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Measuring sustainability achievements in the cleaning sector: The case of Iberlim

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BUSINESS
SCHOOL

Department of Marketing, Strategy and Operations

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Resumo

Ao longo dos anos, as preocupações com a sustentabilidade têm sido uma prioridade crescente para as empresas devido ao efeito que esta tem nos negócios. Os clientes têm pressionado as empresas a tornarem-se mais sustentáveis e a adoptarem estratégias mais ecológicas. De facto, os clientes e mesmo outras empresas tendem a não comprar produtos ou fazer negócios com empresas que não são sustentáveis. Desta forma, têm um impacto negativo sobre o sucesso de uma empresa. Com a pressão que as empresas enfrentam para avançar no sentido da sustentabilidade, é da maior importância tornar-se mais sustentável.

Esta tese visa desenvolver uma ferramenta para medir e monitorizar o progresso da empresa em direção à sustentabilidade. A ferramenta desenvolvida, um *dashboard*, foi preenchida com diferentes indicadores que permitem à empresa analisar a sua sustentabilidade atual e tomar decisões estratégicas para melhorar ainda mais a sua sustentabilidade. Com isto, a tese contribuirá para ultrapassar a necessidade da empresa de ter um método para monitorizar o seu progresso em vista de um negócio mais sustentável.

Com isto em mente, a revisão da literatura centrou-se nos diferentes conceitos em torno da sustentabilidade e nos diferentes métodos que atualmente existem para a medir. Posteriormente, a metodologia da Tese foi escolhida tendo em consideração que o objetivo era desenvolver um artefacto, um *dashboard*. A metodologia escolhida foi a *Design Science Research*.

Para terminar, na última secção é apresentada a conclusão do trabalho desenvolvido e são mencionadas futuras oportunidades de investigação.

Palavras-chave: Sustentabilidade; Desenvolvimento Sustentável; Indústria de Serviços; Sector de Serviços; Clima; Alterações Climáticas; Dióxido de Carbono.

Códigos de Classificação JEL: Q01, L80, Q54

Abstract

Throughout the years sustainability concerns have been an increasing priority for companies due to the effect it has on business. Customers are pressuring companies to become more sustainable and adopt greener strategies. In fact, customers and even other companies tend to not buy products from or do business with companies that aren´t sustainable. Thus, negatively impacting a company's success. With the pressure companies are facing to move towards sustainability it is of the utmost importance to become more sustainable.

This thesis aims to develop a tool to measure and monitor the company's progress towards sustainability. The tool developed, a dashboard, was populated with different indicators that allow the company to analyze its current sustainability and make strategic decisions to further increase its sustainability. With this, the thesis will contribute to overcoming the company's need to have a method to monitor its progress toward a more sustainable business.

With this in mind, the literature review focused on the different concepts surrounding sustainability and the different methods that currently exist to measure it. Afterward, the Thesis methodology was chosen taking into consideration that the goal was to develop an artifact the dashboard. The methodology chosen was Design Science Research.

To conclude, in the last section the conclusion of the work developed is presented and future research opportunities are mentioned.

Keywords: Sustainability; Sustainable Development; Service Industry; Service Sector; Climate; Climate Change; Carbon Dioxide.

JEL Classification Codes: Q01; Q53; L80; Q54

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Glossary of Acronyms

AHP – Analytical Hierarchical Process

DSR – Design Science Research

LCA – Life Cycle Analysis

LR – Literature Review

MCDM – Multi-criteria Decision Making

SSCM – Sustainable Supply Chain

TBL – Triple Bottom Line

CHAPTER 1

Introduction

1.1. Problem Contextualization

It is accepted amongst the literature that organizations should move towards sustainability in their operations (Ahi & Searcy, 2013). Furthermore, it has been shown that customers' concerns with environmental issues and customer demand increased throughout the years, which lead to a search, by organizations, to find methods to measure sustainability (Surampali et al., 2020). Bell & Morse, (2008) stated that sustainability is "meaningless unless we can 'do' it" (p. 5).

Once organizations move towards sustainability it is necessary to find ways to measure it and to do so, indicators are needed. Sustainability indicators allow organizations to identify the To-Be situation, a desirable future state that organizations expect to achieve, and the As-Is situation, the current state of the organization regarding sustainability. Indicators allow the forecasting of future scenarios and identification of risks (Simon, 2003).

