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Identifying Priorities through the Problem Structuring Method to Reduce the Dependencies on Ecosystem Services in Electricity Distribution

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Abstract: Electricity distribution is a fundamental activity for society. However, mitigating actions on risks and dependencies of this activity still need to be discovered concerning Ecosystem Services (ES). This fact can negatively influence its prosperity, especially in the long term. Within this context, this paper aims to identify actions that mitigate the risks and dependencies on ES associated with a company in the electricity sector in Brazil that performs electricity distribution services. The identification was based on the collection, analysis, and interpretation of stakeholders' perceptions of the activity through an adaptation of the Strategic Options Development and Analysis (SODA) problem structuring method. As a result, a structured vision of actions that mitigate ES risks and dependencies of electric power distribution, enabling management focused on the longevity of both the ES and the economic activity.

Keywords: Ecosystem Services; Energy; Risk; Dependency; Problem Structuring.

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1. Introduction

Electricity distribution is a fundamental economic activity for society. However, even though it has a direct or indirect relationship with several ecosystem services (ES), companies that perform this type of activity need to have more clarity on what kind of actions mitigate the risks and dependencies of their business concerning ES.

In the business environment, adopting a management approach that considers the dependence of its activities on the Environment is relatively recent. For many years, the predominant approaches for dealing with sustainability in the business sector were Eco-efficiency (THE WORLD BUSINESS COUNCIL FOR SUSTAINABLE DEVELOPMENT, 2000) and the Triple Bottom Line (TBL) (ELKINGTON, 1993). The latter has significantly influenced socio-environmental accounting and management (RAMBAUD; RICHARD, 2015). However, such approaches do not bring with them the notion of dependence of economic activities on the Environment, given their characteristics associated with continuous economic growth guidelines (COSTANZA; DALY, 1992; LAMBERTON, 2005) and focused on impacts on the social, environmental and economic dimensions (ELKINGTON, 1993).

In recent years, however, a shift in the business sector's approach to sustainability has been observed. This change results from the emergence of initiatives that consider not only the impacts of organizations on the Environment and society but also their dependence on and risks to the Environment.

In 2008, the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WDCSD) launched the Corporate Ecosystem Services Review and a framework highlighting the importance of recognizing, mapping, and managing the Ecosystem Services impacted by and dependent on companies. In 2011, the Sustainability Accounting Standards Board (SASB) introduced standards for reporting information considering financial risks arising from environmental and social variables. In 2013, the International Integrated Reporting Council (IIRC) launched the integrated reporting framework, presenting natural capital as the most important and on which the business model and other capitals are built. In 2015, the Task Force on Climate-Related Financial Disclosures (TCFD) emerged, aiming to make public the financial risks to companies from climate change. In 2015, the Natural Capital Coalition launched the Natural Capital Protocol, which includes guidelines to identify, measure, and value impacts and dependencies on natural capital.

Two main aspects emerge from the scenario described above. The first is the involvement of private sector companies in the initiatives mentioned above. Furthermore, the second is the understanding that the performance of organizations (and their financial success) depends directly on the Environment and its balance.

In this sense, a better understanding of the dependencies and risks related to Ecosystem Services and actions that mitigate them is fundamental, not only for conserving the Environment but also for the generation of value for organizations. A reflection of this is the inclusion of issues related to dependence and impacts on SE for companies listed in the São Paulo Stock Exchange's Corporate Sustainability Index in 2018.

The emergence of this theme, in the context of corporate sustainability, as well as the distribution of electricity, as a fundamental economic activity, underlies the objective of this work, which is to identify actions that mitigate the risks and dependencies concerning SE associated with a company in the energy sector in Brazil that performs the service of energy distribution.

The uninterrupted electricity distribution is directly dependent on some Ecosystem Services since a large part of the supply interruptions is associated with extreme weather events. Thus, maintaining the quality and stability of Ecosystem Services[1] such as those regulating the hydrological cycle and water flow and the chemical composition of the atmosphere and oceans (global climate), are fundamental to the operation and directly impact a company's performance. This is just one example of the relationship between the activity of electricity distribution and Ecosystem Services, which is not only one of dependence but can also lead to risks to their integrity through adverse impacts on the Environment since the activity usually implies the generation of waste and suppression of vegetation.

Thus, identifying actions that mitigate the risks and dependencies concerning ES would allow subsidizing decision-making processes related to the activity of energy distribution, increasing the assertiveness of decisions that make environmental conservation and the generation of economic value compatible.

Next, on the Theoretical Basis, we present some definitions of ecosystem services, characteristics of the energy distribution company (object of study), as well as some aspects related to the Strategic Options Development and Analysis (SODA) problem structuring method, on which the methodology of this work was based. The methodology also presents the other procedures adopted, including the software used. Next, Results, Discussion, and Conclusions are presented.

2. Theoretical Foundation

This item presents the three elements essential to understanding the work: what are Ecosystem Services, the activity of electricity distribution, and the SODA (Strategic Options Development and Analysis) method adopted in the analysis performed.

2.1 Ecosystem Services

Ecosystem functions refer to the habitat, biological or system properties, and processes of ecosystems. The benefits that human populations derive directly or indirectly from ecosystem functions are through ecosystem goods and services. For simplicity, ecosystem goods and services are referred to as ecosystem services (COSTANZA et al., 1997; DE GROOT et al, 2002; MEA, 2005).

