues, thus, the signing of the contract by DM2 was conditioned to the inclusion of actions under its responsibility in the municipal waste management plan for bidding processes. For DM1 and DM3, the contract was signed and regularized without any specific observation.

As a control and monitoring mechanism, deadlines for carrying out the actions were established. The DMs and, consequently, the segments they represent, are subject to a fine of 5% per day, levied on the cost of the action, in case of non-compliance with the established deadlines. In extreme cases of non-compliance, the contract can be revoked. The implementation of the actions should occur gradually, with a forecast of a 25% increase in performance each semester.

3.4 Discussion

To the best of our knowledge, the present study is the first to propose a decision-making approach for defining actions and responsibilities in a shared perspective to tackle the transition to a circular economy regarding the sectoral agreement in Brazil.

The evaluation of the decision problem revealed that for the specific case study the alternative S2- Recycling, which is more efficient in environmental terms than the others considered in the analysis, was not prioritized in the first place. Recycling alternative is commonly used by large beer companies because the glass in the bottles is completely recyclable, consumes on average 70% less energy than the production process of new bottles, and the emission of air pollutants is decreased by an average of 20%, in other words, this may be an alternative to be adopted in low carbon supply chains (SHAHARUDIN et al., 2019). However, despite the numerous environmental benefits, the initial investment made for this recycling structure is high. In this sense, as the case study beer company is a craft, production levels are not high. Thus, an investment in a recycling structure might not be offset by the profit brought (INGRAO et al., 2021).

Moreover, DMs opted for the S1-Reuse alternative, which requires smaller investments since the structure necessary to reuse the bottles in the production process is simpler to operationalize and brings environmental benefits similar to recycling. However, a barrier to implement the reuse alternative is the quantity, quality, and return time of the glass bottles (SILVA; FONTANA, 2021).

It is worth mentioning the alternatives that were not considered in the decision-making process, i.e. non-generation, reduction, and treatment of solid waste. Although the non-generation of solid waste at NSWP has absolute priority over other strategies, it was not considered in the decision-making process because the DMs understood that in the production process of the beer company, the generation of solid waste could not be eliminated, even with investments to mitigate it at the generating source. Moreover, the alternative of reduction was also not considered since DMs established as their principal action the change of raw material by which they make the bottles to more sustainable raw materials, and this according to DM1, could cause effects on the taste of the beer, temperature, thereby being not advantageous to make this change. Likewise, despite being a beneficial alternative in sustainable terms, DMs also didn't consider the treatment of waste alternative as it would require chemical processes that would also impact the beer taste (BRAZIL, 2010).

Another point important to mention is that the individual construction of the VFT with each DM, as well as the search for reverse logistics actions that met the objectives of each of them was essential to preserve the prospects and values of the DMs in the decision-making process about the migration to a circular economy. Otherwise, there could be some biases in the definition of objectives and, later, in the established actions, such as the omission of objectives and sets of actions, due to the imposition of certain lines of reasoning by DMs with strong personalities (BOND et al., 2010).

Additionally, as the workshop had the VFT application as a previous step, value was created, which was one important factor in breaking the resistance of the DMs, making them share their true expectations in the formation of sets of actions for the management of solid waste in a circular economy perspective (URTIGA; MORAIS, 2015).

Furthermore, the use of the FITradeoff brought essential elements to the model, such as: (a) cognitively more accessible questions for the DMs, (b) the possibility of stopping the elicitation process to consult partial results, or even to finalize the process, and (c) the tools used so the DMs can visualize the results, which helped the DMs to express their preferences more clearly and objectively (PÉREZ et al., 2021).

Likewise, it is important to mention the study of De Almeida-Filho et al. (2017) which stated that for *j* criteria considered in the elicitation process, 3(*j*-1) questions would be necessary to find a solution in the traditional Tradeoff procedure. However, in our case study, DM1 had 4 criteria, DM2 also had 4 criteria and DM3 had 3. In this respect, in the traditional Tradeoff procedure, 9 questions for DM1, 9 questions for DM2 and 6 for DM3 would be necessary for the elicitation, but the results show that with FITradeoff, the DMs were only asked 2 questions in the elicitation process. This shows a reduction of 78% in the questions to DM1 and DM2, and of 67% to DM3. Consequently, this reduction impacts directly in less cognitive effort and also in less time being needed for the elicitation process which is crucial for the DMs.

Moreover, a robustness analysis was conducted with the results of the elicitation process in Figure 8(c), which shows the possible interval range of values for the weights of the criteria considered. Thus, the ranking found in the elicitation process for the action sets does not change in the interval range shown in Figure 8(c). Consequently, the results are robust (FREJ et al., 2019).

Additionally, the Shapley value proved to be effective for allocating costs from the perspective of shared responsibility, because, as the DMs chose to participate in the great coalition formed by the cooperation of all, there was a reduction in the costs that each one should bear. Thus, the DMs unanimously demonstrated satisfaction with the costs allocated to them by this approach, thereby eliminating possible mistrust in relation to the contributions allocated to each segment (GUARNIERI et al., 2020).

The multilateral contracts were a way of establishing the commitment between the DMs and showing their receptiveness to the results presented by the proposed model, which clearly presented the costs and benefits of implementing the actions. This fact reinforced the engagement among the DMs to fulfill their responsibilities in a shared perspective, thus meeting the main objective of this study (CLOT et al., 2015).

3.5 Synthesis of the Chapter

The linear model practiced in developing countries as Brazil to solid waste management can no longer absorb the amount of waste generated by the cities’ economic activities, and it hinders the self-recovery ability of the environment leading to environmental problems. Consequently, it is necessary a transition to a circular economy model so that environmental problems may be avoided.

Brazilian authorities have already been mobilized to seek ways to transitioning, and one way is centered on reverse logistics and shared responsibility for solid waste management laid down in Law No. 12,305/2010. However, this transition does not occur smoothly due to solid waste management in Brazil involves different segments of society, which implies different responsibilities for each segment, as well as a good interaction between them, but there is not an adequate approach to define the responsibilities. Therefore, this study aimed to develop a collaborative approach capable of defining responsibilities towards solid waste management. The proposed approach embedded three methods: Value Focused Thinking, Flexible and Interactive Tradeoff, and Shapley value.

The approach was applied to a craft brewery located in a northeastern Brazilian city. The findings show that segments were able to define sustainable responsibilities for the tactical performance of solid waste management in transitioning to a circular economy.

Moreover, the results of this chapter showed that once the responsibilities are allocated to each segment, we may think about the issue of how the segments are going to put the responsibilities into practice, whether they will carry it out internally or outsource it. This issue is a gap in the literature, which is explored in chapter 4.

4 MULTICRITERIA DECISION-MAKING MODEL TO OUTSORCE CIRCULAR ECONOMY STRATEGIES IN FASHION INDUSTRY

This chapter puts forward a multicriteria decision-making model to support managers in adopter and incumbent companies of circular economy in Brazilian Fashion industry to classify strategies in core competencies and non-core competencies. The strategies classified as core competencies should not be outsourced since they may bring competitive advantage, and those classified as non-core competencies should be outsourced so as to managers may focus on their core competencies development. Part of the results of this chapter are under consideration in the Journal of Cleaner Production.

4.1 Context

The Brazilian textile-fashion industry is considered one of the ten largest in the world and is valued at US$ 797 billion dollars (DO AMARAL et al., 2018). According to Pinheiro et al. (2019), the Brazilian textile industry has an average of 29,000 companies that operate legally, without counting those that operate informally. Of these companies, most are classified as small and medium-sized companies, which generate nearly 2 million direct jobs and nearly 10 million indirect jobs. A large part of the workforce is female, their earnings being a major source of income for socially vulnerable families.

In contrast, the production processes of these companies in the Brazilian textile and fashion industry are characterized as being just-in-time, with rapid changes in products in response to fashion demands, but with operations that use rudimentary technologies, resulting in low quality and low cost that, in general, generate post-industrial waste, pre-consumer waste and post-consumer waste (CLANCY et al., 2015).

From this perspective, Koszewska (2018) states that post-industrial waste consists of wastes that arise from the production process itself, such as remnants; pre-consumer waste is that waste generated by producing garments that do not meet the minimum quality requirements and, therefore, are not marketed by retailers; and post-consumer waste is the waste that arises from clothing being thrown away that has been worn, damaged or is unwanted because it has gone out of fashion. Thus, these wastes need to be properly managed to minimize potential environmental risks.

Furthermore, according to the Brazilian Association of Standards and Techniques (NBR10004:2004), textile industry wastes can be further classified in relation to the risk they cause, such as: Class A (Non-inert) waste which has the properties of being biodegradable, being combustible and soluble in water, and Class I (Hazardous) if these same residues are contaminated by materials such as machine oil that are harmful to the environment. This makes the management of waste in the textile and fashion industry in Brazil even more critical and necessary.

However, it is noticeable that a large part of this industry operates on the linear economy model and its processes are supported by the extraction of natural resources, production of goods, and consumption until the garments are thrown out (SPATHAS, 2017). These issues are in line with the circular economy (CE) model that has been gaining strength around the world, the pillars of which are production, using the products and reintroducing them to various supply chains (KAZANCOGLU et al., 2020).

The main characteristics of the circular economy are that it reduces the use of natural resources and energy, and at the same time seeks to minimize the generation of waste by systematically reintroducing goods to the production and/or business cycle in order to recover value (ROSSI et al., 2020).

At the same time, the circular economy reduces production costs and fines that would be incurred if environmental issues established by regulations are not met, in addition to which it generates opportunities for innovations to take place both in product design and in the production process, thus boosting the emergence of new business opportunities (KORHONEN et al., 2018).

From this perspective, the circular economy also promotes the generation of new job vacancies, the strengthening of democratic participation in decision-making on environmental issues and a shared responsibility for the life cycle of the goods produced (PRIETO-SANDOVAL et al., 2018; SILVA; FONTANA, 2021). Thus, the circular economy for the textile industry is a plausible alternative that can minimize harmful impacts on the environment and on the social and economic spheres.

In a recent study from the Ellen MacArthur Foundation (2017), four objectives are pointed out for a circular economy in the textile industry. The first is the gradual elimination of hazardous chemical substances and of the release of microfibers that contaminate the environment. The second is a fundamental rethinking of the design of clothing, and of the way it is marketed and used, aiming to transform the culture of throw-away clothes into a culture of long-lasting garments. The third is to radically modify the processes of the supply chain to minimize the generation of waste. And the fourth, is a conscious use of natural resources, yet always looking for renewable alternatives.

In this perspective, many companies in the Brazilian textile and fashion industry are already showing initiatives that lean towards a circular economy. These companies develop their activities based on different Circular Business Models (CBMs) that are defined as facilitators for the transition to the circular economy to happen at the company level, thus closing the loop between production and consumption (HENRY et al., 2020; CENTOBELLI et al., 2020).

Therefore, two CBMs that will be studied in this chapter concern the so-called Adopters and Incumbents. Adopters are companies whose businesses are based on the traditional principles of a linear economy, but that are transitioning to adapt to the circular economy model. Incumbents, on the other hand, are companies whose businesses are based on the principles of the circular economy (URBINATI et al., 2020). However, some major problems are present.

- First of all, despite advances, there is the challenge of identifying circular strategies in the value stream of textile and fashion companies that are at the same time profitable, environmentally correct, socially responsible and also commercially viable so that real impacts of the circular economy are observed (HAN et al., 2017). This creates a paradoxical tension in these companies, since, if on the one hand they wish to meet the objectives of the circular economy, on the other hand, they are afraid that the other companies they cooperate with are not circular and that this will harm their business (DADDI et al., 2019).
- As a consequence of this, we have the second problem, which arises from the pressures suffered by companies within the supply chain itself for quick decision-making in relation to their circular activities (GUARNIERI et al. 2015). Under this panorama, thinking from the perspective of their businesses to the detriment of meeting the objectives of the circular economy (DANO et al., 2020), many companies choose to outsource activities without any prior analysis of the impact on their competitiveness. In this context, core competence is important for the study of outsourcing, as it indicates to the company activities that cannot be outsourced as they are a potential source of competitive advantage (MCIVOR, 2005). In other words, those activities that form part of the core competencies and that can bring competitiveness when well-planned and -managed cannot be outsourced and those that are part of the non-core competencies that do not directly contribute to the success of the business and can, therefore, be outsourced (PRAKASH; BARUA, 2016).

- Last but not least, the literature on outsourcing decisions in the circular economy focuses on the development of models that support supplier selection in adopter companies; in other words, in companies that are fundamentally rethinking their business to adhere to the principles of the circular economy and set aside incumbent companies and how they make these outsourcing decisions, which could be an important starting point of good practices for the transition process of the adopters (HVASS; PEDERSEN, 2019).

None of these three problems have been adequately addressed in the literature. Thus, this chapter puts forward a model for evaluating the competencies of adopter and incumbent companies of the circular economy to serve as a strategic guide on activities that may or may not be outsourced without harming their competitiveness, while contemplating, the business perspective and the objectives of the circular economy.

More specifically, by using the proposed model it is possible to assess what the differences are between adopters and incumbents of the circular economy in relation to what is and is not a core competence, and what consequently can or cannot be outsourced, to generate insights into this unexplored area of the circular economy.

4.2 Proposed model

The concept of core competence was introduced by Prahalad and Hamel (1990) who defined it as the harmonious combination of multiple resources and skills that distinguish a company in the market. Some studies relating core competencies to outsourcing decisions were verified over time.

First, studies can be identified that addressed the theory of core competencies by relating two attributes in a quadratic decision matrix. The purpose of these matrices, in general, is to define outsourcing strategies (HUI; TSANG, 2004; MCIVOR, 2005; SANDRES et al., 2007; FONTANA; ARAGÃO; MORAIS, 2017). The use of matrices as an aid in outsourcing decision-making has helped managers to establish core competencies, because the outsourcing literature sets the focus on core competencies as one of the main advantages of adopting this strategy (MURTHY; KARIM; AHMADI, 2015). However, the matrices presented do not exclusively indicate what is or is not a core competence; in some cases, other evaluations are necessary. Also, using only two attributes may not be the best strategy. This decision, most of the time, involves multiple criteria and, therefore, the use of MCDM presents itself as a viable alternative.

Thus, the study by Hafeez, Zhang and Malak (2002) stand out as it presented a methodology for determining core competence using the AHP multicriteria method. Quantitative (sales growth, operating profit and return on capital employed) and qualitative (PRAHALAD; HAMEL, 1990) criteria were evaluated using the Saaty scale (1987). Despite incorporating the decision maker's (DM's) personal judgments and values by means of a structured logic (SAATY, 1987), the AHP method can present problems regarding its use. Because AHP is a method that performs peer-to-peer comparisons, a potentially large number of alternatives and criteria can require considerable cognitive effort from the DM and a considerable amount of his/her time. Furthermore, a mistaken interpretation by the DM when using the AHP scale can occur, e.g., it is difficult to assign a relative importance of the profit in monetary units with the reduction of the liability measured in the expected processes (OLSON,1988). Another critical point in this model is that the criteria used are imposed and generic and, very often, they may well not take account of the perspective of the business analyzed. Furthermore, there were no studies in the literature that use MCDM to identify core competencies in the context of the circular economy for the textile industry. Therefore, the model proposed in this study stands out.