Indicators can be used to assess sustainability in a variety of ways. Composite indices and dashboards of indicators were highlighted by Sardain et al., (2016) as two techniques for measuring progress toward sustainability.

One of the biggest sustainability challenges organizations are facing today is connected with decarbonisation, in other words, reduction of human-caused CO_2 emissions. This is justified by the fact that carbon emissions are one of the leading causes of climate change (Ritchie & Roser, 2020).

Furthermore, over time, sustainability has been seen as a competitive advantage, as a way to adopt strategies that aren't at the reach of their competitors (Ioannou & Serafein, 2019). Therefore, companies recognize the need to tackle this challenge not only because of its effect on the environment but also due to the customers' pressure to adopt greener strategies and to remain competitive.

Being decarbonisation a global concern amongst organizations and being Iberlim a corporation in the services industry, more specifically in the cleaning services industry, it is also one of the major challenges it faces. Nonetheless, Iberlim has already taken steps toward sustainability, although its ambition is to go even further and be a factor of change across its supply chain. To do so, it has to be able to assess its long-term sustainability and track its progress. However, it currently lacks a tool and a comprehensive collection of indicators related to sustainability measurement.

As a result, it is seeking for procedures, such as tools, to monitor and measure and assess sustainability since it doesn't currently have techniques for doing so.

1.2. Research Problem

The research problem in question is that Iberlim is unable to analyze the influence of procedures on long-term sustainability. After assessing the company's goal of influencing clients and its suppliers in such a manner that sustainability is a choice by design, and the objective of being transparent with all stakeholders, this research problem arose. The problem with these objectives is that the organization hasn't been able to develop a comprehensive list of metrics to measure sustainability.

To reach the company's objectives, there is an obvious need for identifying indicators that measure sustainability as well as providing a tool, such like, a dashboard to view those indicators.

Furthermore, the research problem in question is connected with a condition to be improved, specifically to improve Iberlim's sustainability. It is related to comprehending how a company can become more sustainable and a catalyst for change.

The relevance of a study pertaining to sustainability and the measurement of sustainability in supply chains of the service sector is also due to a gap found in the literature. This gap was identified, among several other articles, by Singh, (2016) which stated that trends in sustainable supply chain management in the "service sector has gained limited attention from researchers" (p. 10).

Another gap that supports the study of this problem was concluded by Panigrahi et al. (2019), which stated that "research on SSCM is still at a preliminary stage and major research works have not been supported by quantitative findings" (p. 1027).

Furthermore, based on the findings in the preceding section and on the description of the research problem, it is possible to conclude that there is an opportunity to develop a master thesis with the following research question:

How can Iberlim monitor the sustainability of its processes and the adoption of more sustainable practices?

The objective of answering this research question is described in the following subchapter.

1.3. Thesis Objectives

As mentioned in the previous subchapter, this thesis focuses on the research and selection of sustainability indicators that will enable Iberlim to achieve its goal of achieving greater sustainability and measure and monitor its progress toward sustainability. To put it another way, the purpose of this study is to provide the organization with a practical solution for monitoring and evaluating its sustainability. Therefore, the main objectives of this Thesis will be to select indicators based on the company goals and develop a practical solution.

Concluding, this Thesis has the aim of contributing to the literature on this topicand providing a practical solution and a comprehensive list of indicators to the company.

1.4. Methodology Overview

To achieve the goals mentioned above and answer the research question in study, the methodology will follow the framework for Design Science Research (DSR) as presented by Johannesson & Perjons, (2014). In other words, this thesis follows a DSR framework since its goal is to develop a dashboard with a set of indicators to improve its sustainability. Therefore, in short, these are the artefacts that will be developed.

To further explain, according to Dresch et al., (2015), DSR is considered a "Design science research is a method that establishes and operationalizes research when the desired goal is an artefact or a recommendation" (p. 67). Besides, DSR's goal is to develop an artefact with the purpose of, for example, overcoming a problem.

In brief, the third chapter aims at explaining how the method framework for DSR, presented by Johannesson & Perjons (2014), was used by describing each phase of this method.

Additionally, each phase of the DSR method framework as presented by the authors mentioned above will be further explained in chapter 3. By doing so, several research strategies and data collection methods will be introduced.