1 - The two ecosystem services cited as examples follows the nomenclature established by CICES (Common International Classification of Ecosystem Services), available at: https://cices.eu/

For Muradian et al. (2010), ecosystem services deal exclusively with the human benefits derived from natural ecosystems, and ecosystem services designate the environmental benefits resulting from intentional interventions by society in ecosystem dynamics, such as human activities for the maintenance or restoration of ecosystem components.

The concept of Ecosystem Services has been discussed by several authors, who have addressed, for example, aspects such as definition and classification. The concept of Ecosystem Services is related to that of Ecosystem Functions to the extent that Ecosystem Functions correspond to ecological processes and structures of nature that generate Ecosystem Services (DE GROOT; WILSON; BOUMANS, 2002). According to Daly and Farley (2004) Ecosystem Services are the ecosystem functions that have value and utility to humans, generated from emerging properties resulting from the interaction of elements and structures in complex ecological systems. Thus, some ecosystem services that are currently classified by the Millennium Ecosystem Assessment (MEA, 2005) as supporting are considered by these authors as ecosystem functions. The Millennium Ecosystem Assessment (MEA) considers ecosystem services as the benefits derived from ecosystems and categorizes them into four groups: provisioning services, regulating services, cultural services, and supporting services. More information on each service can be found in MEA (2005).

International initiatives, such as The Economics of Ecosystems and Biodiversity - TEEB (http://www.teebweb.org/), The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services - IPBES (http://www.ipbes.net/) and Ecosystem Services Partnership - ESP (http://www.es-partnership.org), brought concepts and publications that highlighted the importance of knowledge and discussion about ecosystem services, reinforcing those conserved and well-managed ecosystems such as forests, mangroves, marine ecosystems, among others, play a key role in providing these services.

These definitions emphasize the human contribution to the maintenance or expansion of the flow of goods and ecosystem services since the result of human actions can affect their flow positively or negatively (SIMÕES; ANDRADE, 2013). Thus, it is considered the distinction between the concepts of ecosystem services and environmental services for research purposes and application in society to formulate public policies (PARRON et al., 2015).

In order to standardize the understanding of these concepts, we adopt the definition of "ecosystem services" given by De Groot et al. (2002), for which ecosystem services would be the human appropriation of the benefits of ecosystem functions, defined by De Groot (1992) as the capacity of natural processes to provide goods and services that directly or indirectly meet human needs. In summary, when dealing with "ecosystem services," the benefits to human activity arising from natural capital[2] functions will be considered.

This distinction is essential because the popularization of "environmental services" and "ecosystem services" has brought many interpretations that often obscure their

2 - Natural Capital is a concept developed by ecological economists in the late 1980s (EKINS; FOLKE; DE GROOT, 2003a; PELENC and BALLET, 2015) and refers to the ways in which the environment produces and supports most aspects of human existence (DALY, 1997).

original meaning. On the other hand, propositions with a certain degree of antagonism or generalization make it challenging to adopt conceptual clippings.

Some of the services provided favor society as a whole, such as the protection of genetic resources, scenic beauty, protection of endemic species, and climate change mitigation (BRASIL, 2012). On the other hand, the combined effects of population growth, economic development, and greater global integration result in deforestation, land degradation, and pollution of air and water bodies. In this sense, understanding the relationship between economic activities and ecosystem services and the problems arising is fundamental to maintaining the quality and integrity of ecosystem services and the economic activity itself.

2.2 Characteristics of the Electricity Distribution Activity and of the Company

Electricity distribution is characterized as the segment of the electricity sector dedicated to lowering the voltage coming from the transmission system, connecting generating plants, and supplying electricity to the end consumer (ANEEL, 2015).

The power distribution system in Brazil is composed of the electrical grid and a set of electrical facilities and equipment. This equipment operates at three voltage levels: high voltage (greater than 69 kV and less than 230 kV), medium voltage (greater than 1 kV and less than 69 kV), and low voltage (equal to or less than 1 kV) (ANEEL, 2015).

The power distribution company in question is in the state of São Paulo, Brazil, in the Alto Tietê and Vale do Paraíba region, and serves 1.8 million customers.

The operation of electric power distribution occurs in cities of different sizes, from cities with a few thousand inhabitants to cities with more than one million inhabitants. In this sense, the challenges faced vary, especially concerning interruptions in the supply of electricity, which generate complaints from end consumers and may be linked to several factors, among them environmental factors.

As it is essential for the company to maintain the supply of electricity to the population, it becomes essential to understand better its activity's dependence on Ecosystem Services to establish targeted and more effective management measures.

2.3 Strategic Options Development and Analysis (soda)

Strategic Options Development and Analysis (SODA) is a method mainly used to structure problem situations, being also widely used to assist the strategy formulation process (EDEN; ACKERMANN, 2001; ACKERMANN; EDEN, 2010). Such characteristics of the method can assist in identifying actions to mitigate the risks and dependencies of electricity distribution concerning the ES.

2.3.1 History

The Strategic Options Development and Analysis (SODA) problem structuring method was devised in the 1980s by Colin Eden and Fran Ackermann (EDEN et al., 1983), initially at the University of Bath and later at the University of Strathclyde, both in the United Kingdom. Since its inception, SODA has been widely used to assist the strategy formulation process by public and private organizations, large and small (ACKERMANN; EDEN, 2010).