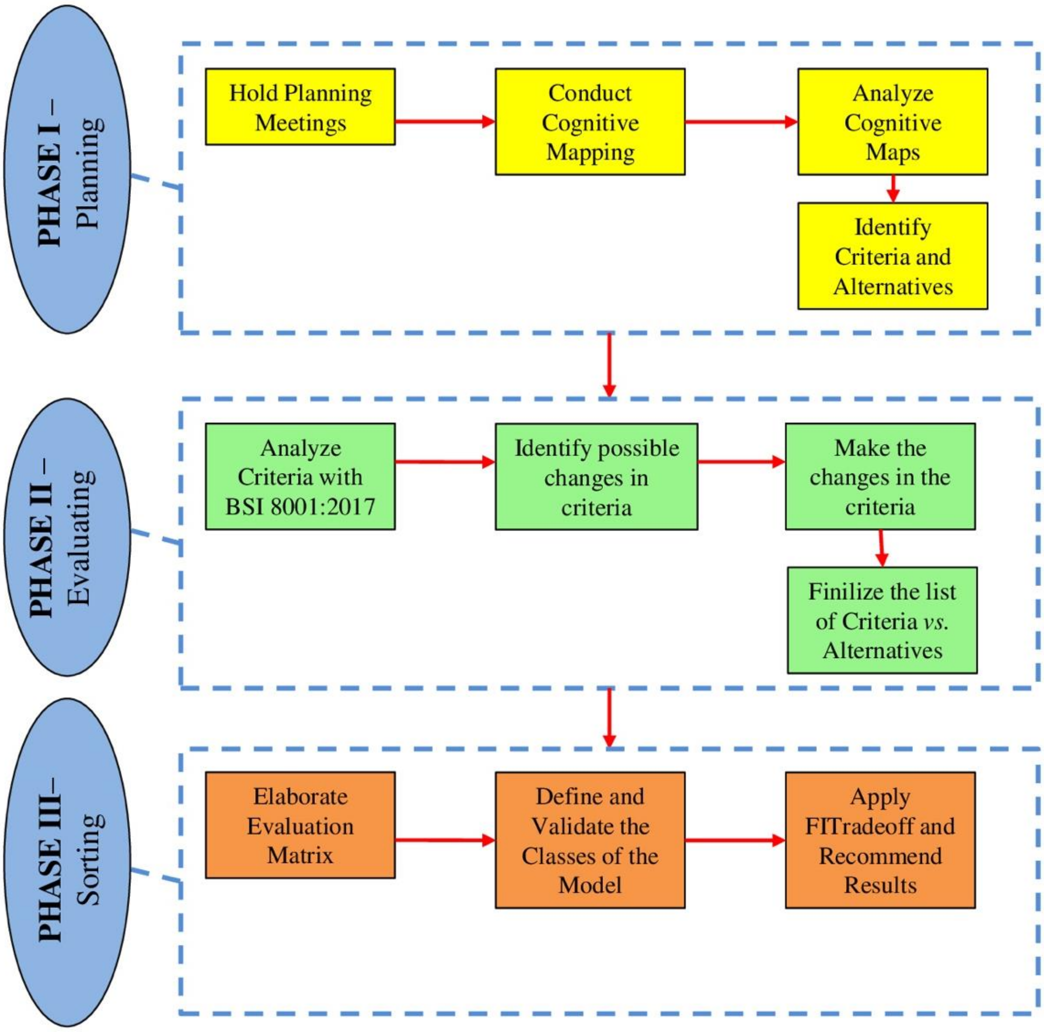
Initially, the model proposes the use of cognitive mapping, which has the following benefits: the visual representation of the DM's thinking about a problem situation, thus enabling it to be more fully understood and communicated; it is the basis for identifying and interpreting important issues for solving the problem, in addition to which it can be used as a tool to facilitate a clearer and more objective process for defining and selecting the criteria and alternatives of the problem from the DM's perspective (EDEN, 2004; BRITO et al., 2019).

Subsequently, the British Standards Agency (BSI) standard - BSI 8001:2017 is used, which assists in implementing the principles of the circular economy and can assess the degree to which the issues identified by cognitive mapping simultaneously meet the objectives of the circular economy and generate competitive value for business (BSI, 2017).

Finally, the Flexible and Interactive Tradeoff Elicitation (FITradeoff) method for the Sorting Problematic is used to classify strategies into core competencies and non-core competencies, i.e., whether they cannot be outsourced or whether they can be outsourced, respectively (KANG et al., 2020). The main benefits of this method have been presented previously.

Figure 9 shows the phases of the proposed model.

Figure 9 - Proposed model



Source: The Author (2022)

More in-depth details about the proposed model are presented in the following sections.

4.2.1 Phase 1 – Planning

Initially, Planning Meetings are held to identify the actors in the decision-making process (Decision-maker, Analyst, Specialist, etc.) and unstructured interviews are conducted with the company manager who provides information about his/her company and strategies in relation to the circular economy.

With this information, the analyst starts the Cognitive Mapping process with the DM for which a computational tool is used, which is called Decision Explorer free version.

Subsequently, the analyst will carry out, together with the DM, the Analysis of the Cognitive Map collectively and exhaustively. This process is repeated until the DM feels satisfied with the problem situation represented on the cognitive map.

This analysis will be used to Identify Criteria and Alternatives that will be used in the decision problem, and after doing so, one can move on to Phase 2.

4.2.2 Phase 2 – Evaluating

Initially, this phase sets out to Analyse Criteria with BSI 8001:2017 and thus the support of an expert is required. The BSI 8001:2017 standard will be used to evaluate the criteria defined in phase 1, as the criteria are the key points in analysing what is a core competence and what is not. In other words, the BSI 8001:2017 is used to analyse if the criteria identified are able to both measure the development of circular economy strategies and the development of the business model.

Subsequently, the analyst will conduct a workshop phase with the DM in order to Identify Possible Changes in Criteria that will make strides towards increasing the intensity with which circular economy principles are met.

In case the DM identifies which changes can be made, it will be possible, with the support of the analyst, to Make the Changes in the Criteria and, later, to Finalize the List of Criteria vs. Alternatives. Otherwise, the DM can go directly on to finalising the list.

4.2.3 Phase 3 – Sorting

In phase 3, with the support of the analyst, the DM Elaborates the Evaluation Matrix by conducting evaluations of each alternative for each criterion resulting from the final list of phase 2.

In addition, the DM also sets out to Define the Classes of the Model. Both the Evaluation Matrix and the Classes defined will be inputs to FITradeoff for the Sorting Problematic. FITradeoff for the Sorting Problematic has a decision support system to automate the entire elicitation process.

Later, the analyst will recommend the results to each DM, who may choose to follow or not to follow it.

Finally, the results of both DMs will be compared in order to generate insights that can aid adopters' companies into the transition to a circular economy.

4.3 Application

In order to implement the proposed model, in-depth multiple individual case studies were carried out with two companies, one incumbent and the other, an adopter of the circular economy model. These companies operate in the northeast region of Brazil and in the state of Pernambuco, more specifically in the Local Production Arrangement for textiles and fashion formed by the towns of Caruaru, Santa Cruz do Capibaribe and Toritama. Details of the results are presented in the following sections.

4.3.1 Phase 1 – Planning

Initially, two individual planning meetings were conducted with the managers of the adopter and incumbent companies that lasted about 80 minutes each. Relevant information was collected to characterize the companies. This information is summarized in Table 12.

Table 12 - Characteristics of the companies

Characteristic \ Company	Adopter	Incumbent
Founded	1983	2014
Revenue	R$88.000,00/Month	R$38.000.00/Month
Employees	97	52
Company Size	Medium	Medium
Product	Denim Wear	Denim Wear
Business	Business to Business (B2B) and Business to Consumer (B2C)	Business to Business (B2B)
Strategy with Circular Economy	Gain competitive advantage in Local Productive Arrangement (LPA) through market differentiation and increased profits	The idea for the business came from the lack of circular companies in the LPA textile in the region.
Approach to Circular Economy	Product by product towards the Circular Economy	Ethics, social responsibility, and sustainability are the company's foundations.

Source: The Author (2022)

The main actors in the decision-making process were also identified: the manager of the adopter company and the manager of the incumbent company are the decision-makers, here called DMA and DMI, respectively. In addition to these, there were the analyst of the decision-making process who is one of the authors of this study and, finally, a specialist in circular entrepreneurship from the Federation of Industries of the State of Pernambuco (FIEPE).

Subsequently, a further two 120-minute meetings were held with each DM to carry out the cognitive mapping of them both.

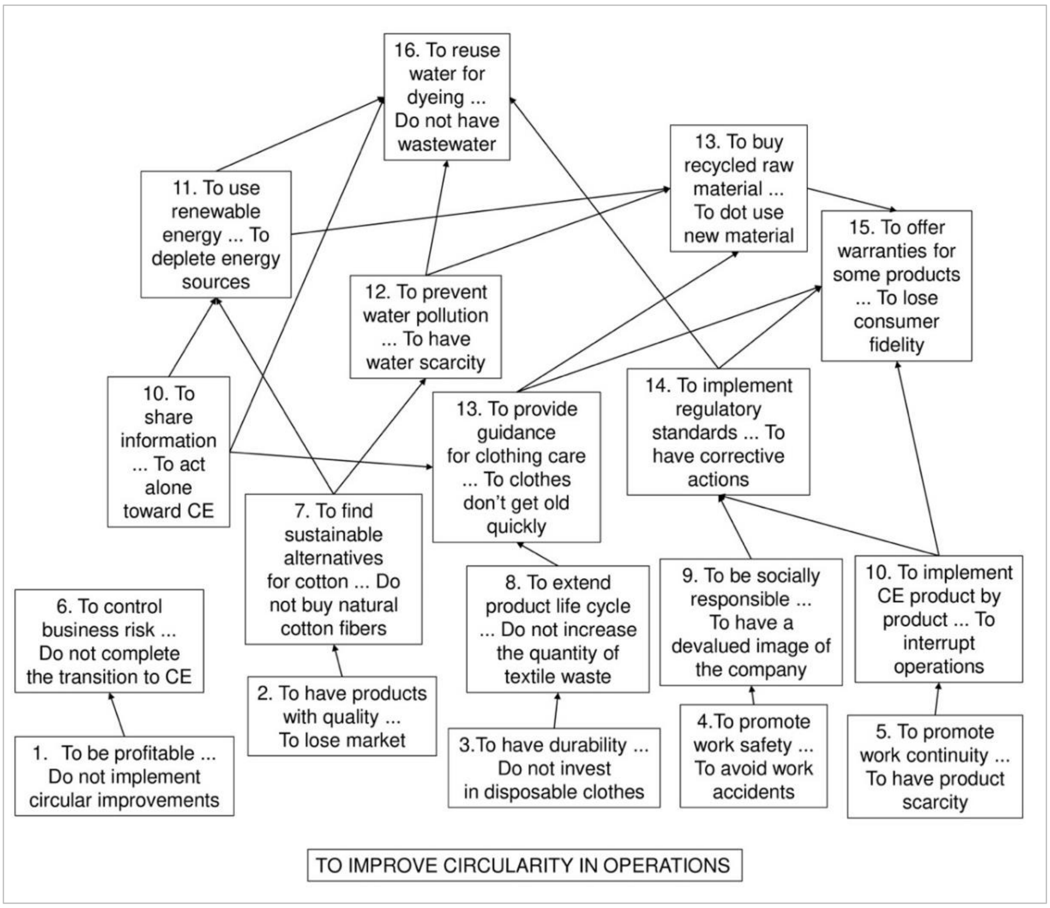
To prepare the DMA's cognitive map, initially, he defined the problem label as "TO IMPROVE CIRCULARITY IN OPERATIONS". Afterwards, the DMA was asked by the analyst which words would be related to attending to the label of the problem. This led to the DMA issuing his PEAs, which were: Profitability, Product Lines, Water, Garment Durability, Collection, Quality, Safety at Work.

Subsequently, the DMA was asked by the analyst about the importance of each PEA and the consequences of not attending to them for example, as to PEA Quality, the DMA responded that the importance was "To have quality products" and that the consequence was "To lose Market", thus forming the present and opposite pole of construct 2. Later, the DMA was asked why construct 2 was important and he answered “To find sustainable alternatives for cotton” and that the consequence would be “Do not buy natural cotton fibers” as can be seen in construct 7.

Then, the DMA was asked about what would be the result of meeting construct 7 and he replied: “To use renewable energy ... To deplete energy sources” and “To prevent water pollution ... to have water scarcity”, constructs 11 and 12 on the map. Finally, DMA was asked how the questions pointed out in constructs 11 and 12 could be attended to and he answered that this would be “To reuse water for dyeing... Not to have wastewater”, construct 16 of the map. The (...) in the constructs mean “instead of” and the arrows on the map show how one construct relates to another from the DMA's perspective. The same procedure was performed to draw up the DMI's cognitive map, the label of which was “TO DEVELOP STRATEGIES FOR CONTINUOUS CE IMPROVEMENT” and the PEAs were: Responsibility, Ethics, Ecology, Social Respect, Design, and Cooperation. The result of the DMA's and DMI's maps are shown in Figure 10-11, respectively.

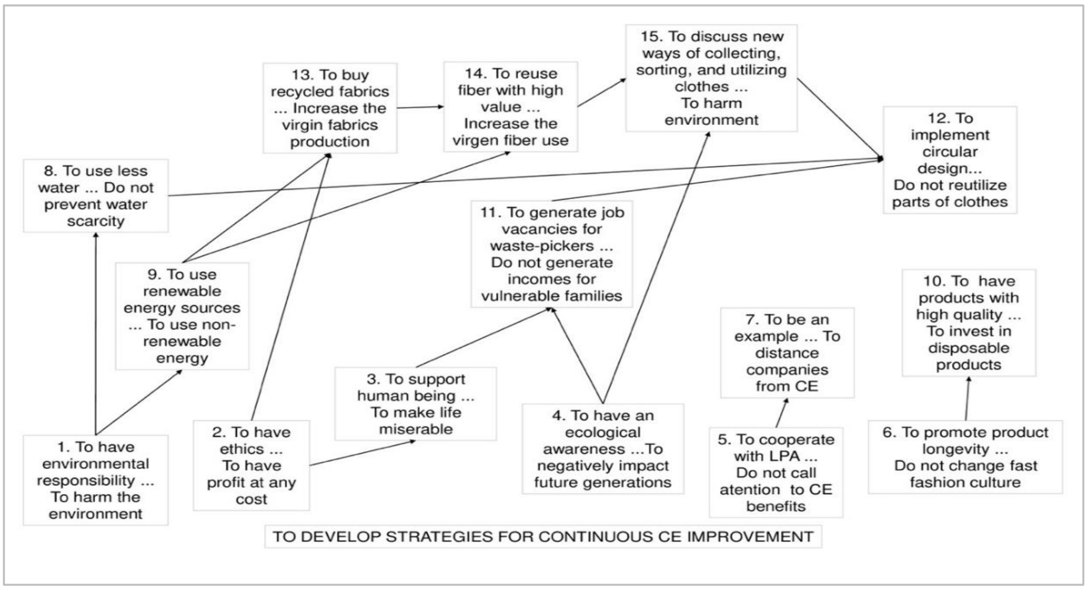
Furthermore, the analyst supported the DMs in analyzing their cognitive maps to see if they were satisfied with the representation of the problem situation expressed in terms of constructs. Both DMs said they were satisfied with the result of their maps.

Figure 10 - Cognitive Map of DMA



Source: The Author (2022)

Figure 11 - Cognitive Map of DMI



Source: The Author (2022)

Consequently, the DMs and the analyst analyzed the map constructs one by one, two by two, until all constructs were analyzed collectively and exhaustively. From this analysis, the DMs expressed the evaluation criteria (Table 13-14) and the alternatives of the problem (Table 15-16).