Since the early 1980s, there have been numerous publications about SODA. These publications discuss the theory on which SODA is based, the applicability of the method, and available tools. Among the seminal publications are: The intersubjectivity of issues and issues of intersubjectivity (EDEN et al., 1981), Messing about in problems: an informal structured approach to their identification and management (EDEN et al., 1983), Action-oriented strategic management (EDEN; HUXHAM, 1988), and Rational analysis for a problematic world: problem structuring methods for complexity, uncertainty and conflict (EDEN; ACKERMANN, 1989).

Among the publications from the 1990s that discuss the SODA method, the most relevant is Making strategy: the journey of strategic management (EDEN; ACKERMANN, 1998). After the 1990s, the chapter Strategic Options Development and Analysis, from the book Systems Approaches to Managing Change: A Practical Guide (REYNOLDS; HOLWELL, 2010), is considered the most current work that presents in detail this method.

2.3.2 Theoretical Background

The SODA method is based on the construction and analysis of cognitive maps.

Cognitive maps, in turn, are based on Kelly's theory (1955) and are characterized as graphical representations capable of systematically bringing together actions, situations, or perceptions raised mainly through interviews. As far as SODA is concerned, these maps are based on the relationships that various constructs have with each other.

A construct, a fundamental element of a cognitive map, consists of a pair of antagonistic assertions, separated by three points, that report a specific action, situation, or perception, ensuring that no ambiguous interpretations occur.

Thus, a cognitive map is composed of a series of constructs linked together, respecting the cause and consequence relationships and the polarity of the assertions of these constructs. Arrows connect constructs with or without a negative sign at the tip. Unsigned arrows lead to a direct relationship. That is, the first statement of one construct is linked to the first statement of another, just as the second statements are also linked to each other. On the other hand, arrows with a negative sign on the tip make a "cross" connection, for example, the first statement of a construct with the second statement of another construct, and vice versa (EDEN; ACKERMANN, 2001; ACKERMANN; EDEN, 2010).

Cognitive maps are subject to a series of analyses that yield relevant information

about the mapped problem situation. These analyses are based on the relative position of the constructs on the map and the number of links they have. Such characteristics make it possible to obtain information that goes beyond that obtained in traditional quali-quantitative research based on descriptive statistics. For example, obtaining information through descriptive statistics takes into account the number of times a certain answer is repeated in a sample, that is, the more this answer appears, the more evidence it has, according to the approach in question. In contrast, the analysis of cognitive maps, based on graph theory (CHRISTOFIDES, 1975), can highlight something that was mentioned only once within the sample but which has a privileged position in the network that structures the problem situation. In this way, the analysis of cognitive maps provides a more comprehensive and systemic view of the whole, corroborating that the whole is different from the sum of its parts. Among the analyses that can be performed, the following stand out: determination of head constructs, determination of strategic options, determination of dominant constructs, segmentation of clusters in the form of drops of water, determination of potent constructs, determination of tails constructs, and determination of composite tails.

Head constructs represent long-term objectives and their main characteristic is that they have no outgoing links, i.e., they are not the cause of any other construct. These constructs generally represent the objectives of the mapped situation (EDEN; ACKERMANN, 1998; EDEN; ACKERMANN, 2001; ACKERMANN; EDEN, 2010).

Strategic options are characterized as constructs selected to perform the map segmentation into clusters (drop-shaped). They can be just below the head constructs or be determined, by the stakeholders, as goals (which make up the objectives) to be achieved (GEORGIOU, 2010; GEORGIOU, 2012). Dominant constructs have the highest centrality in the network formed and have a high degree of connections. This is probably because during the interviews with stakeholders, the issue represented by the construct was addressed significantly. Thus, these constructs are considered key points in the network, presenting bottlenecks or solutions for the situation as a whole (EDEN; ACKERMANN, 1998). Constructs tails and composite tails do not receive links, thus representing primary actions. What distinguishes them is the fact that the composite tail presents more than one output link, and, consequently, presents a more significant influence on the problem situation. Finally, potent constructs have the potential to influence two or more strategic options simultaneously (EDEN; ACKERMANN, 1998).

For building the cognitive maps and processing the analyses mentioned above, the following steps are traditionally observed (BANXIA SOFTWARE Ltd, 2017):

Individual interviews and preparation of individual cognitive maps: The group members considered for analyzing the problem situation are interviewed in isolation by a facilitator. At this time, each interviewee expounds on the problem situation according to his/her perception. The results of each interview are "translated" into individual cognitive maps;

Modeling and Analysis: The facilitator aggregates the individual cognitive maps into a single map, called the causal map. Through this map, it is possible, with the help of the Decision Explorer software, to identify head constructs, strategic options, clusters, dominant constructs, potency constructs, tails and composite tails.

Group workshop: The facilitator prepares a workshop where all interviewees, or as many of them as possible, can be present. At this point, the causal map is discussed among the participants and may even be reorganized for a re-presentation;

Group Decision Support Workshop: There is an exhibition of the causal map to those involved in the problem situation to generate knowledge for the group and expose other points of view about the problem situation. Another objective of the workshop is to identify possible actions to improve the problem situation, based on a negotiation process among the participants (mediated by the facilitator);

Monitoring, Control and Evaluation: The final causal map, which results from steps 1 to 4, can be used to track and monitor the implementation progress of the identified actions.

Although there is a traditional procedure for applying SODA, it is adaptable considering the characteristics of the problem situation, the structure available to study it, and the stakeholders' agenda, among other factors. An example of an adaptation of the methodological procedure can be seen in Hjortso (2004) and Santos et al. (2019), who performed steps 1 and 2 by presenting the results in written form to those involved in a given problem situation. Bryson et al. (2004) discuss the possibility of using an adapted form of SODA to structure a problem situation based on the perception of only one individual. The method is also not restricted only to the construction of cognitive maps from interviews, as evidenced by Georgiou (2007), who used data from scientific articles to build constructs and a cognitive map about the dynamics involved in planning a national railway system in Brazil.

3. Methodology

In order to identify actions that mitigate risks and dependencies concerning ES of a company in Brazil (more specifically in the metropolitan region of São Paulo and Vale do Paraíba, in the State of São Paulo), which distributes electricity, the following steps were adopted for the application of the SODA method: selection of stakeholders, conducting interviews, construction of individual cognitive maps, unification of individual cognitive maps, validation of general cognitive map, a first analysis of the general cognitive map, the inclusion of ecosystem services in the general cognitive map, and second analysis of the general cognitive map. All these steps are described throughout this section.

3.1 Stakeholder selection

The choice of stakeholders was made primarily in line with the framework of influence versus interest proposed by Ackermann and Eden (2011). This framework offers a method for selecting stakeholders of problem situations considering two variables: influence in triggering changes in the problem situation and interest concerning it. According to Ackermann and Eden (2011), the stakeholders with more significant influence and interest have tremendous potential to contribute to improving the problem situation. Thus, the selection process should prioritize influential and interested stakeholders.

Besides being supported by the influence versus interest framework, the stakeholder selection also considered the validation and suggestions of managers of the activity performed by the electric power distribution company since they have specific knowledge about the stakeholder's interest and influence. Five stakeholders were selected to be interviewed at the end of the mentioned process. Three are representatives of the public authorities and are employees of the environmental secretariats of the three municipalities where the greatest impacts on the operation and Environment occur (Guarulhos, Mogi das Cruzes, and Monteiro Lobato). One is a representative of ICMBio, an important agency for licensing and carrying out electricity distribution activities in areas of restricted land use, such as conservation units, present in some areas where the company operates (Vale do Paraíba and the São Paulo metropolitan region). The other interviewee represented the service provider responsible for the collection of pruning waste, an activity directly linked both to the maintenance of the electric power distribution service (since the maintenance of pruning avoids falling branches and power cuts) and to the generation of organic pruning waste.

3.2 Conducting interviews

The five selected stakeholders were contacted and interviewed personally. The interviews, which lasted approximately 90 minutes, were guided by a script composed of 3 blocks of questions:

Block 1 - Context/understanding: composed of questions that sought to understand the relationship of the stakeholder interviewed with the electricity distribution company, that is, to understand the roles and responsibilities of each one in this relationship.

Block 2 - Ecosystem Services: composed of questions aimed at capturing the interviewee's point of view about which ecosystem services are most impacted by the electricity distribution company or which ecosystem services the company's operations would be most dependent on.

Block 3 - Institutional Relationship: composed of questions that sought the interviewee's (or the institution he represents) understanding of his relationship with the electricity distribution company and any existing tensions or problems. This block of

questions also aimed to capture perceptions about possible actions to mitigate problems or tensions in the relationship.

The question script is in the Appendix, and the main aspects of each interview were transcribed into a notebook that served as the basis for the construction of the individual cognitive maps.

3.3 Construction of individual cognitive maps

The individual cognitive maps were established based on the answers from the questionnaires transcribed onto an annotation pad. These maps were created in the Decision Explorer® software and respected the cause and consequence relations mentioned during the interviews. It is worth noting that the construction of the maps sought, at all times, to translate ipsis litteris the interviewees' speech, into the graphic expression of cognitive maps. It should also be noted that the techniques for creating cognitive maps were based primarily on those set out by Ackermann and Eden (2010).

In all, five individual cognitive maps were created, one for each interview conducted.

3.4 Unification of individual cognitive maps

The five individual cognitive maps were merged into one overall map (or causal map). According to Eden and Ackermann (1998) this unification process, known as merging maps, consists of the following phases:

Creating a new blank file in the Decision Explorer® software;

Renumbering of the constructs of all the existing individual cognitive maps in order to avoid duplicate numbers for different constructs;

Copy all the cognitive maps and paste them into the previously created file;

Finding constructs with the same meaning (using the FIND command of the Decision Explorer®) and aggregation (using the MERGE command of the Decision Explorer®), thus generating a new construct that maintains the links of the previous ones;

Identification of insufficient connections in eventual constructs that do not contain links (through the ORPHAN command of the Decision Explorer®), checking the possible connections that may exist;

Identification of redundant connections, i.e. whether two distinct lines of argument connecting nearby constructs have the same meaning.

At the end of the 6 phases mentioned, a general cognitive map was obtained, which was subsequently validated, as provided by Eden and Ackermann (1998).