Table 13 - Evaluation criteria of DMA

Code	Criterion	Description	Optimization Direction	Scale
C1	Cost	Total cost of implementing the alternative	Minimize	Financial Resources (In Thousands of R$)
C2	Ability	Ability to carry out the process	Maximize	1 – Very little to 5 – Very Large
C3	Quality	Quality generated of the product	Maximize	1 – Very little to 5 – Very Large
C4	Risk	Risk generated for the business	Minimize	1 – Very little to 5 – Very Large
C5	Scope of Task	Degree of responsibility assigned to third-party providers	Minimize	1 – Very little to 5 – Very Large
C6	Raw Material	Degree of virgin material used in the production of clothes	Minimize	1 – Very little to 5 – Very Large
C7	Product Durability	Percentage of time added to the Product's life cycle	Maximize	0% to 100%
C8	Job creation	Number of vacancies created	Maximize	Number of new job vacancies
C9	Concentration of Pollutants	Level of pollution generated	Minimize	Kg/m^3
C10	Work Continuity	Ability to continue the production process without interruptions due to lack of material	Maximize	1 – Very little to 5 – Very Large

Source: The Author (2022)

Table 14 - Evaluation criteria of DMI

Code	Criterion	Description	Optimization Direction	Scale
C1	Circular Investment	Investment made to implement the circular alternative	Minimize	Financial Resources (In Thousands of R$)
C2	Recycled Materials	Measures the percentage of recycled material used in the product	Maximize	0% to 100%
C3	Recyclability Potential	Measures the percentage of product parts that can be recycled after use	Maximize	0% to 100%
C4	Water Use	Measures the amount of clean water used	Minimize	m^3

C5	Energy Use	Measures the percentage of non-renewable energy used in the process	Minimize	0% to 100%
C6	Ability	Ability to carry out the process	Maximize	1 – Very little to 5 – Very Large
C7	Quality	Quality generated of the circular product	Maximize	1 – Very little to 5 – Very Large
C8	Risk	Risk generated for the business	Minimize	1 – Very little to 5 – Very Large
C9	Scope of Task	Degree of responsibility assigned to third-party providers	Minimize	1 – Very little to 5 – Very Large
C10	Renewable Raw Material	Percentage of material reused in the clothing production process	Minimize	0% to 100%
C11	Product Longevity	Percentage of time added to the Product's life cycle	Maximize	0% to 100%
C12	Job creation	Number of job vacancies created	Maximize	Number of new job vacancies
C13	Income generated by new Jobs	Measures the income generated by new job openings due to circular processes	Maximize	1 – Very little to 5 – Very Large
C14	Concentration of Pollutants	Level of concentrated toxic substances	Minimize	Kg/m^3
C15	Work Continuity	Ability to continue the production process without interruptions due to lack of material	Maximize	1 – Very little to 5 – Very Large

Source: The Author (2022)

Table 15 - Alternatives of DMA

Code	Alternative	Description
A1	Raw Material Fiber Production	Process for producing cotton fiber
A2	Spinning	Process for using fibers to form cotton threads
A3	Weaving	Process for forming fabrics by the manual or mechanical interweaving of threads
A4	Dyeing	Process for dyeing fabrics to obtain the right colour for orders
A5	Manufacture of Clothing	Process for producing denim garments
A6	Washing	Process for washing garments for sale
A7	Recycling	Process for recycling garments or raw materials used in production

A8	Collection	Process for collecting pre-consumer or post-consumer waste
A9	Sorting and Grading	Process for screening and evaluating proper disposal
A10	Garment Care Information	Provide information on the store's website or on product packaging on how to care for clothes to extend their life cycle
A11	Reverse Logistics	Define take-back systems to collect pre-consumer stock
A12	Regulatory Standards	Implement regulatory standards for safety at work performed in the factory

Source: The Author (2022)

Table 16 - Alternatives of DMI

Code	**Alternative**	**Description**
A1	Design for Environment	Product designed to be disassembled and for its parts to be reused or recycled
A2	Raw Material Fiber Production	Process for producing cotton fibers
A3	Spinning	Process for using fibers to form cotton threads
A4	Weaving	Process for forming fabrics by the manual or mechanical interweaving of threads
A5	Dyeing	Process for dyeing fabrics to obtain the right color for orders
A6	Clothing Manufacturing	Process for producing denim garments
A7	Washing	Process for washing garments for sale
A8	Recycling	Process for recycling garments or raw materials used in production
A9	Collection	Process for collecting pre-consumer or post-consumer waste
A10	Sorting and Grading	Process for screening and evaluating proper disposal
A11	Garment Care Information	Provide information on the store's website or on product packaging on how to care for clothes to extend their life cycle
A12	Reverse Logistics	Define take-back systems to collect pre-consumer dead stock
A13	Upcycling	Produce higher value-added products than the original product
A14	Downcycling	Produce products with lower added value than the original product
A15	Donation	Donate clothes to people in socially vulnerable situations
A16	Support Center	Donate wastes so that socially vulnerable people in support centers can transform these products and generate income for their families

A17	Textile Banks	Creation of a bank of fabrics for reuse
A18	Information System	Creation of an information system for LPA companies to disseminate information on waste types and quantities
A19	E-commerce	Develop e-commerce to market high value recycled fiber
A20	Thrift Store	Sell pieces at a thrift store with little or no use of the brand, but with a lower quality than the garments that arrive in stores
A21	Reuse	Reuse of material in the production process

Source: The Author (2022)

Then, we proceeded to carry out Phase 2 – Design.

4.3.2 Phase 2 – Evaluating

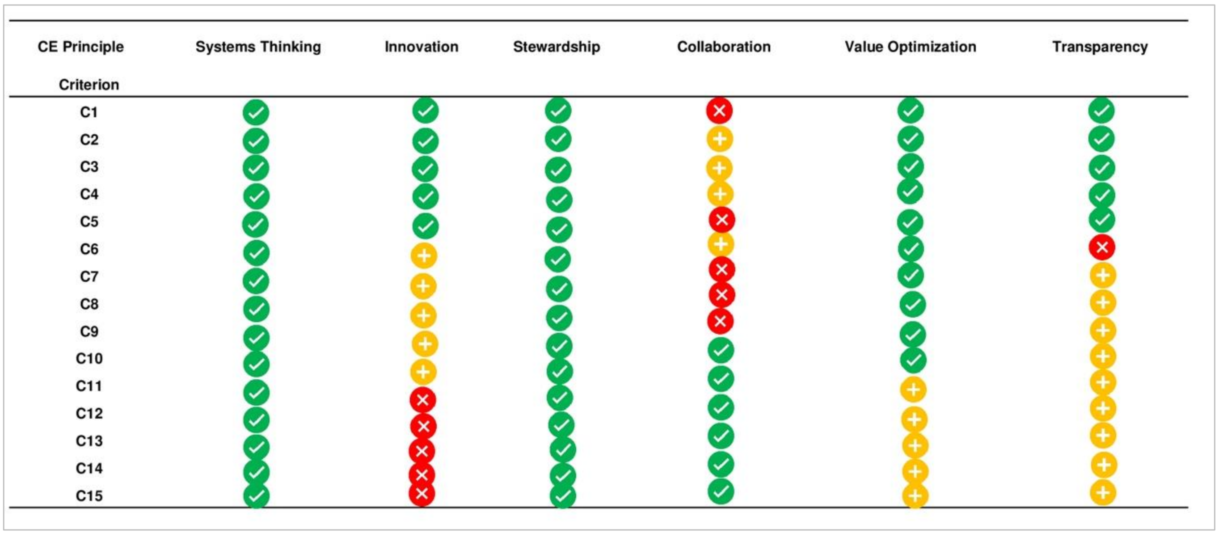
In this phase, the specialist in circular entrepreneurship from FIEPE was asked to analyze the criteria using the international standard BSI 8001:2017 to verify if the criteria identified were able to assess both the dimensions of the CE and to generate value for the business. The results of this analysis are shown in Figure 12-13.

Subsequently, the results of the analysis were presented to the two DMs and they were asked if they would like to make any changes to the criteria. Both said no as they were satisfied with their results.

Figure 12 - Analysis of the Specialist using DMA's criteria

Source: The Author (2022)

Figure 13 - Analysis of the Specialist using DMI's criteria



Source: The Author (2022)

Thus, the final lists of criteria and alternatives remained the same as in Tables 13-16. Consequently, Phase 3 – Sorting was started.

4.3.3 Phase 3 – Sorting

In this phase, initially, the DMs, with the support of the analyst, drew up their evaluation matrices of the alternatives for each of the criteria listed in Tables 17 and 18.

Table 17 - Evaluation matrix of DMA

Criterion / Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
A1	50	4	5	2	1	5	20	5	115	5
A2	20	4	5	2	1	5	20	5	10	5
A3	10	4	5	2	1	5	20	5	5	5
A4	30	3	5	3	5	5	10	5	220	5
A5	10	5	5	1	1	5	50	20	30	5
A6	40	2	4	3	3	5	5	5	320	5
A7	20	1	2	5	3	1	57	4	215	2
A8	5	1	1	4	3	1	12	5	30	5
A9	1	4	5	1	1	1	63	2	10	5
A10	10	5	5	1	1	1	58	1	0	5
A11	10	2	2	5	5	1	67	5	40	1
A12	30	1	1	5	5	1	2	4	0	1

Source: The Author (2022)

Table 18 - Evaluation matrix of DMI

Criterion / Alternative	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
A1	1	75	85	12	1	5	5	1	1	85	80	10	5	34	5
A2	3	65	65	6	2	4	4	1	1	65	60	5	4	56	5
A3	2	65	65	6	2	4	4	1	1	65	60	5	4	10	5
A4	1	65	65	6	2	4	4	1	1	65	60	5	4	5	5
A5	1	70	70	12	2	5	5	1	1	70	75	5	5	110	5
A6	12	75	75	6	2	5	5	1	1	75	70	20	5	15	5
A7	2	70	70	0	2	4	4	1	1	70	75	5	4	160	5
A8	6	70	70	0	0	3	3	4	4	70	75	4	3	115	2
A9	1	45	45	0	0	5	5	2	2	45	40	5	5	15	4
A10	1	55	55	0	2	5	5	1	1	55	50	2	5	5	5
A11	1	75	75	5	0	5	5	1	1	75	70	1	5	0	5
A12	3	10	10	5	5	5	5	2	2	10	10	5	5	20	2
A13	2	45	45	0	5	3	3	2	5	45	40	20	3	0	2
A14	1	35	35	0	0	3	3	2	5	35	30	20	3	10	1
A15	0	45	45	10	0	5	5	1	5	45	40	2	5	0	1
A16	0	25	25	0	0	5	5	1	5	25	30	20	5	100	1
A17	15	15	15	10	10	1	1	5	5	15	20	5	3	0	3
A18	7	5	5	10	10	1	1	3	4	5	10	2	1	0	4
A19	1	5	5	10	10	3	3	2	4	5	10	2	3	10	4
A20	4	5	5	10	10	4	4	2	2	5	10	4	4	10	4
A21	3	5	5	10	10	2	2	2	2	5	10	5	3	115	4

Source: The Author (2022)

Subsequently, the DMs defined and validated the profiles of the classes under which the alternatives would be categorized. It is worth mentioning that there is not a specific procedure to establish and validate the profile of the classes when considering compensatory methods. Thus, we have used here the notion of percentual that is easier for to DMs understand and the values may arise from the interaction between DM and analyst by questioning DMs from 0 to 1 how many classes he/she desires and what are the minimum and maximum percentual values that the classes are better suited. The results are given in Table 19-20.

Table 19 - Profile definition for DMA

Class	Profile ($b_{low} - b_{high}$)	Description
L2 – Core Competence	(0.75 – 1.0]	The alternatives that are classified in this region are considered as core competencies and, therefore, should not be outsourced as they present a high potential for generating a competitive advantage for the company through the Circular Economy.
L1 – Non-core Competence	[0.0 - 0.75]	The alternatives that are classified in this region are considered as non-core competencies and, therefore, can be outsourced as they do not present a high potential for generating competitive advantage or risk for the company through the Circular Economy.

Source: The Author (2022)

Table 20 - Profile definition for DMI

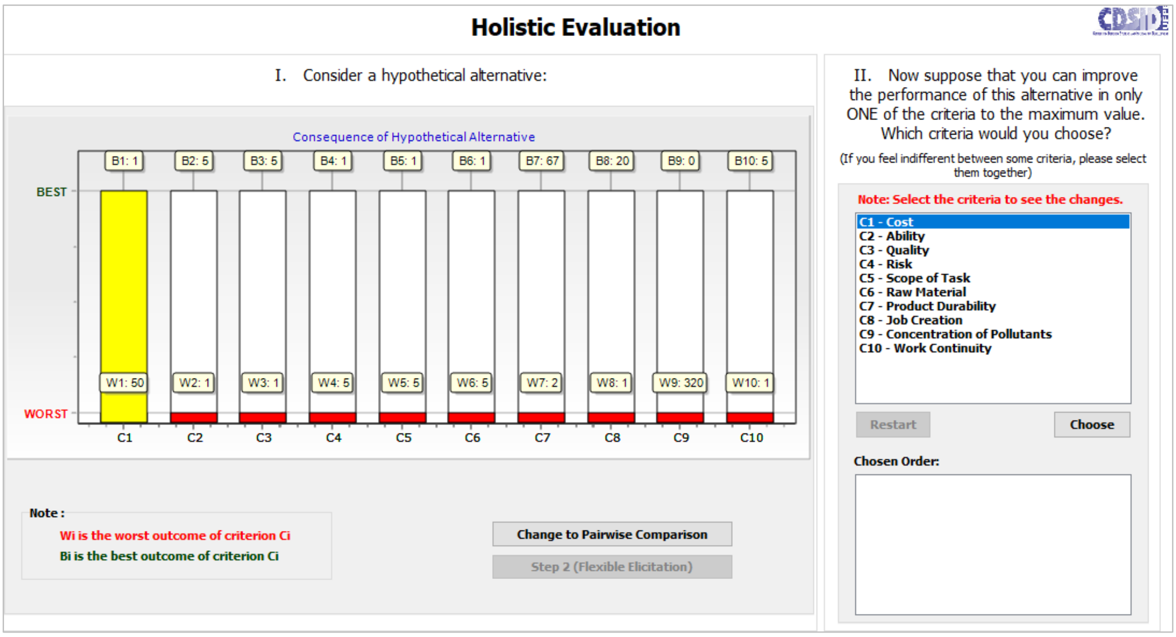
Class	Profile ($b_{low} - b_{high}$)	Description
L2 – Core Competence	(0.35 – 1.0]	The alternatives that are classified in this region are considered as core competencies and, therefore, should not be outsourced as they present a high potential for generating a competitive advantage for the company through the Circular Economy.
L1 – Non-core Competence	[0.0 - 0.35]	The alternatives that are classified in this region are considered as non-core competencies and, therefore, can be outsourced as they do not present a high potential for generating competitive advantage or risk for the company through the Circular Economy.

Source: The Author (2022)

After that, the evaluation matrices and class profiles were used as input for the FITradeoff for Sorting Problematic software (FU-T1CNO-CT1 free version) available for free download on its institutional website. From there, the elicitation process was conducted with each DM.

Initially, each DM was asked to order the weights of their criteria as exemplified in Figure 14.