3.5 Validation of the overall cognitive map

The incompatibility of the interviewed stakeholders' schedules and the consequent impossibility of gathering all interviewees in a single workshop (as suggested by the SODA method) forced the adaptation of the general cognitive map validation phase. In this sense, it was decided to present the general map to the interviewers (via video conference), who made suggestions and corrections. After the insertion of the appropriate changes, the map was then validated. It is worth noting that this phase was conducted by a facilitator, as advised by Franco and Montibeller (2009).

3.6 FIRST Analysis of the overall cognitive map

Using the Decision Explorer® software, the following analyses of the overall cognitive map were performed: determination of head constructs; determination of strategic options; segmentation of tear-drop shaped clusters; determination of potency constructs; determination of dominant constructs; determination of tails constructs and determination of composite tails. The following lists the commands required and the form chosen for the identification of the mentioned constructs:

The determination of head constructs (those with no outgoing links) was obtained using the "LH" command;

The strategic options were assigned to the constructs whose action is the improvement of a particular ecosystem service;

Once the strategic options have been determined, it becomes possible to group the actions that lead up to them; to do this, the HIESET command was used, which groups all the hierarchically inferior constructs subordinate to each strategic option (thus creating clusters);

The potency constructs (those that are in more than one cluster at the same time and thus can influence the achievement of more than one strategic option) were obtained using the POTENT command;

Dominant constructs were raised using the "DOMT" command;

The tails constructs were raised using the "LT" command;

The cotails (constructs within clusters with branches on outgoing links) were raised using the "COTAIL" command.

3.7 Inclusion of ecosystem services in the overall cognitive map

Once the general cognitive map was validated and analyzed, a workshop was held, via an online platform, with the interviewers, who are also experts in valuing ecosystem services. In this workshop, the map served as a device for the experts to identify the dependencies and risks of the electric power distribution activity in relation to ecosystem services. Once the identification was made, constructs were created that represented the ecosystem services identified by the experts, with the following assertions: Ecosystem

service improvement X... Ecosystem service worsening X... It should be noted that the ecosystem services referred to on the cognitive map follow the CICES[3] (Common International Classification of Ecosystem Services) classification.

Once created, these constructs were inserted into the general cognitive map respecting their cause and consequence relationships. In this way, the problem situation of the electric power distribution activity was structured in terms of dependence and risks concerning ecosystem services.

3.8 Second Analysis of the General Cognitive Map

With the problem situation structured, a second analysis was performed on the general cognitive map, whose goal was to identify potential actions that mitigate the dependence and risks of the activity of electricity distribution on Ecosystem Services. In this sense, it was determined that the constructs representing ecosystem services (those created as described in the previous item) would be the map's strategic options. Once the strategic options were determined, we proceeded to cluster the map, and all other analyses mentioned in item 2.2.2 and described in item 3.6.

4. Results and Discussions

The actions that mitigate the risks and dependencies, concerning the SEs associated with the company addressed in this study were obtained from the analysis of the validated general cognitive map. Table 1 presents a summary of such actions, relating them to their function and/or generic attribute in the organizational context.

Chart 1 -Specific actions related to your function and/or generic attribute in the managerial contexto

Function and/or generic attribute	Specific Actions
Strategic Options (long-term demands)	Improvement of the following ecosystem services: Hydrological Cycle, Global Climate, Fiber and Other Materials, Air Quality, and Erosion Rate
Ability to influence various Strategic Options, and should receive attention from managers	Fostering Dialogue and Institutional Relations, Environment Team Trained and on site monitoring
Topic with the most centrality on the map (the one with the most links, "on the lips of the people")	Decrease in vegetation cover

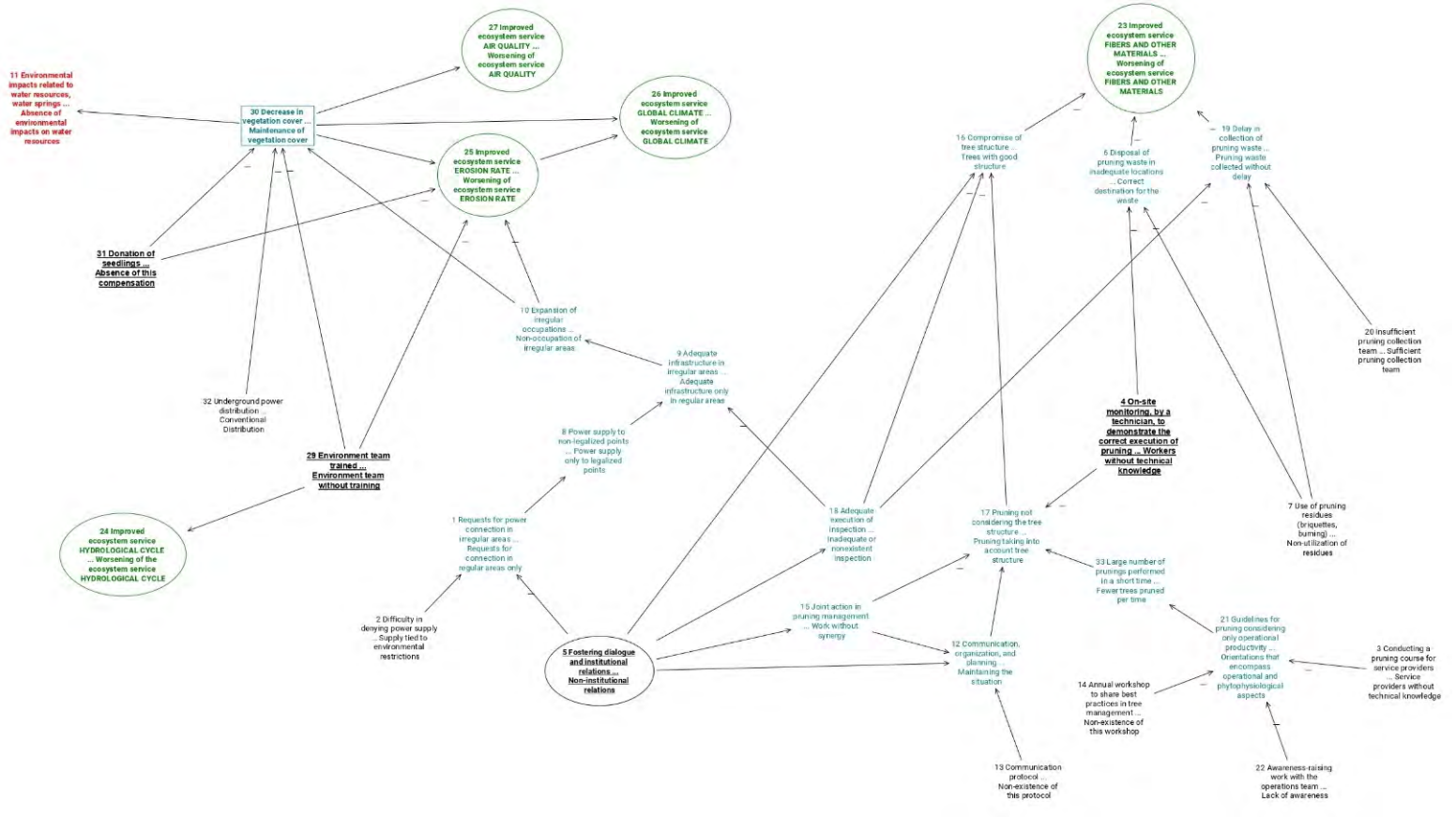
3 - The Common International Classification of Ecosystem Services (CICES) was developed from work on environmental accounting by the European Environment Agency (EEA). More information at: https://cices.eu/ (accessed 30/10/2021).

Possible actions that can be taken in the concise term that contribute the most to improving the problem situation	Fostering Dialogue and Institutional Relations, Follow up in loco by a technician to demonstrate the correct implementation of pruning, trained environmental team, Donation of seedlings

Source: authors, 2023

Moving on to a more detailed presentation of the results, we have the validated general cognitive map composed of 32 constructs, as shown in figure 1. It should be emphasized that the constructs highlighted in the analyses will be discussed in this section, thus concentrating the focus on the results.

Figure 1 - General cognitive map - In green and with an oval border, the constructs referring to ecosystem services, which are also the strategic options, are identified; in black, the tails; in black and underlined, the composite tails; in black and with oval border, the potency constructs; with rectangular border, the dominant; in red the head constructs that are not ecosystem services; and in blue the constructs that were not classified in any of the analyses.



Source: authors, 2023

Next, the results are presented and the analyses performed on the validated general cognitive map are discussed, namely: (1) determination of head constructs and strategic options; (2) determination of potency constructs; (3) determination of dominant constructs; and (4) determination of tails and composite tails. Note that the clusters derived from the HIESET command will not be presented since they can be easily visualized in the cognitive map in figure 1.

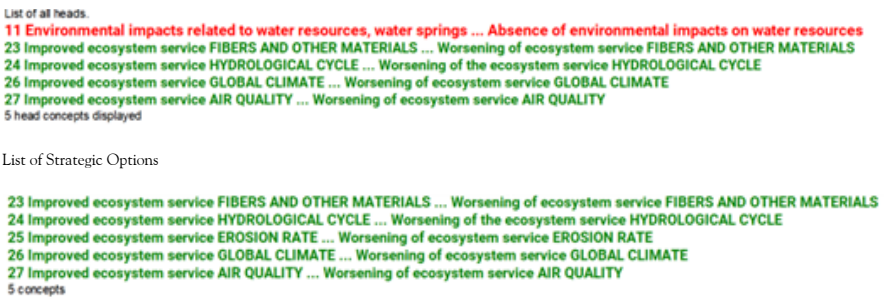
The results of the general cognitive map analysis performed with the Decision Explorer software (constructs highlighted in each of the mentioned categories) bring information about the operational reality of the electricity distributor since they came from the answers given by the stakeholders during the interviews.

The discussion of these results occurs by comparing them with the reality and problems expressed in the interviews, which allows us to observe how adherent to the observed reality the results that emerged from the SODA analysis are.

4.1 Head Constructs and Strategic Options

Figure 2 below are presented the head constructs resulting from the analysis of the general cognitive map with the Decision Explorer® software.

Figure 2 - Result of the analysis of head constructs and the choice of strategic options



Source: authors, 2023

Recall that head constructs are those that have no outgoing links. So, they represent the final causes of the cognitive map and/or the goals of the mapped problem situation.

That said, the identified head constructs are almost entirely assertions that refer to ecosystem services and that have also been designated as strategic options (shown in green in Figure 2). Of the five strategic options identified, four are also head constructs, and only one, referring to the SE Erosion rate, presents an output link.