Figure 14 - DMA'a ordering of the weights of the criteria



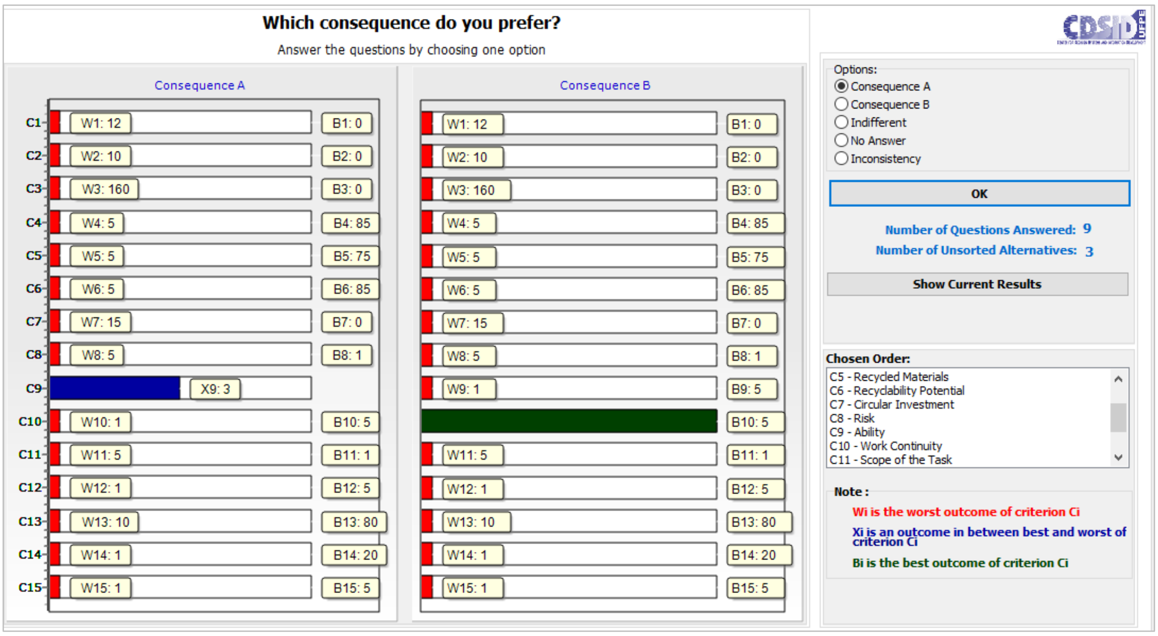
Source: The Author (2022)

DMA's ordering of the weights of the criteria was C1>C4>C10>C2>C5>C3>C6>C7>C8>C9 while DM1 ordered them as follows: C4>C5>C14>C10>C2>C3>C1>C8>C6>C15>C9>C7>C11>C12>C13. Only with the information of this ordering, for the DMA, 8 alternatives were categorized into a class and only 4 were not (A3, A4, A11, A12). For the DMI, 14 alternatives were categorized and 7 were not (A1, A2, A3, A5, A15, A17, A18).

Consequently, the DMs had to assess the consequences that were presented, as exemplified in Figure 15.

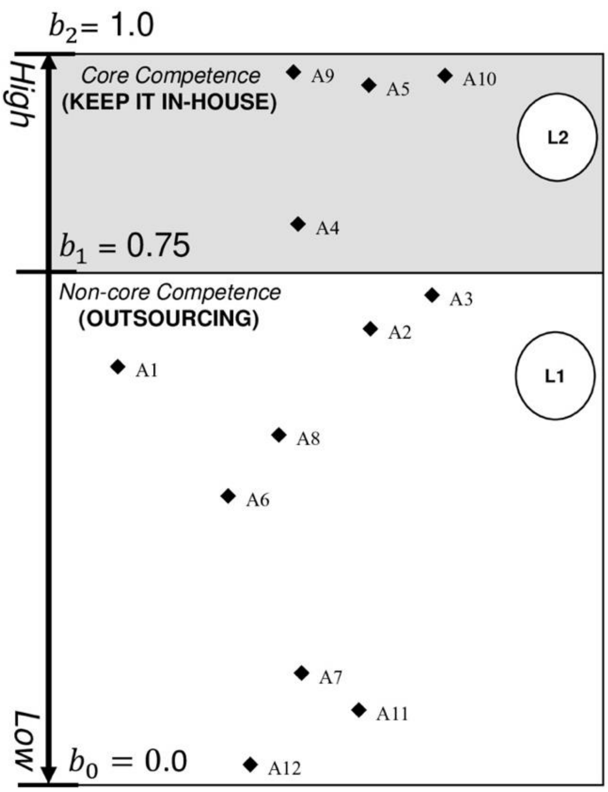
In order to find a complete classification of DMA's alternatives, 16 question cycles were needed and for DMI, 20 question cycles. The sorting results for the DMs are shown in Figures 16 and 17.

Figure 15 - DMI's evaluation of the consequences



Source: The Author (2022)

Figure 16 - Sorting results for DMA

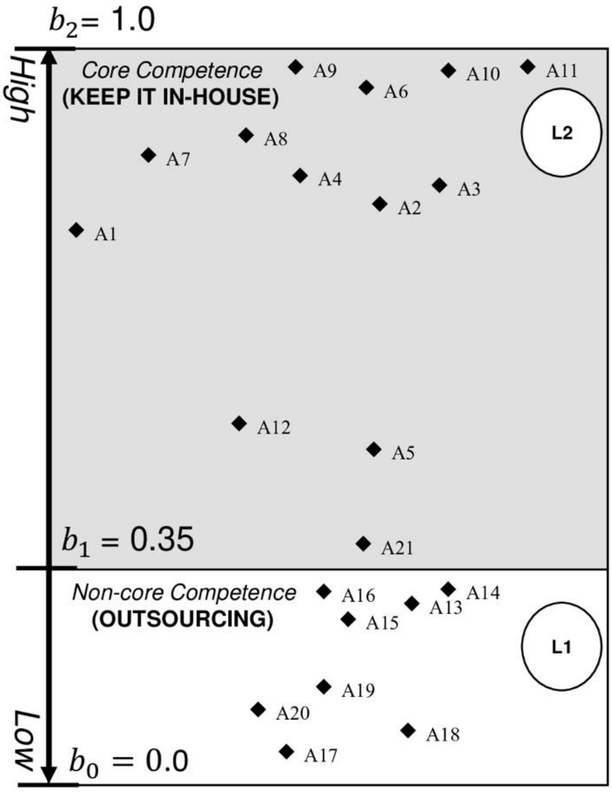


Source: The Author (2022)

For the DMA, the alternatives categorized in class L2 = {A4, A5, A9, A10} are part of his core competencies, therefore, they should not be outsourced. Those categorized in class L1

= {A1, A2, A3, A6, A7, A8, A11, A12} are non-core competencies, so they can be outsourced so that management can focus its efforts on the strategies that can bring competitive advantage due to the circular economy.

Figure 17 - Sorting results for DMI



Source: The Author (2022)

For DMI, the alternatives categorized in class L2 = {A1, A2, A3, A4, A5, A6, A7, A8, A9, A10, A11, A12, A21} are part of its core competencies, so they should not be outsourced. Those that were categorized in class L1 = {A13, A14, A15, A16, A17, A18, A19, A20} are non-core competencies and can therefore be outsourced.

Furthermore, recommendations on whether or not to outsource the circular strategies were given to each of the DMs. After that, the DMs gave positive feedback on their implementation in the recommended way.

From this point on, comparisons between the results of both DMs are made to discuss some important points. Firstly, the criteria defined by the DMA demonstrate that the adopter company is not willing to implement the CE at any cost (C1-Cost) nor if there are considerable risks for its business (C3-Quality and C4-Risk). Thus, the decisions to be taken must be initially profitable and offer a low risk, so that only in this way, can the social and environmental issues of the CE can be thought of in a lesser degree (C5 - Scope of Task and C6 - Raw Material). This thinking was also reflected in DMA's ordering of the weights of the criteria. On the other hand, the criteria defined by DMI show that the incumbent company is able to balance economic, environmental and social issues and still make a profit, without bringing risk to his company, as shown in Table 14. And this was also reflected in the ordering of the weights of his criteria, as DMI ordered in the first instance that set of criteria that assesses environmental impacts (C4-Water use to C3-Recyclable Potential), in the second instance the set of criteria that evaluated the economic outlook of the CBM (C1- Circular Investment to C11- Product Longevity) and, last but not least, the set of criteria that evaluated the social perspective of the CBM (C12- Job Creation and C13- Income generated by new Jobs). It is also important to mention that while, for DMA, circular economy strategies were considered as a cost (C1 - Cost), for DMI, they were considered as an investment (C1- Circular Investment), showing that a cultural change of thinking is also necessary so that adopters transition to EC in the best possible way (URBINATI et al., 2019).

Secondly, the evaluation of the criteria defined by the DMs using the BSI 8001:2017 standard with the support of the expert was extremely important to identify how these criteria could effectively measure the environmental, economic and social perspectives of the circular economy, but also how the CE impacts on the generation of value for the two CBMs studied. When comparing Figures 12 and 13, it is clear that most of the criteria defined by DMA (Fig. 12) have a medium to weak link with CE. Even so, they are able to measure circular opportunities in the early stages of their implementation, as in the case of the following criteria: C7-Product Durability, C8-Job Creation and C9-Concentration of Pollutants. These can assess circular strategies in the economic, social and environmental dimensions, respectively. And this suits the CBM adopter, as the transition process to CE demands time and planning.

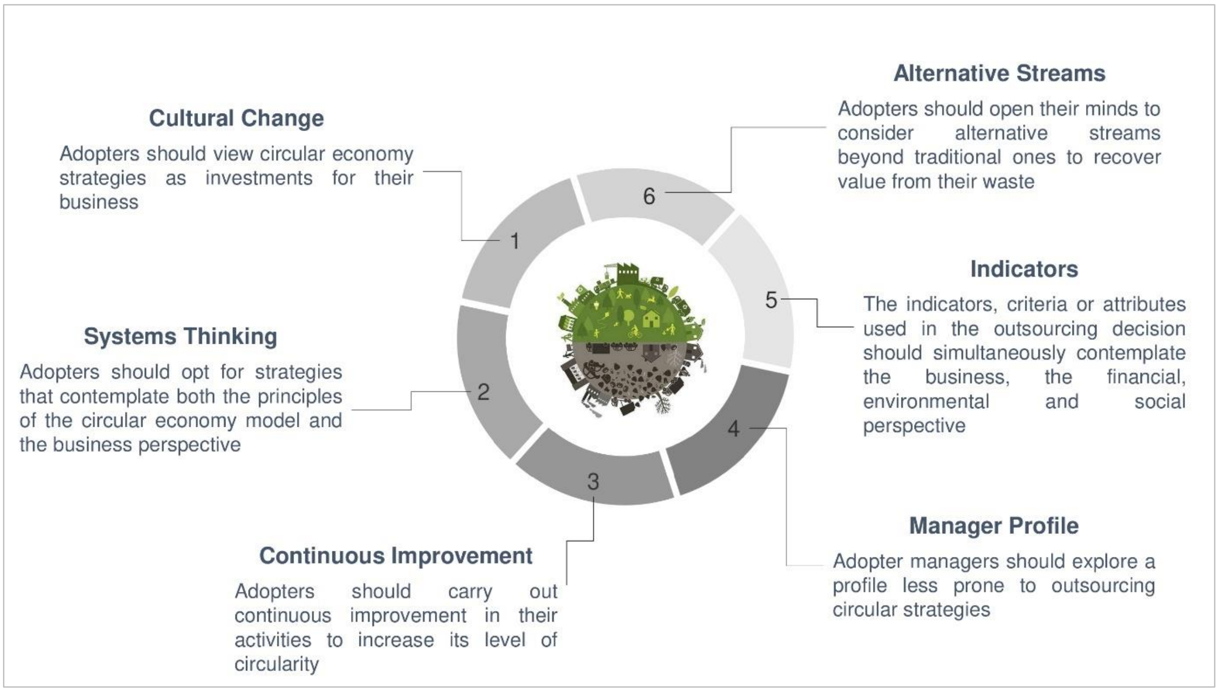
On the other hand, in the criteria defined by DMI, there is a greater concentration of strong links with the CE for the incumbent, since its business has already been based on this perspective. Nevertheless, criteria such as C13- Income generated by new Jobs and C15- Work continuity present opportunities for continuous improvement for the bases of the CE in this CBM in terms of Innovation, Value Optimization and Transparency. These are extremely relevant principles since the impact of the CE is felt not only at the company level, but also at the level of the supply chain of which it is a part and of the town it is in. These results were consistent with the CE approach that the incumbent company manager pointed out in Table 12 (ROSSI et al., 2020).

Regarding the alternatives identified by the manager of the adopter company, note that they establish basic circular strategies that are widely known and practiced in the textile and fashion industry (A10-Garment Care Information and A11-Reverse Logistics). On the other hand, the incumbent manager explored alternatives that reveal new ways to extract value from textile waste (A1-Design for Environment, A13-Upcycling, A15- Donation, A17-Textile Banks) (PARAS et al., 2019).

Finally, the profiles of the classes established by the DMA show a greater propensity to outsource circular alternatives, which may be a reflection of the fact that the adopter company does not have the skills or the necessary structure to carry them out in-house. On the other hand, the profiles of DMI's classes reflect a lower propensity for outsourcing, since in the supply chain assessed there are not many companies that apply the CE model. Thus, the DMI prefers to invest in the necessary skills and structure so as not to abandon the company's mission (DE OLIVEIRA et al., 2021).

Moreover, we can visualize a summary of the insights observed from the comparisons made between the results of CE adopters and incumbents in Figure 18.

Figure 18 - Insights for CE adopters



Source: The Author (2022)

From Figure 18, it is noticeable that the insights for adopters were classified into six points:

- Cultural Change: a cultural change is necessary to CE adopter managers can consider circular economy strategies as investments that will pay off in the long term, not necessarily in cash, but also in strategic gains;
- Systems Thinking: the focus of CE adopter manager should lay in strategies that contemplate both the principles of circular economy and the business perspective to keep them in house and outsource just the ones whose extent is punctual;
- Continuous Improvement: since CE adopters are not willing to implement circular economy at all costs, they should put strategies into practice and keep improving them throughout the time step-by-step so that CE could make part of adopters daily routine;
- Manager Profile: the manager profile should show less willingness to outsource strategies, and this should reflect in the parameters used in the model of analysis, as in their classes;
- Indicators: the indicators, attributes, or criteria used in the outsourcing decision should lean towards environmental, economic, social, and business perspectives to manage better recommendations about what outsource or not to; and
- Alternative Streams: CE adopters managers should not limit their possibilities in the traditional streams to recover value from their waste. Instead, They should explore alternative streams through benchmarking to reduce as much as possible the amount of waste to be disposed of.

Finally, CE adopters may use these insights to make better outsourcing decisions in order to contribute to circular economy deployment in the fashion industry.

4.4 Discussion

To the best of our knowledge, this study is the first to address the issue of outsourcing circular economy strategies in the context of the textile and fashion industry. More specifically, this study carried out assessments of competencies, whether core ones or not, both from a business perspective and to drive the implementation of the circular economy in adopter and incumbent companies.

Initially, the planning and cognitive mapping meetings were useful for exploring deeper layers of the thinking of the managers of adopter and incumbent companies and to identify the approaches that each of them had in relation to the circular economy (SILVA; MORAIS, 2021).

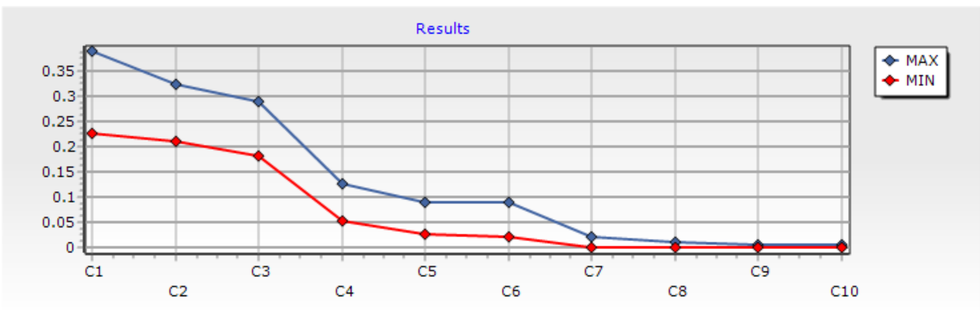
From Table 12, we can note that the adopter has a focus on developing circular strategies that have a result at the operation level while the incumbent shows a more systemic thinking, which generates continuous improvement in the foundations of his business that has already been designed in a circular shape (CHAE; HINESTROZA, 2020).