The intersection given by the head constructs and the strategic options corroborates the map's intention, which is precisely to identify actions that mitigate risks and depen-

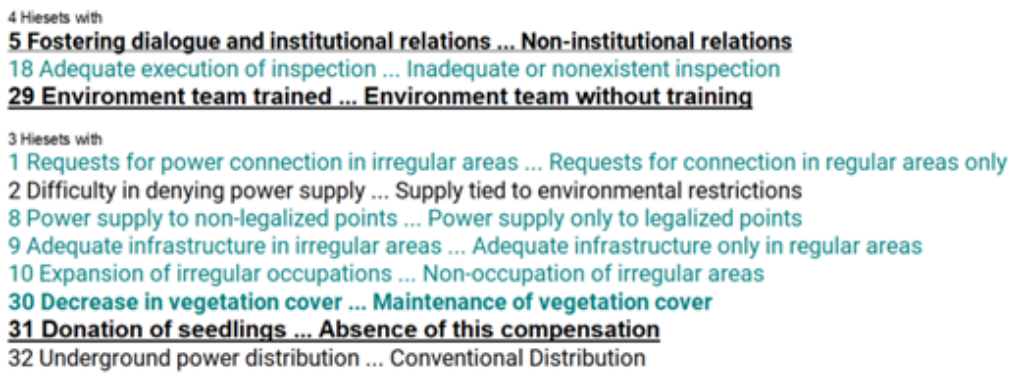
dencies concerning ES. In this sense, the constructs that represent ecosystem services (strategic options) should necessarily be the final consequences of the cognitive map and/or the objectives of the mapped problem situation, as is the case. One can perceive the efficiency of the problem structuring method used since the causes are hierarchically inferior (at the bottom of the map) concerning the final consequences (which are at the top of the map).

The fact that the strategic options are hierarchically superior on the map made it possible to cluster the map, thus allowing the identification of potency actions. These actions, represented by the potency constructs, simultaneously affect more than one strategic option and, consequently, have greater power to influence the problem situation structured in the overall cognitive map.

4.2 Potent and Dominant Constructs

Next, in figure 3, the results of the analyses to identify potency and dominant constructs are presented:

Figure 3 - Result of the analysis to identify potency and dominant constructs



Domain

Source: authors, 2023

Potency constructs are those that are in more than one cluster at the same time and thus can influence the scope of more than one strategic option. That is, they can influence more than one ecosystem service simultaneously.

As can be seen in figure 3, the most potency constructs are: Fostering dialogue and institutional relations...Non-institutional relations, Adequate enforcement...Inadequate or non-existent enforcement and Trained environmental staff...Untrained environmental staff.

Each of these constructs influences 5, 3, and 3 actions, respectively (as seen in the general cognitive map shown in Figure 1), reflecting an essential factor that emerged in the interviews (in four of the five interviews): the pruning problem. Most of the problems arise from failures in the execution of pruning, which results in many complaints and problems with public entities, such as municipalities.

In this sense, the three highlighted constructs are related as follows: a trained environmental team is essential for the proper implementation of the pruning service. Adequate supervision is equally crucial for correctly implementing this practice. Both factors will contribute to the reduction of problems related to pruning.

In parallel, it is imperative to promote dialogue and institutional relations between the electricity distribution company and the municipalities of the cities where it operates. This is because the trees are located in public areas, which makes the pruning management to some extent shared with the public entity, either by authorization or by mediating complaints from citizens. For these reasons, these constructs reveal activities that are significantly important for the operation of the electric power distribution company.

The dominant constructs are those that have the highest centrality in the network of constructs formed, having a high degree of connections, which probably occurs because during the interviews the points represented by them were addressed significantly. Thus, these constructs are considered key points in the network, presenting bottlenecks or

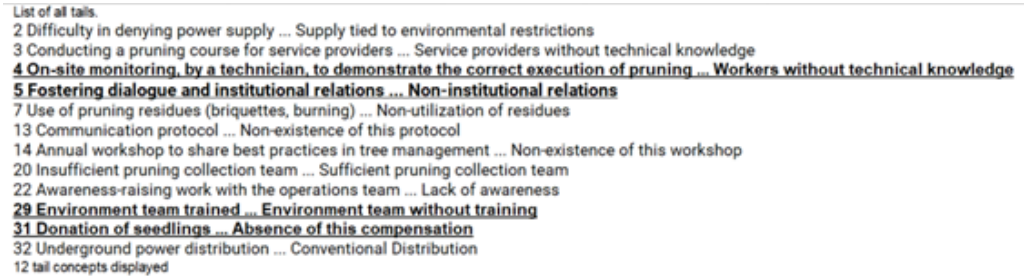
solutions for the situation as a whole (EDEN and ACKERMANN, 1998).

As shown in figure 3, the construct Decrease in vegetation cover... Maintenance of vegetation cover configures it as a key point in the network since it is the cause and consequence of a series of constructs. Vegetation suppression, in turn, is also directly linked to the action of expanding power distribution networks (especially when over vegetated or environmentally protected areas).

4.3 Tails and Composite Tails Constructs

The followings are the Tails and Composite Tails constructs (figure 4) arising from the software analyses:

Figure 4 - Result of the composite tail analysis



Source: authors, 2023

Constructs tails and composite tails do not receive links and thus represent primary actions. What distinguishes them is that the composite tail has more than one outgoing link and consequently has more influence on the problem situation.

In general, the Tails and Composite Tails constructs presented are configured as the recommendations made by the stakeholders in the interviews to solve the problems.

Looking at the Composite Tails, one sees the importance of the company's relationship with the municipalities and, again, the problem of tree pruning (which affects the electricity distribution network).

This reveals, again, that the analysis made by the software is able to highlight a problem that emerged throughout the interviews and that is of great importance for the operation of electric power distribution in the area of operation of the company considered here.

5. Conclusions

Based on the construction and analysis of cognitive maps, the methodology used allowed us to observe, in a structured way, the leading causes and consequences of the

reality portrayed by the stakeholders interviewed. More than this, it allowed the selection, considering the systemic nature of the problem situation, of the most relevant actions to improve not only the performance of the activities of the company studied, but also the quality of ecosystem services associated with it.

Thus, the potency constructs detected reveal the main actions to mitigate risks and dependence on SEs: Fostering dialogue and institutional relations, Adequate enforcement, and Training the environmental team.

The dominant construct, which has the highest centrality in the network of constructs formed and which represents the point that was significantly addressed throughout the process, is the Decline in vegetation cover, evidencing, in this case, a risk to Ecosystem Services arising from energy distribution activities.

The Composite Tails - which are the constructs at the base of the map and have more than one output and, therefore, more significant influence on the system - are configured as a set of short-term actions. These actions are essential for the mitigation of risks and dependence on ecosystem services, and they are: the company's relationship with the municipalities and a set of actions related to pruning vegetation, such as: technical training for the team that performs pruning, technical monitoring of pruning activities and donation of seedlings.

It is worth noting that the analysis was applied to an electric power distribution unit and its results relate only to it due to the specificities of its reality, which were captured during the interviews and reflected in the analyses of the general cognitive map with the Decision Explorer® software.

For an understanding of the relationship (dependence and risks) of other enterprises in the electric power sector concerning ecosystem services and which actions would be appropriate to minimize risks and dependence, it is recommended that other studies be carried out replicating this methodology to reflect the particularities and context of each enterprise, thus enabling results and analyses that are more directed to the investigated reality.

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Appendix - Interview Script

Block 1 - Background/understanding

1 - How is your (the institution you work for/represent) relationship with the energy distribution company? (in the formal sense - what are each party's obligations, and activities performed).

Block 2 - Ecosystem Services (ESS)

2 - For you, what are the main environmental impacts that the distribution company generates?

Bloco 3 – Block 3 - Institutional Relationship

3 - How is the relationship with the distribution company? What are the main problems?

3.1 - How do you think these problems could be solved? What would you expect from the distribution company?

3.2 - Would the operations of the distribution company be at risk? Why? In what way?

4 - What recommendations would you make to the distribution company to improve its environmental impacts, contributing to society?

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SciELO

Identificação de Prioridades Através do Método de Estruturação de Problemas Para Reduzir as Dependências dos Serviços Ecossistêmicos na Distribuição de Eletricidade

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Resumo: A distribuição de energia elétrica é uma atividade fundamental para a sociedade. No entanto, pouco se conhece sobre ações que mitiguem os riscos e dependências dessa atividade em relação aos Serviços Ecossistêmicos (SE). Tal fato pode influenciar negativamente sua prosperidade, especialmente, no longo prazo. Dentro desse contexto, o presente trabalho tem por objetivo identificar ações que mitigam os riscos e dependências em relação aos SE associados a uma empresa do setor elétrico no Brasil que realiza o serviço de distribuição de energia elétrica. A identificação se baseou na coleta, análise e interpretação de percepções de stakeholders envolvidos na atividade, por meio de uma adaptação do método de estruturação de problemas Strategic Options Development and Analysis (SODA). Como resultado, obteve-se uma visão estruturada de ações que mitigam os riscos e dependências da distribuição de energia elétrica em relação aos SE, possibilitando uma gestão focada na longevidade tanto dos SEs quanto da atividade econômica.

Palavras-chave: Serviços Ecossistêmicos; Energia; Risco; Dependência; Estruturação de problemas.

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SciELO

Idenificación de Prioridades Mediante Método de Estructuración de Problemas Para Reducir la Dependencia de los Servicios Ecosistémicos en la Distribución de Electricidad

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Resumen: La distribución de electricidad es fundamental para la sociedad. Pero, se sabe poco sobre las acciones que mitigan los riesgos y la dependencia de esta actividad en relación con los servicios de los ecosistemas (ES). Tal hecho puede influir negativamente en su performance económica a largo plazo. Así pues, este trabajo tiene como objetivo identificar acciones que disminuyen los riesgos y dependencia de los SE, de una empresa del sector energético en Brasil que realiza el servicio de distribución. La identificación se basó en recopilación, análisis e interpretación de percepciones de actores involucrados en la actividad, mediante una adaptación del método Strategic Options Development and Analysis (SODA). Como resultado, se obtuvo una visión estructurada de las principales acciones que tienen potencial de disminuir los riesgos y dependencias de esta actividad en relación con los SE, permitiendo una gestión direccionada a la longevidad de los SE y a la actividad económica.

Palabras-clave: Servicios ecosistémicos; Energía; Riesgo; Dependencia; Estructuración de problemas.

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