Moreover, the use of FITradeoff for Sorting Problematic in the proposed model boosted the occurrence of essential elements for real-world problem solving, such as a) the questions presented to the DMs to assess consequences require less cognitive effort to answer, b) it presented graphical tools during the elicitation process which enabled the DMs to analyze and track the partial results in a more intuitive way, and c) the possibility of stopping the elicitation process as soon as they were satisfied with the partial results (KANG et al., 2020).

Furthermore, it is important to mention that according to De Almeida-Filho et al. (2017) for j criteria considered in the decision problem, the traditional Tradeoff procedure would require $3(j-1)$ questions to reach a solution. In the case of DMA, following this logic, 27 questions would be necessary. However, only 16 questions were made to reach a solution. In the case of the DMI, 42 questions would be necessary but only 20 questions were asked. This implies a reduction of 59,25% of questions to DMA and 47,62% to DMI, thus reaffirming the efficiency of FITradeoff to reach a solution more quickly, while maintaining the robust axiomatic structure of the traditional Tradeoff procedure. In real world problems, this reduction of questions is important for the DM, as less time is needed for decision-making, and the time thus saved can be used to plan other issues related to the circular economy in companies (SILVA; MORAIS; URTIGA, 2021).

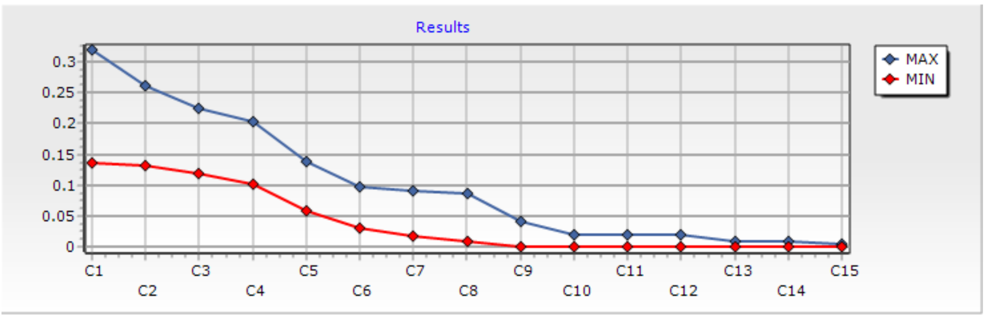
Therefore, a robustness analysis of the results was conducted, as seen in Figure 19-20.

Figure 19 - Robustness analysis for DMA's results



Source: The Author (2022)

Figure 20 - Robustness analysis for DMI's results



Source: The Author (2022)

From Figures 10 and 20, note that the results found for the classification of circular alternatives remain the same for the ranges of maximum and minimum values that each criterion considered in the analysis can assume (FREJ et al., 2019). Consequently, this implies greater security for the DMs regarding the postures that will be adopted towards the circular economy model.

4.5 Synthesis of the Chapter

The fashion industry is one of the industries that most uses natural resources and one of those in the world that most pollutes. This is caused by the excessive and often irrational consumption of textile products. In this context, the circular economy is an alternative approach to improving business processes since it aims to slow down the use of natural resources, and to close and narrow the loop between materials and products. However, most companies in fashion industry operate in the linear model and despite the incentives to transition to a circular model, companies face difficulties in finding strategies that are both circular and do not pose risks to the business. Thus, whether due to the lack of skills or the structure needed, many companies choose to outsourcing circular economy strategies.

However, outsourcing circular decisions are underestimated and arbitrarily taken without any prior analysis of whether these strategies are part of companies' core competencies. Core competencies indicate great potential for competitive advantage and therefore should not be outsourced. Hence, the objective of this chapter was to propose a multi-criteria decision model for sorting circular strategies into core competencies or non-core competencies. Case studies in adopter and incumbent companies of the circular economy were conducted to identify the main differences between the outsourcing decisions of these companies.

The results showed that the adopter focuses on cost-based circular operating strategies. The incumbent, on the other hand, develops circular strategies that can balance environmental, social, and economic issues without harming business continuity.

Moreover, as the fashion industry uses a huge amount of water to put into practice its activities the results of this chapter made us reflect about the issue of economic activities that are developed around hydrographic basins, and more specifically to think about how watershed committees manage to resolve their conflicts about the circular economy strategies to preserve water from pollution, and scarcity. This issue is also a gap in the literature, which is explored in chapter 5.

5 INTEGRATIVE NEGOTIATION MODEL TO DEAL WITH CONFLICTS IN WATERSHED COMMITTEES TO DEFINE CIRCULAR STRATEGIES FOR WATER RESOURCES MANAGEMENT

This chapter puts forward an integrative negotiation model to deal with conflicts in watershed committees (WSC) so as to define circular strategies for water resources management. It is important to mention that the results of this chapter were published in Environment, Development and Sustainability Journal by Silva, Morais and Urtiga (2021).

5.1 Context

Since the 1990s, Brazil has experienced a paradigm shift concerning Water Resources Management (WRM) based on the principles of the Integrated Water Management (IWM) approach (DENG et al., 2016). Thus, federal law No. 9,433 / 1997 established the National Water Resources Plan (NWRP) which reflects IWM principles (PERKINS, 2011). These principles are based on changes that include a decentralized, participatory and integrated approach to planning and managing the decision-making process for protecting water resources and their uses (CARVALHO; MAGRINI, 2006; URTIGA et al., 2016).

Moreover, at the basin level in Brazil, there are public bodies called Watershed Committees (WSCs) which make decisions on WRM. WSCs are formed by representatives of different groups in society, such as representatives from government bodies, water users and civil society, in order to guarantee that WRM decisions are informed by different background expertise and to promote the democratic participation of the whole of society in such decisions. This chapter regards these representatives as decision-makers (DMs).

Despite the efforts of WSC members to involve society's diverse water users to develop sustainable attitudes to minimize the impacts of water scarcity and pollution due to its misuse, many conflicts jeopardize the capacity of WSC to improve the basin health and avoid the problems that the inefficient management of water resources bring (REZENDE et al., 2019; CHURCH et al., 2020).WSCs are responsible for dealing with water conflicts such as (1) water availability for different demands; (2) how to tackle water pollution from industrial and community activities; (3) silting up of the river; (4) anthropical action associated with the urbanization process, especially when it comes to the disorderly occupation of the natural course of the river; (5) water supply network obstruction caused by debris, garbage and sediment; and (6) urban flooding occurrence due to interference caused by debris, garbage, and sediment in the drainage systems of the urban perimeter (ZAREIE et al., 2021; PANHWAR et al., 2020; WEERASOORIYA et al., 2021) However, WSCs in Brazil face difficulties in reaching consensual decisions for WRM since these multiple DMs have different preferences and points of view (SCHRAMM; SCHRAMM, 2018). Therefore, approaches coordinating DMs' different perspectives need to be developed in order to reach a consensual decision (BUTLER; ADAMOWSKI, 2015; WOLDESENBET et al., 2020).

Furthermore, this chapter contributes towards solving conflicts in WSCs with respect to water resources management in a Brazilian context because it sets out a structured, logical, and objective way to negotiate circular strategies and responsibilities between DMs that represent different segments of society from an integrative perspective by the model.

5.2 Proposed model

The model proposed has three different phases, which are called pre-negotiation, negotiation and post-negotiation.

In this sense, the model is integrative because it seeks to create values as a result of negotiating various issues and the integration of different perspectives from the WSC members. To do so, the negotiation process is based on information exchange, and the parties focus on interests that they have in common, not on the positions hitherto adopted by those they represent, which is consistent with IWM principles (KERSTEN, 2001).

We opted to a negotiation model in detriment of a group decision model because in the National Water Resources Plan - federal law No. 9,433 / 1997 , it is stablished that the conflicts over water resources management may be first deal in the hydrographic basin level by the WSCs, whether the consensus is not found at this level, the conflict will be held by the state level, and in extreme cases of non-consensually decisions, the conflict will be arbitrated in the federal level. Consequently, it is not necessarily to resolve the conflict and coming to a decision in the WSC level, and then, this is one important characteristic of negotiations processes.

Furthermore, the model proposed in this chapter fills the gaps that participatory approaches have been shown to have and embedded new features not presented yet in the literature (i.e., the Valued Focused Thinking extended to a multilateral negotiation to support DMs to reach an accommodative environment and find a consensual decision (URTIGA; MORAIS, 2015), the FITradeoff procedure to identify trade-offs among issues in the negotiation (DE ALMEIDA et al., 2016), and the GCM to scoring and bargaining the sets of alternatives identified in the process (BOYCHUK; OVCHINNIKOV, 1973)).

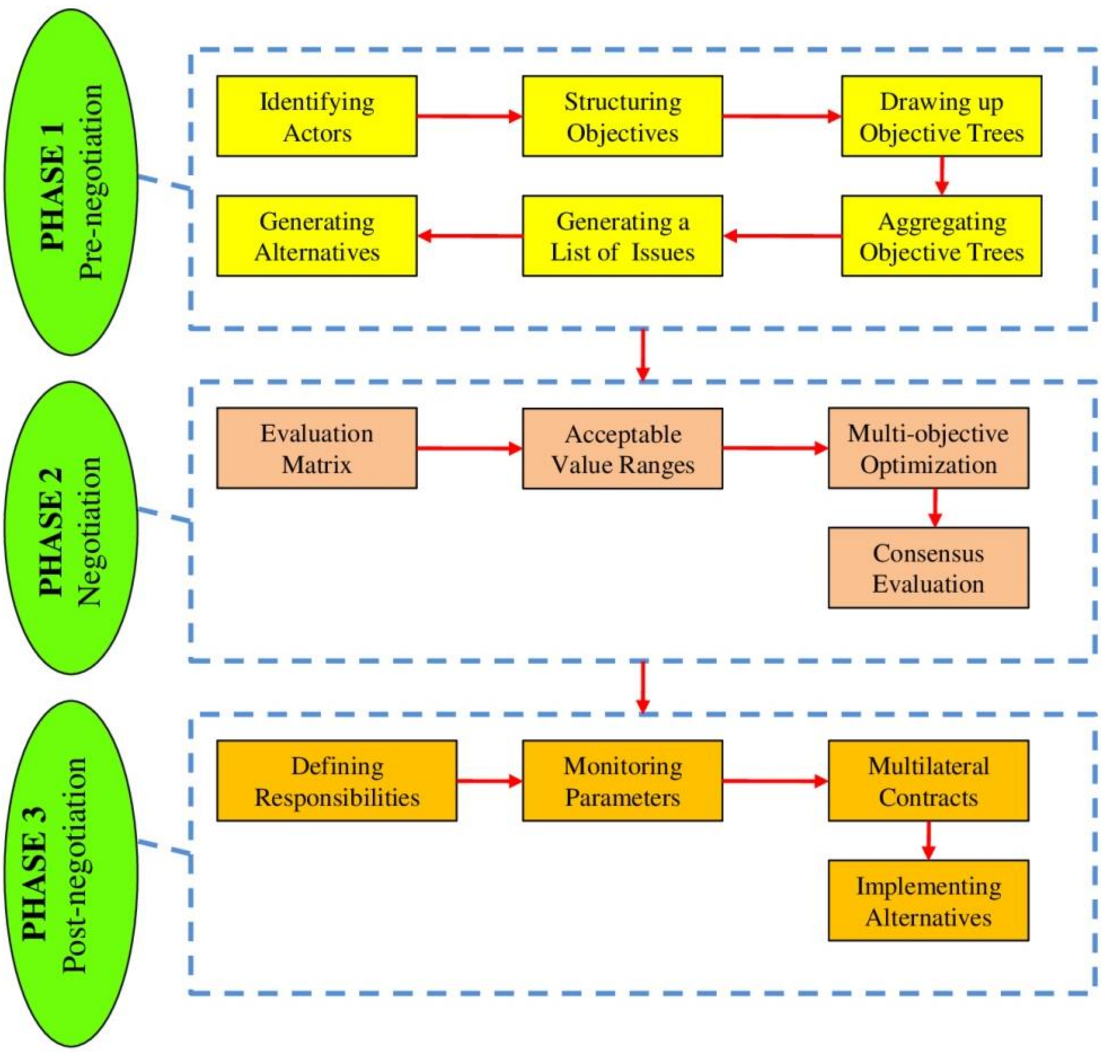
Figure 21 illustrates the design of the steps for each phase of the negotiation model. The following Sections 5.2.1, 5.2.2 and 5.2.3 contain more in-depth information about each phase.

5.2.1 Phase 1 – Pre-negotiation

The first phase is concerned with value creation in the negotiation process. So that the Value Focused Thinking for Group Decision contexts will be used (VFT) (KEENEY, 1992; URTIGA; MORAIS, 2015).

At the end of the pre-negotiation phase, alternatives will be obtained to deal with WRM problems and similarly the issues (attributes) to be negotiated. Subsequently, the negotiation phase may be conducted, as presented in Section 5.2.2.

Figure 21 - Proposed model



Source: The Author (2022)

5.2.2 Phase 2 – Negotiation

The steps proposed for the negotiation phase are as follows:

- Evaluation Matrix**:** The DMs must use the matrix (alternatives v. attributes) to evaluate the alternatives against the attributes.
- Acceptable Value Ranges: Besides, DMs are required to assign the best and worst acceptable values to each attribute based on the evaluation matrix, and they must be as realistic as possible. This step is done confidentially between DMs and the analyst since DMs do not want to let other DMs know about their reserve values which are the worst values they are willing to negotiate. Next, the analyst will identify the zones of possible agreement (ZOPA) for each attribute in order to visualize whether there are possibilities to negotiate. The ZOPA is a value range in which all DMs are liable to negotiate simultaneously. If there is no ZOPA for any issue (attribute), it is recommended that the analyst leads the DMs to a reassessment of those issues.
- Multi-objective Optimization: Therefore, the analyst will formulate the problem with a multi-objective model for each DM because, even when DMs share the same issues, their objectives in each issue may be different. To do so, the analyst will use the alternatives as variable decisions, the attributes as the limited resources to be optimized, while tending in the direction of the DM's preferences, and the information given in the evaluation matrix so as to formulate the model to select a set of alternatives that will be allocated to each DM who will be responsible for implementing it (SILVA; FONTANA, 2021). Furthermore, a relevant issue to be mentioned is the process for eliciting scaling constants (w_j) which is performed by using the Flexible and Interactive Tradeoff Elicitation Procedure (FITradeoff). Moreover, the w_j is used in multi-objective models so as to try to find viable solutions which are mapped into p-dimensional objective function space $F = \{z = f(x) \in \mathfrak{R}^p : x \in X\}$, i.e., a viable solution$x \in X$ is represented by a vector $z = f(x) = (z_1, z_2, \ldots, z_p)$. Thus, a solution $x' \in X$ is efficient, if and only if, there is no other solution $x \in X$ such that $f_k(x) \geq f_k(x') \ \forall k = \{1, \ldots, p\}$, this being a strict inequality for at least one $k,\ f_k(x) \geq f_k(x')$. After that the GCM will be used to aggregate the multi-objective models for each DM in order to solve it using Simplex Method. The CGM was chosen as the technique to be used because it requires less information from the DMs, its resolution process is simple, and it allows sensitivity analysis. Also, using the optimal values found with GCM in the original multi-objective problem results in viable solutions and the bargaining process is enriched by a form of scoring the exchange of offers.

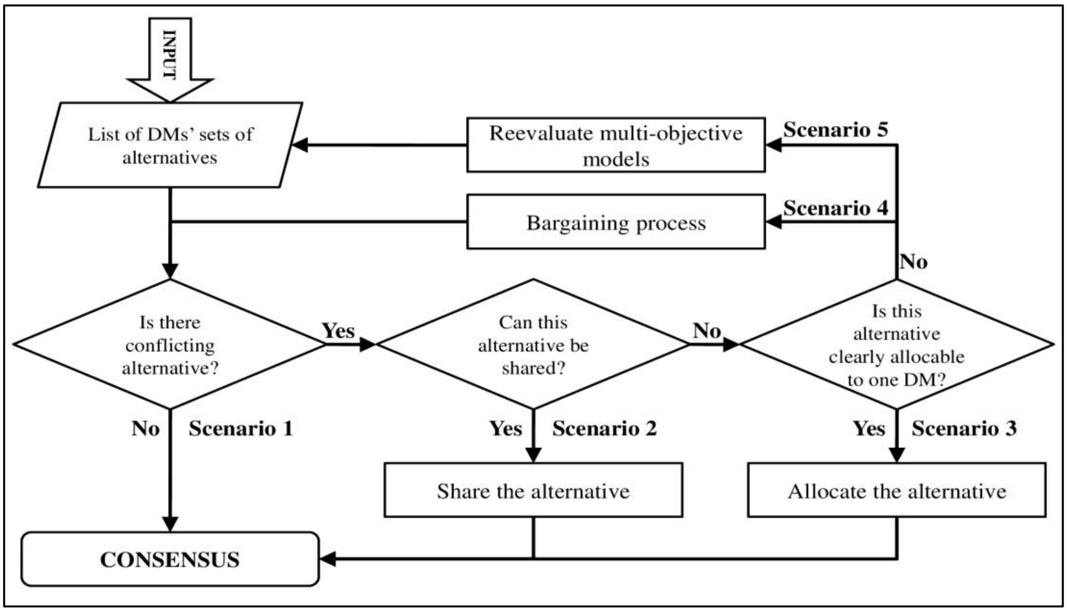
- Consensus Evaluation: After formulating and solving the multi-objective problems individually using GCM, the results will show the alternative sets selected to be allocated to each DM.

  Hence, Figure 22 shows the pathway that DMs should follow to analyze the sets of alternatives selected for each of them through the scenarios proposed so that they may maximize their chances of reaching a consensual decision.

  Moreover, these scenarios cover situations that go from optimistic cases in which there are no conflicts (e.g., scenario 1) to situations in which there are no possibilities to reach a consensual decision due to the current characteristics of the problem (e.g., scenario 5).

  Finally, Figure 22 puts up alongside the possible resolution for the conflictual situations faced. Thus, DMs may reach a consensual decision more objectively.

Figure 22 - Possible scenarios



Source: The Author (2022)

- Scenario 1: In an optimistic view, there are no conflicting alternatives in the sets for each DM. A conflicting alternative is defined as an alternative that is present in more than one set simultaneously. Once consensus is reached, the negotiation phase is closed;
- Scenario 2: There are conflicting alternatives in the DMs' sets. However, the content of these alternatives may be shared among DMs without jeopardizing their implementation;

- Scenario 3: There are conflicting alternatives in the DMs' sets. However, certain alternatives are clearly allocable to only one DM, whether for lack of legal, knowledge or structural reasons, consequently, there is no other DM who can perform these alternatives. Thus, allocation of these alternatives to the DM who can perform them will be considered as the solution to reach consensus in this scenario.
- Scenario 4: There are conflicting alternatives in the sets, but the situation does not fit either in scenario 2 or in scenario 3. Therefore, a bargaining process must begin. As a way of minimizing conflicts, only the DMs whose sets present conflicting alternatives should participate in the bargaining process. For this purpose, the results of FITradeoff procedure will be useful here so that the DMs may verify the tradeoffs, which occur when a given payoff for a set of alternatives is as good as a payoff for a different set of alternatives (DE ALMEIDA et al., 2016). Also, the offers and counteroffers made will be evaluated based on Equation 2.15., which is a form of scoring offers. This allows the DM to analyze whether or not the offer is good for him/her. Another relevant point is that a sensitivity analysis may be conducted based on Equation 2.15 using Simplex method. With this analysis, the DM can have an economic interpretation of the problem to verify possible concessions since the acceptable value ranges assigned to each attribute in the pre-negotiation phase are realistic, but they are not the exact reserve values. The bargaining process is conducted in this way until a consensus is reached;
- Scenario 5: In a pessimistic view, there is no consensus between DMs. Therefore, it is recommended that the multi-objective models be re-evaluated and that the evaluation process be continued until consensus is reached.

When consensus on the sets of alternatives for each DM is reached, the post-negotiation phase may begin.

5.2.3 Phase 3 – Post Negotiation

For the post-negotiation phase, four steps are proposed, as follows:

- Defining Responsibilities: In the Post-negotiation phase, the agreement about responsibilities over the sets of alternatives selected for each DM which are appropriate for water resource management must be formalized. To do so, the National Water Resources Plan established five instruments that can be used: the water resources master plans, the classification of bodies of water into classes of predominant uses, the granting of the right to use water resources, charging for the usage of water and the national information system on water resources (BRAZIL, 1997).

- Monitoring Parameters: The fines and penalties to be applied in case of some DM not complying with the agreement and, respectively the group he/she represents will be based on Art. No 5 of NWRP, which imposes a range of penalties which range from fines to blocking the use of water, depending on the case (BRAZIL, 1997).
- Multilateral Contracts: The multilateral contracts are formalized.
- Implementing Alternatives: Finally, the alternatives may be implemented.

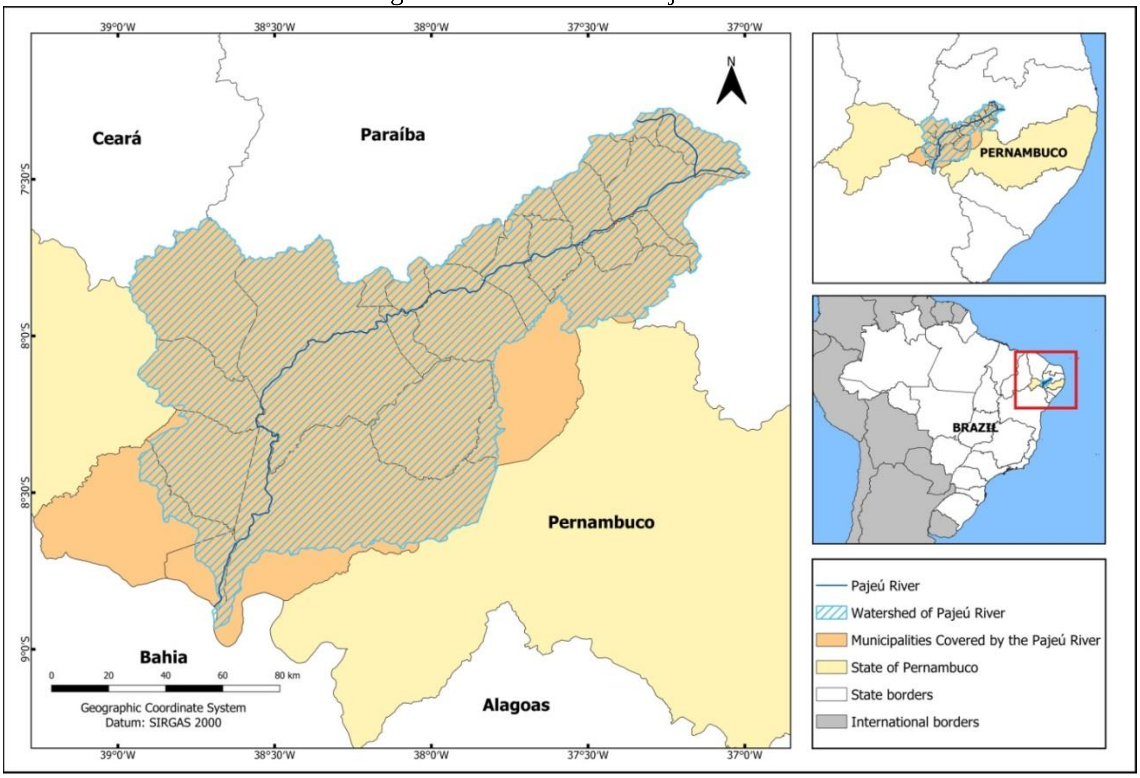
One application of the model is presented in Section 5.3 so as to illustrate how the model works.

5.3 Application

The information used in this case study was gathered by having the authors attend Advisory Council and WSC meetings, interviewing representatives, conducting searches in the literature and by evaluating the minutes of meetings which were made available by the Agency of Water and Climate of Pernambuco (APAC).

The geographical area studied in this chapter was the hydrographic basin of the Pajeú River located in the northeastern region of Brazil, which can be seen in Figure 23. The basin serves several municipalities in the state of Pernambuco and is considered the largest watercourse in this region. The region bathed by the hydrographic basin of the Pajeú River is characterized by the agricultural activities of small producers, industrial activities in the towns, in addition to the use of water for domestic purposes by local communities.

Figure 23 - Watershed of Pajeú River



Source: The Author (2022)

The main problem faced in this basin is the pollution caused by the local community using pesticides in their agricultural activities. They still work with rudimentary techniques and, thus, contaminate the groundwater. Another problem is the pollution caused by industrial activities in towns and by domestic effluents. Consequently, in periods of drought, water availability is even more restricted, which causes conflicts regarding the allocation of water among users. Therefore, there is a need to resolve these conflicts.

To do so, the Pajeú River Watershed Committee is responsible for participatory decision-making about water resource management in the region. Thus, the model proposed in this study was used to identify and allocate responsibilities for the circular economy strategies that must be put into practice in water resource management to minimize conflicts in this region between the members of the committee, who represent government bodies, the population at large, and the private sector.

5.3.1 Phase 1 – Pre-negotiation

In this phase, three representatives were considered as the DMs, one representing the local community (DM1), one representing the local authorities (DM2), and one representing the local industry (DM3). Moreover, for the application of the model, the participation of an analyst is necessary.

For identifying individual objectives, the questioning process proposed by Keeney (1996) is used. As an example, the analyst initially questions DM1 “What do you see as wrong that happens in the Pajeú River basin?” DM1 replies, “The water quality is not fit for consumption due to the pollution caused”. After that, DM1 is asked “What are the main causes of pollution in the basin?”, DM1 replies, “Pollutants are released indiscriminately”. Likewise, the analyst asks DM1 "How did you notice that the water was polluted?" who replies, "From studies conducted by laboratories that found that the levels of pollutants were higher than those allowed by law". Subsequently, DM1 is asked “What could be done to deal with pollution in the basin?”, DM1 replies “As a more severe penalty, industries should be prevented from using water from the basin”, but argued that if that were not possible "The discharge of effluents from industries should undergo pre-treatment and the government should present stricter policies for monitoring water use by industries". This process of questioning continues until the individual tree is finalized.

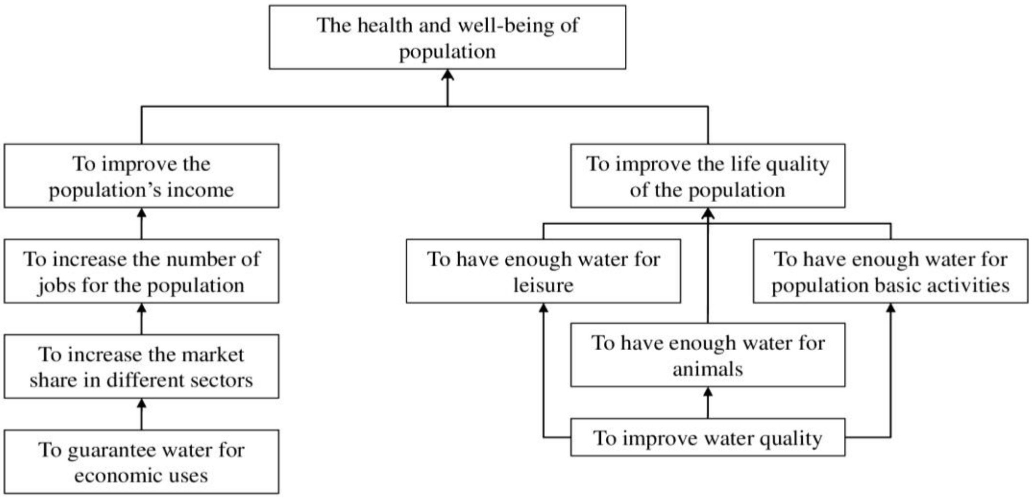
Using these questions is important so that the relationships between fundamental objectives and main objectives can be identified and, consequently, the objective trees of each DM can be drawn up. Furthermore, it is up to the analyst to guide the DMs to identify the objectives and how to hierarchize them into fundamental and main objectives.

Also, the trees drawn up are put into practice with the aid of the analyst. The objective trees for DM1, DM2, and DM3 are shown in Figure 24, Figure 25, and Figure 26, respectively.

For DM1, the most general fundamental objective is the “The health and well-being of the population” while two more detailed fundamental objectives are “To improve the quality of life of the population” and “To improve the income of the population”. For DM1, it is important to have water available for the basic economic activities of the local population and their domestic use, and at least to keep this at current levels. In other words, the income for the population and their quality of life are maintained. The other objectives are considered as main objectives, such as "To have enough water for leisure" as a way to guarantee the most general fundamental objective, the “The health and well-being of the population”.

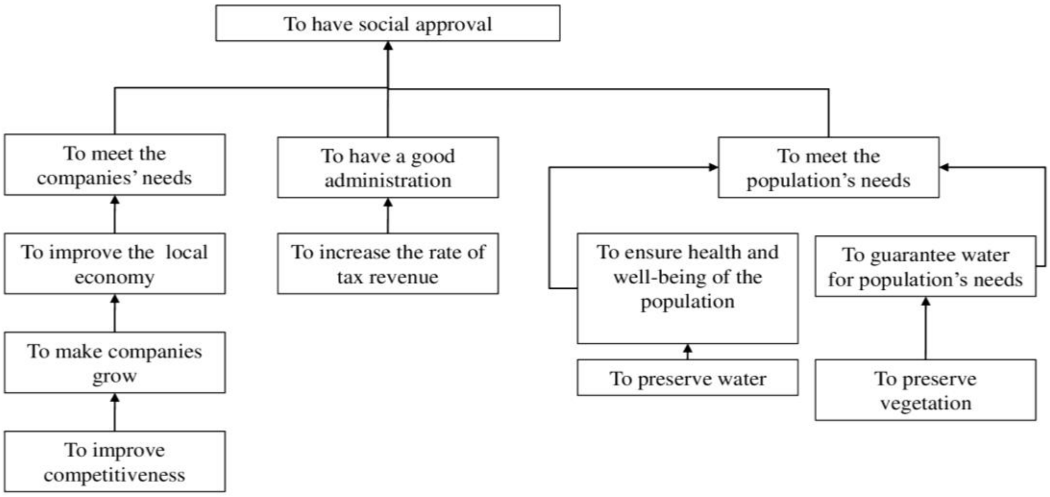
For designing the trees for DM2 and DM3, the same reasoning is followed. Thus, in Figure 24, Figure 25, and Figure 26 from top to bottom, the objectives that are at the top of the tree are the most general fundamental objectives, under which come the fundamental objectives and under these, the more detailed fundamental objectives and, finally, there are the main objectives.

Figure 24 - DM1: Local community tree



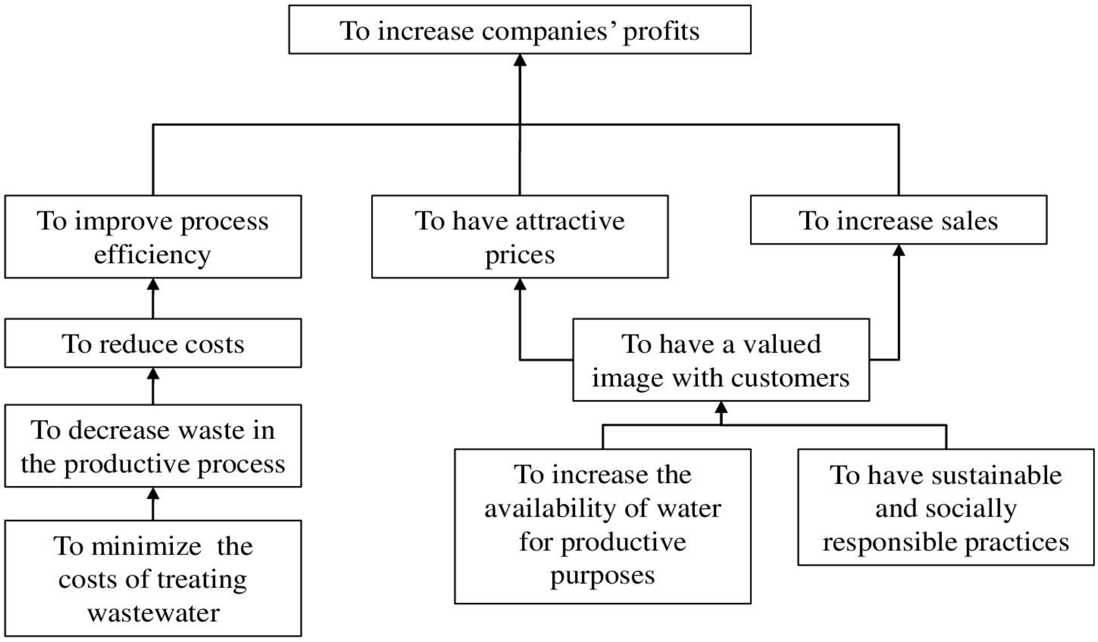
Source: The Author (2022)

Figure 25 - DM2: Local authority tree



Source: The Author (2022)

Figure 26 - DM3: Local industry tree

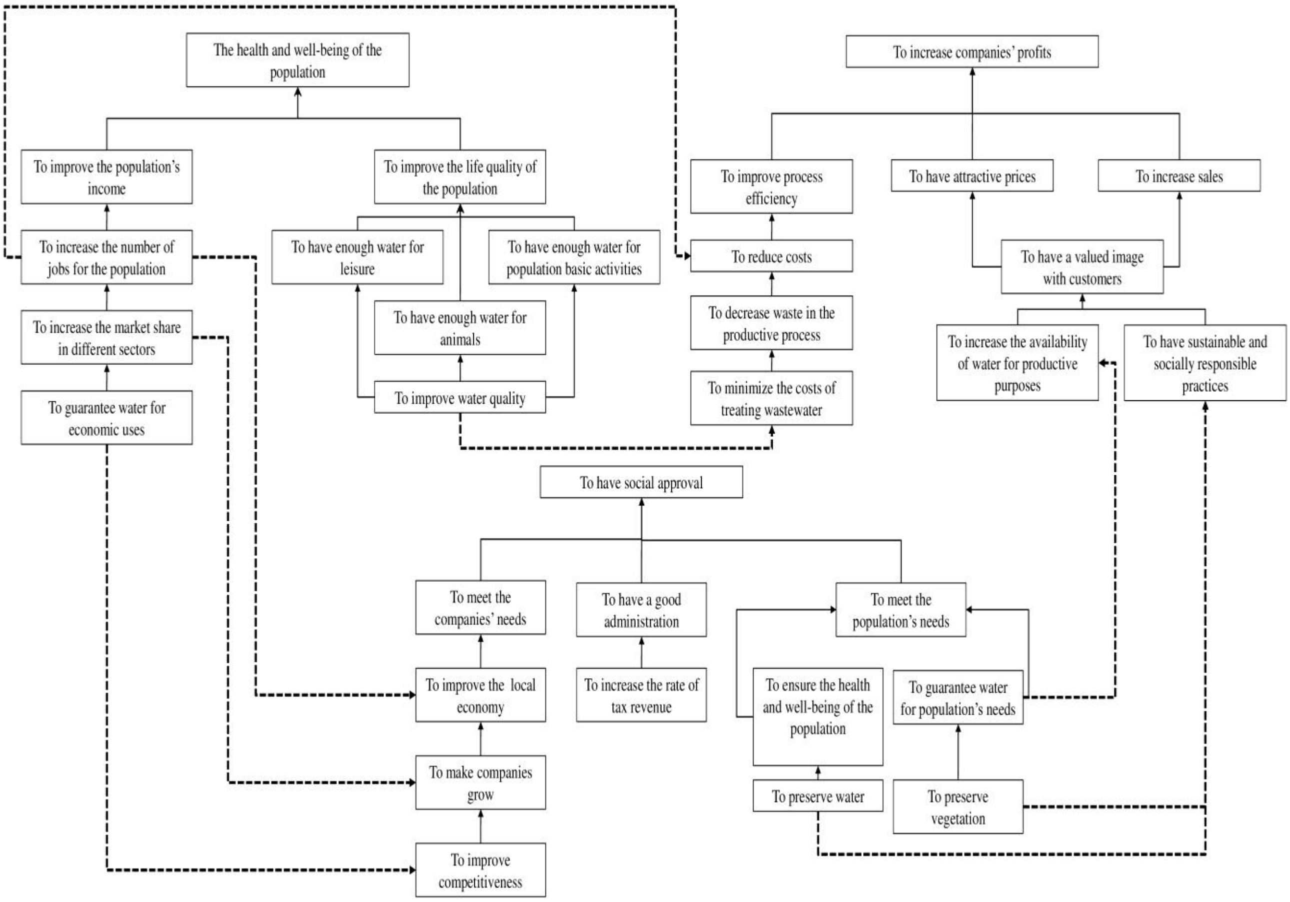


Source: The Author (2022)

Then, the individual trees must be aggregated to obtain the final single tree of the group. To do so, the analyst brings these trees together identifying common values, objectives, and clusters. It was noticed that, for example, the objective "to increase the number of jobs for the population" of DM1 is related to the objective "to improve the local economy" of DM2.

Therefore, these objectives are linked by dotted arrows to show the relationship between them. Hence, an exchange of information and sharing of perspectives take place during the workshops. The analyst has to discuss the single tree with the group so as to make the necessary adjustments prior to finalizing it. The final joint tree of the group is shown in Figure 27.

Figure 27 - Final joint tree



Source: The Author (2022)

Therefore, issues (attributes) to be negotiated in the process are highlighted. For this, the analyst pointed out five issues for the objectives which are presented in Table 21.

Table 21 - Attributes

Attribute	Description	Scale
Costs Incurred (C)	Costs incurred in the implementation of the alternative.	In 10^3 R$
Concentration of Pollutants (P)	Concentration of pollutants present in the implementation of the alternative.	Kg/m^3
Number of new job vacancies generated (J)	Number of new job vacancies generated by the implementation of the alternative.	Nº of jobs
Volume of allocated water (W)	Volume of water allocated for the implementation of the alternative.	m^3
Hectares of cultivated riverside vegetation (V)	Hectares of cultivated riverside vegetation due to the implementation of the alternative.	Hectare

Source: The Author (2022)

Thus, DMs could have different objectives represented by the same issues. For example, the attribute “costs incurred” is related to the objectives “to improve the population’s income” of DM1, “to increase the rate of tax revenue” of DM2 and “to reduce costs” incurred by DM3.

Moreover, in another workshop, the analyst discusses the objectives with the DMs. The objectives are evaluated in cycles of one by one, two by two, and so on until the objectives are collectively and exhaustively evaluated. At each cycle, alternatives are generated to meet the objectives, such that the same alternative could meet more than one objective simultaneously. For example, alternative A1 - public educational campaigns for environmental awareness, is related to the objectives “to increase the availability of water for productive purposes”, “to have enough water for leisure”, “to have enough water for basic activities of the population”. The alternatives generated are summarized in Table 22.

Table 22 - Alternatives

ID	Description
A1	Public educational campaigns for environmental awareness
A2	Pre-treatment of effluents discharged by industries
A3	Sustainable agriculture plan for the local community
A4	Training for the local community to preserve soil and water
A5	Replanting to recover native vegetation in the Basin
A6	Improve waste collection in the basin region
A7	Monitoring agricultural and industrial practices
A8	Collect sediments in the basin and dispose of them in suitable places
A9	Create technical team to guide the use of alternative water sources
A10	Create technical team to guide construction of systems for water reuse
A11	Maintenance in the water distribution channel to reduce waste
A12	Modify the current irrigation system to a drip system
A13	Modify the harvesting system to one that requires less water

Source: The Author (2022)

5.3.2 Phase 2 – Negotiation

In the negotiation phase, the analyst requests the DMs to add detail to their evaluation matrix, which is shown in Table 23. Therefore, the DMs, confidentially with the analyst, assign ranges of acceptable values to each issue (attribute) that they are willing to negotiate based on the evaluation matrix. The ranges of acceptable values for each issue (attribute) and their respective ZOPA are shown in Table 23. Subsequently, the analyst is able to identify a ZOPA for all attributes, i.e., the zone they can negotiate. In case the ZOPA is not identified, the analyst will guide the DMs on re-evaluating the lower and upper limits to check the possibility of making them flexible.

Thereafter, the analyst formulates with each DM the multi-objective optimization models. The general multi-objective optimization model is based on Equation 5.1-5.4.

In Equation 2.12 D_x is the coefficient matrix of the objective functions based on the attributes considered in Table 21 and x are the decision variables, which represent the alternatives of the problem. Equation 2.13 represents the constraints related to the attributes, where e is the maximum value that DM is willing to negotiate. These are also presented in Table 23. Finally, Equation 2.14 uses the FITradeoff method to find the weights, which is put into practice using a decision support system (DSS) available for free download on Fitradeoff.org. The procedure is run with each DM individually. As FITradeoff works with a space of weights we had to support DMs to choose a combination of weights for the criteria in the weight space in which the sum was equal to one. If the sum chosen by the DMs was not equal to one we have to use a procedure to normalize the weights in an adequate scale.

The weights found are also shown in Table 23.

Table 23 - Evaluation matrix

Attribute / Alternative	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)
A1	20	1	50	10000	10
A2	100	50	100	2500	100
A3	30	30	150	1000	150
A4	10	1	20	20000	50
A5	150	20	200	10000	200
A6	120	10	100	50000	90
A7	10	1	70	15000	55
A8	130	10	250	15000	150
A9	30	1	50	70000	30
A10	35	1	50	70000	30
A11	1000	10	300	50000	65
A12	70	5	200	30000	150
A13	80	5	200	30000	150
Acceptable Value Range					
DM1	10 – 200	1 – 42	20 – 615	≥ 71250	10 – 470
DM2	10 – 1470	1 – 54	20 – 1055	≥1000	10 – 660
DM3	10 – 320	1 – 76	20 – 485	≥ 107600	10 – 420
ZOPA	[10 – 200]	[1 – 42]	[20 – 485]	[1000 – 107600[	[10 – 420]
Weight					
	w_C	w_P	w_J	w_W	w_V
DM1	0.3	0.2	0.3	0.1	0.1
DM2	0.1	0.3	0.3	0.2	0.1
DM3	0.4	0.1	0.1	0.3	0.1

Source: The Author (2022)

The direction of optimization of each negotiation issue (attribute) for the DMs is shown in Table 24.

Table 24 - Optimization direction

Attribute	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)
Optimization Direction					
DM1	Min	Min	Max	Max	Max
DM2	Min	Min	Max	Max	Max
DM3	Min	Min	Min	Max	Min

Source: The Author (2022)

The results of individual optimization for each attribute were obtained using the IBM software ILOG CPLEX academic version 12.6.2. These results represent the ideal solutions that DMs should seek to achieve in the negotiation, as they represent efficient solutions and are shown in Table 25.

Table 25 - Individual results for optimizing the attributes

Attribute	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)
Individual Attribute Performance					
DM1	175	36	605	71005	465
DM2	1445	48	1045	240005	655
DM3	320	78	475	107505	400

Source: The Author (2022)

After that Equation 2.15 was used to aggregate these objectives into a single global criterion function. Furthermore, the results obtained with the optimization, after aggregation using Equation 2.15, are shown in Table 26.

Table 26 - Optimization of attributes - individual results after aggregation

Attribute	C (In10^3R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)	G(x)	Set of Alternatives
Individual Attribute Performance							
DM1	200	41	550	72500	410	0,26	A1, A3, A12 and A13.
DM2	1470	54	1040	240000	650	0,13	A1, A4, A5, A6, A7, A8, A9 and A11.
DM3	315	73	470	107500	395	0,46	A1, A2, A5, A7 and A10.

Source: The Author (2022)

Thus, from Table 26, it can be seen that there are conflicts between the sets of alternatives of the DMs about alternatives A1, A5, and A7. From this point on, the analyst evaluates case by case to see which scenarios these conflicts fit into using Figure 22.

Thus, concerning A1, the analyst initially noticed that this alternative fits Scenario 3, where a certain alternative was clearly allocable to DM2 and DM3 since A1 is concerned with public educational campaigns for environmental awareness and may not be conducted by DM1. Therefore, A1 was excluded from the DM1 set of alternatives.

Consequently, A1 also fits Scenario 2, in which the content of this alternative could be shared between DM2 and DM3 without jeopardizing activities. Thus, A1 remained in the DM2 and DM3 alternative sets so that they could share its content.

After that, alternative A7 fit into Scenario 3, where A7 was clearly allocable to DM2 in which the responsibility for monitoring agricultural and industrial practices falls to local authorities. Thus, A7 was excluded from the set of alternatives of the DM3.

Besides, the last conflictual situation concerns A5 which fits Scenario 4 due to the fact that A5 deals with replanting to recover native vegetation in the Basin. In this respect, based on the polluter-pays principle, the local authority argues that industry should be responsible for this alternative. On the other hand, industry representative argued that the pollution caused was due to the economic activity that had been brought to the region, without which the income level of the region could be even worse.

Thus, DM2 and DM3 were in a situation of total conflict with each other. Thus, a bargaining process began, as can be seen in Table 27.

Table 27 - Bargaining process initialization

Attribute	**C (In 10^3 R$)**	**P (Kg/m^3)**	**J (Nº of jobs)**	**W (m^3)**	**V (Hectare)**	$\boldsymbol{G^0(x)}$
Individual Attribute Performance						
DM2	1320	34	840	230000	450	0.097
DM3	155	52	200	82500	140	0.42

Source: The Author (2022)

Initially, DM2 made the first proposal for the bargaining process, which can be seen in Table 28.

The column of $G^1(x)$ means the value of the offer made in this cycle of bargain considering Equation 2.15, the other columns (C, P, J, W and V) show the individual attribute performance for each DM based on the offer made in the cycle. The same reasoning can be followed for Table 29-30.

Table 28 - Cycle 1: DM2 offer

Attribute	**C (In 10^3 R$)**	**P (Kg/m^3)**	**J (Nº of jobs)**	**W (m^3)**	**V (Hectare)**	$\boldsymbol{G^1(x)}$
Individual Attribute Performance						
DM2	1320	34	840	230000	450	0.097
DM3	305	72	400	92500	340	0.45

Source: The Author (2022)

However, DM3 didn’t accept DM2 offer, and DM3 made a counteroffer which can be seen in Table 29.

Table 29 - Cycle 2: DM3 counteroffer

Attribute	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)	$G^2(x)$
Individual Attribute Performance						
DM2	1470	54	1040	240000	650	0,13
DM3	155	52	200	82500	140	0,42

Source: The Author (2022)

It took 3 cycles of proposals for the DMs to reach an agreement as can be seen in Table 30.

Table 30 - Cycle 3: DM2 counteroffer

Attribute	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)	$G^3(x)$
Individual Attribute Performance						
DM2	1395	44	1040	240000	650	0,11
DM3	230	62	300	87500	240	0,44

Source: The Author (2022)

The compromise solution between the DMs is presented in Table 31 and shows the set of alternatives under the responsibility of each DM as well as the values reached for each issue negotiated in the process.

Table 31 - Final agreement

Attribute	C (In 10^3 R$)	P (Kg/m^3)	J (Nº of jobs)	W (m^3)	V (Hectare)	G(x)	Set of Alternatives
Individual Attribute Performance							
DM1	180	40	500	62500	400	0,24	A3, A12 and A13.
DM2	1395	44	1040	240000	650	0,11	A1, A4, A5, A6, A7, A8, A9 and A11.
DM3	230	62	300	87500	240	0,44	A1, A2, A5, and A10.

Source: The Author (2022)

Having obtained these results, the post-negotiation phase can begin and the following section explains how this is done.

5.3.3 Phase 3 – Post-negotiation

In the post-negotiation phase, the water resources master plan was used as an instrument based on which an agreement was reached between the DMs which they both signed. This plan contains the responsibilities of each DM for the alternatives, which are shown in Table 31.

Monthly monitoring and control measures were also defined for implementing alternatives.

In case of non-compliance, the segments represented by the DMs are subject to fines in the amount of 10% per day over the value of alternatives that have not been implemented. For extreme cases of non-compliance with the agreement or due to the non-use of water for a period of 3 years, the right to use water will be revoked.

Having agreed to this, alternatives can be implemented.

5.4 Discussion

Firstly, in the pre-negotiation phase, performing the initial stages of the VFT individually with each DM is essential to avoid the bias that would arise from omitting objectives. A possible cause of this could be the imposition of certain lines of reasoning by DMs with strong personalities (CUNHA; MORAIS, 2017).

Moreover, in the workshop, the DMs are able to deal with the asymmetry of power/knowledge that is a critical factor in participatory approaches (MURO; JEFFREY, 2008) since the DMs become aware of the importance of the perspectives of other segments interested in the use of water and can better assess the impact of non-cooperation on society (BARNAUD et al., 2013; LYU et al., 2020).Thus, this adaptation of VFT to the negotiation context is also important for the process because it helps the DMs to identify relevant aspects, objectives, attributes, the complexities inherent in the environment and common points of view, by sharing information and experiences. This creates a more friendly and reliable environment and increases the possibilities of reaching a better compromise solution (DUCROT et al., 2014).

In the negotiation phase, FITradeoff uses a DSS that has visualization tools that help DMs assess the consequences using strict preferences throughout less questions than in the traditional Tradeoff procedure, which is less cognitively demanding for DMs. Consequently, the process may result in fewer inconsistencies (MENDES et al., 2020). Moreover, using the Global Criterion Method to deal with the multi-attribute optimization models of DMs raises some interesting points. In the first place, the low level of complexity of the method fits using it in the context of multilateral conflict resolution with negotiations. Next, the information that the analyst requires to formulate the models requires the DMs to make less cognitive effort, which may have an impact on reducing inconsistencies in the negotiation process. Finally, the DMs considered that the quality of the compromise solution reached during the bargaining process was satisfactory since the performances for the attributes in the compromise solution were very close to the values of the ideal solution (MAKAROUNI et al., 2016). It is also important to note that the GCM was a way found to score the proposals made in the bargaining process when the conflict scenarios were verified in relation to the sets of alternatives of each DM. Hence, it was possible to trace the bargaining path taken until a compromise solution was reached. This way of highlighting the proposals and displaying them gives DMs the support they need to observe and analyze how close they would be to meeting their preferences, depending on the proposal selected (ROSELLI et al., 2019).

Another important point to mention about the bargaining process for real situations such as when conflicts arise for managing water resources is that the DMs are concerned not only with the roles and responsibilities that they themselves obtain but also with those that the other DMs will obtain (FENG et al., 2020). In this respect, the attitude developed by the DMs during the bargaining process, of whether or not they are more likely to make concessions, will depend on the way they feel that they are being treated. Furthermore, as in the pre-negotiation phase, a friendly environment is created by understanding the multiple perspectives of the DMs, and this makes them were more likely to collaborate with each other. This has a direct influence on the concessions made and consequently entails that it is likely that it will take less time to reach a compromise solution (HONEY-ROSÉS et al., 2020).

5.5 Synthesis of the chapter

An integrative negotiation model is proposed so as to watershed committees to deal with conflicts over circular strategies to preserve water resources from pollution and scarcity such as conscious use of water and soil, best agricultural practices, and recovery of riparian forest, which impact the hydrological cycle and the basin health.

The proposed model consists of three phases: pre-negotiation, negotiation, and post-negotiation. In the pre-negotiation phase, an approach that extends Value Focused Thinking (VFT) to situations that involve a group is applied to provide WSC members (representatives from different segments of society) with the opportunity to think creatively about their values, objectives, attributes, and also to generate alternatives that integrate their perspectives and encourage collaboration for water efficient and sustainable use.

In the negotiation phase, multi-objective optimization models and the Global Criterion Method (GCM) are used so as to select and allocate sets of alternatives among the representatives of the WSC. Also, GCM is proposed as a new way of scoring proposals in the bargaining process.

Finally, in the post-negotiation phase, the agreement on implementing alternatives is formalized. A realistic case study based on the WSC of the Pajeú River in northeastern Brazil is presented to illustrate the use of the proposed model and the results show the compromise solution among the segments. This study advances the understanding of negotiating circular strategies to water resources preservation from a proactive perspective and also enhances users' capabilities for utilizing this model for conflict resolution in other hydrographic basins worldwide.

6 FINAL REMARKS AND FUTURE STUDIES

This chapter presents the main conclusions, implications for theory and practice, and suggestions for future studies. The results showed a satisfactory response to the objectives outlined in the introduction.

6.1 Conclusions

In general, the thesis succeeded in designing and implementing decision-making and negotiation models to promote a paradigm-shift from the linear economy model to the circular economy model. Furthermore, we could observe that the circular economy is an umbrella topic and can be put into practice in diverse contexts as this thesis has showed.

The proposed models for group decision-making, individual decision-making, and negotiation for conflict resolution were shown to be important approaches in understanding, seeking, defining, and evaluating circular strategies that can be used in the diverse contexts that the models were implemented. Moreover, these strategies can be the means to keep the goods in the supply chain channel until no more value may be recuperated.

Furthermore, the proposed models do not impose a solution on the DMs for migrating to a circular economy, but presents means, methods, and tools necessary for reflection for building a collaborative environment, based on information sharing, on understanding different perspectives and on creating trust between those involved. Thus, the application of the models in the case studies presented can be extended to other contexts, as an alternative way of complying with circular economy, and can be implemented in other developing countries that want to make the transition to a circular model.

Although the chapters bring proposals for different problems, they complement each other in circular economy context. First, we proposed a decentralized approach to manage solid waste in Brazil in the packaging sector.

Then, once the responsibilities are allocated to each segment they must be put into practice. In this sense, regarding companies' responsibilities they can opt to make it in-house or outsource it to a supplier.

Next, this is the first study to consider conflict resolution about identification and allocation of circular strategies to manage water resources in hydrographic basins by watershed committees.

Additionally, it is worth mentioning that when it comes to the group decision and negotiation models proposed, the segments did not work together before to lean towards the circular economy because there was no win-win view of the problems addressed. In this sense, these segments may achieve this view through the approaches proposed in this thesis as they are put into an experimenting-learning process to introduce circular solutions in their activities.

From this point on, while segments that want to migrate to a circular economy must rethink their structures to suit these new circular solutions, new circular businesses models may emerge. At the same time, new stakeholders also appear, thereby being necessary to integrate them into the business model so they may work.

In relation to the individual decision-making model, it proved to be and important approach to support adopters and incumbents companies to asses their competencies by using tools that provided understanding and the means to search for and classify those circular strategies that companies should focus efforts on to develop in-house and those that should be outsourced in order to eliminate the paradoxical tensions between the survival of the business and the transition to a circular economy.

In addition to the benefits presented by the sustainable development in a circular perspective on implementing the actions, the models had some other implications. For the private sector, in the production process makes it possible to reduce the purchase of new material, assists in the process of integrating and coordinating the direct and reverse flows of operations, thereby improving their management. Furthermore, it helps to improve the company's corporate image by the adoption of environmentally friendly actions, which will have both an environmental and a long-term economic impact.

The government benefits directly from the reduction of waste to be collected by the public urban cleaning service and from the reduction of overcrowding of landfills, which directly results in lower pollution rates. Moreover, waste-pickers benefit mainly by the formalization of their profession and generating income, factors that imply a reduction in social vulnerability, thereby coping with the circular economy social perspective.

Also, this thesis contributes to the enrichment of the literature by evaluating the issues decision-making about the migration to a circular economy in developing countries. It encompasses issues that range from the stage of understanding this complex issue to implementing the circular strategies itself. Furthermore, this thesis demonstrates through the participation of different segments that the transition to a circular economy is actually a collaboration between many segments in different levels, and by doing this, they can find circular solutions that cope with their necessities being environmentally correctly without jeopardize their business.

Finally, it is important to mention that although the thesis focuses on packaging textile and fashion industry, and water resources management the proposed models can be used to assess circular strategies from other sectors of industry regardless its size or core business.

6.2 Implications for Theory and Practice

In packaging sector, the actions defined to the transition to a circular economy model regarding solid waste management in Brazil involve a group decision process in which we noticed some implications for theory and practice.

For companies, the proposed approach revealed that there are strategies such as recycling, reuse, treatment of waste that can significantly reduce the amount of waste generated in the entire production chain. These strategies require investments that have an impact on efficiency throughout the manufacturing process, from the product design stage, when choosing the most sustainable raw materials that can lead to the complete reuse of solid waste, being also essential in product design to facilitate its disassembly and reintroduction to the productive-business cycles or its environmentally appropriate final disposition (PEREIRA et al., 2019). It is worth noting that these implications are not limited to manufacturing, but we may also extend it to the services sector. In this way, the actions taken by DMs are aligned with the circular economy goals since it has a regenerative perspective and intends to recover as much value as possible from the goods produced (JABBOUR et al, 2019).

In this respect, the market demands professionals with knowledge capable of harmonizing the production process with circular economy practices. Thus, for scholars, the results of this study call attention to the necessity to develop innovative methods and technologies that replace those currently practiced in the linear model but that are also suitable for developing countries and their particularities (MOKTADIR et al., 2019; JABBOUR et al., 2020a).

Moreover, the approach supported a developing country like Brazil to plan guidelines strategically and tactically for the packaging sector to migrate to a circular economy model. This result implies that policymakers from developing countries can use the approach to plan guidelines for other productive sectors as well, encouraging environmentally conscious attitudes such as the implementation of standards (e.g., ISO 14000), the use of cleaner energy, conscientious consumption of water, in addition to strengthening compliance with the environmental regulations that already exist. However, when elaborating on new regulations, policymakers must consider the flexibility of companies to manage their businesses, as long as they change their production systems to decrease the negative impact on the environment (SEHNEM et al, 2019; GEDAM et al., 2021). This scenario is different in developed countries such as the European Union, in which policymakers already have a sustainable agenda with guidelines until 2030.

Additionally, other actions defined by DMs called for the development of school materials and environmental awareness campaigns to spread in various communication media to reach all age groups of potential consumers, thus placing them at the center of the transition to the circular economy. This result implies that it is necessary to promote environmental awareness education throughout people's lifetime, as well as providing direct information whenever possible about sustainable consumption options, thereby focusing more on the human side of circular economy (JABBOUR et al, 2019; SCHULTZ et al., 2021).

Last but not least, the gradual measures to implement actions defined in the sectoral agreement phase show that redimensioning excessive consumption of the natural resource will take time. This redimensioning will reach adequate levels of effectiveness for the circular economy when there is a cultural change of all segments of society based on trust and cooperation with concrete everyday actions, which will effectively transcend the linear model, and form a pathway to a circular economy model (DE OLIVEIRA et al., 2019; JABBOUT et al. 2020b; STUMPF et al., 2021).

In textile and fashion sector, in addition to the issues already presented throughout the text, this study also presented concrete implications for theory and practice. From this perspective, by analyzing the results, it could be observed that the transition to the circular economy concerns any type of business, regardless of its size and/or main activity. However, small and medium-sized businesses tend to have greater difficulty in aligning themselves with the objectives of the circular economy. Thus, for scholars, this study draws attention to the need to systematize knowledge of the circular economy by providing strategic guides on how CE principles can be aligned in practice by business.

Thus, for companies, the study revealed that the transition to the circular economy will require organizations to fundamentally rethink their activities at the micro, meso and macro levels. For, activities that were once considered non-core competencies, such as repair and reverse logistics, can now play core competence roles in business development and, consequently, generate value through the CE. In time, by comparing the strategies identified for adopters and incumbents, what could be visualized were many alternative streams (i.e., donation, textile banks, upcycling, downcycling, design for the environment) for the management of textile waste that is beyond the traditional (i.e., recycling and reuse) depending on the type of waste and the characteristics it presents at the time of collection. Thus, companies must consider these alternative channels when designing their value chain and the environmentally appropriate way in which they will dispose of their waste.

At the same time, it was also noted that the results for local supply chains are still underestimated regarding the relationship between their territorial roots and the way in which they interact and collaborate with other companies that are components of the supply chain in order to close the loops between materials and production in the local value chain generated by the circular economy. Thus, these questions invite policymakers to develop socio-technical regulations that facilitate the transition to the CE in local supply chains (Braz and De Mello, 2022).

Finally, for society, studies have shown that a paradigm shift is needed in relation to the unrestrained consumption of textile products, in order to prolong the life cycle of the garments and not to make them discardable at each new season or fashion trend.

In the case of water resources management in Brazil, by the analysis of the circular strategies defined in the proposed negotiation model we noticed some implications for theory and practice.

For industry, the strategies such as “Pre-treatment of effluents discharged by industries” revealed that there exist ways of significantly reduce pollution levels in the river basin. Consequently, it calls industry to rethink its entire production process and to make an investment that will increase efficiency in sustainability to the whole value chain (i.e., from the supplier choice stage, the product design when using more sustainable raw materials, the conscientious use of water, to the environmentally friendly disposal of products at the end of its life cycle). Thus, it will decrease the problems in the availability of water resources to other users.

In this respect, the results of this study demand from scholars the development of innovative methods of production and technologies to prevent water pollution that replace those current practices in the industry so the professionals can harmonize the sustainable development in the river basin region with the knowledge that came from research.

Besides, it is important to mention that the government instruments to water resources management should *per si* be effective to preserve watershed from pollution and scarcity. However, the proposed model supported the government in the development of strategical and tactical guidelines to users dealing with the environmental preservation of soil and water (e.g., Sustainable agriculture plan for the local community and monitoring agricultural and industrial practices). Moreover, this result implies that when elaborating on new regulations, policymakers must consider the particularities of the local community and industry to give them the flexibility to manage their water use, as long as they make changes to transitioning to a circular economy and to decrease the negative impact on the river basin.

Finally, this study contributes to enriching the literature on conflict resolution with respect to the management of water resources. We hope that academics and practitioners in this area will consider that it is a useful and helpful starting point for their endeavors to make further advances in circular economy to water resources management.

6.3 Future Studies

The limitations faced in this thesis are at the same time the suggestions for future studies.

In packaging sector, it was noticed that additional studies based on questionnaires with qualitative and quantitative information would be of great value in assessing consumers' perceptions of established actions, which could strengthen the democratic process of group decision-making about circular economy strategies deployment.

In textile and fashion sector, it was observed that additional studies are needed to develop a decision support system that automates the proposed model and is made available on a web-based platform to support companies from different sectors to carry out the evaluation of their competencies, to take outsourcing circular economy decisions and, finally, to select suppliers that adequately meet CE principles. Moreover, it is also necessary to develop indicators or maturity models to assess companies' improvements over time in terms of level of circularity. These indicators or maturity models can be a guide for companies to observe where they are positioned regarding CE and how much effort they must do to reach high levels of circularity.

Finally, regarding water resources management, as future studies, we suggest that synergies should be included in the multi-objective models to facilitate allocating alternatives equitably between the different interested parties and to promote a reduction in conflict scenarios that may arise in the negotiation process.

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