1.5. Thesis Structure

This Thesis is divided into five chapters, including the present chapter: Introduction. In this chapter, firstly the contextualization of the problem was detailed, then as a result, the research question was introduced. Moreover, it is possible to find in this chapter the thesis objective and a methodology overview. The remaining chapters are divided as such:

- Chapter 2 is concerned with the literature review, were the main concepts and conclusions of the topics and area in discussion are presented. In addition, a review of different existing methods as well as the view of authors on these decision-making methods were presented.
- Chapter 3, regards Methodology, were the chosen methodology and its different stages are detailed. Furthermore, different guidelines and principles followed within the methodology are also described in this chapter.
- The case study is found in chapter 4, Proposal and Evaluation. In a global view this chapter is concerned with the development of the dashboard with the indicators identified, needed by the company to overcome their current problem: the lack of methods to analyse and monitor sustainability. It involves several iterations, starting with an initial prototype of the dashboard, improving it, and ending with an optimal dashboard.
- The last chapter, chapter 5, focuses on recommendations for future work and presents the limitations and gaps of this study.

CHAPTER 2

Literature Review

In order to position this paper in the literature, previously published papers, related to the focus of the present project, were analysed. Therefore, this chapter presents a review of recent literature on concepts that are the basis of this project and support its development. This literature review (LR) is divided into three main sections.

The main purpose of 2.1 Sustainability was to understand what sustainability is and why it is important to any organization.

Subchapter 2.2 builds on the previously introduced concept of sustainability by focusing on the aspects of measuring sustainability. Its primary goal was to broaden comprehension of the Triple Bottom Line by explaining each dimension. Moreover, the topics of carbon footprint and decarbonisation were introduced. More specifically, the topic of carbon emissions was discussed. First, a literature review on carbon footprint and greenhouse gases was conducted. Moreover, the different types of scope emissions were discussed and how urgent decarbonisation is needed.

Still in subchapter 2.2 different types of approaches for selecting indicators were also identified.

To conduct the research and to identify relevant literature several databases were used, such as EBSCO, b-on, Web of Science, and Scopus. These databases were used to search for peer-reviewed articles, paper conferences, and book chapters published over the last ten years (2010 through 2021). However, it is important to note that some of the articles mentioned might be prior to 2010 and even date back to the 1990s, when some of the concepts were first coined. Searches were carried out in the titles and abstracts. Regarding, keywords the following terms were used: “sustainability”, “sustainable supply chain management”, “supply chain”, “triple bottom line”, “sustainability dimensions”, “decarbonisation” and “carbon emissions”. In addition, the resulting articles from the search have also been used to identify additional related literature.

The conclusion, subchapter 2.4, outlines gaps found in the literature and presents the findings of the literature review.

2.1. Sustainability

There is a need for companies to adopt 'greener' strategies. It is apparent that many companies have recognized the need for this transition and the world has become aware of existing global issues. Camarinha-Matos et al., (2010) supports this statement by concluding that "Pursuing sustainable solutions is one of today's major challenges for the society" (p.14).

To elaborate, recent research suggests that the main drivers for companies to move towards sustainability are pressures from the government, stakeholders, and clients (Gold et al., 2010).

Regarding, customers pressure, this sustainability driver is related to more conscious customers and the increasing customer concerns regarding environmental issues. Customers seek products that are more environmentally friendly. Additionally, stakeholders and customers are increasingly seeking out and supporting organizations that are more transparent concerning their environmental and ethical practices (Ashby et al., 2012).

To achieve a more sustainable way of life it is critical for the world not to deplete existing resources, but rather to reuse, recycle, and reduce their use. Therefore, sustainability advocates that resources can't be used to the point of depletion.

In fact, exploiting resources at such a rate that they become depleted, poses a hazard to future generations (Portney, 2015).

Furthermore, sustainability is inherently connected with the concept of Triple Bottom Line, which will be further explained in section 2.2.

2.2. Triple Bottom Line

Initially, environmental concerns were sustainability's sole focus. However, over the years there has been a shift in sustainability and environmental concerns no longer are the sole focus. Now sustainability focuses on social, environmental, and economic issues (Singh, 2016).

These three dimensions, also known as sustainability pillars, are commonly referred to as the Triple Bottom Line (TBL). Additionally, Hourneaux Jr et al., (2018) concluded that "TBL adds both social and environmental dimensions to the traditional economic results to measure a firm's performance from a sustainable perspective" (p. 414). TBL is also known as 3Ps: Planet, People, and Profit.

TBL is important because it allows managers to focus on the fundamental pillars of sustainability to lead supply chain performance measurement. Moreover, by understanding what each dimension encompasses managers and experts can select the right indicators to measure sustainability.

2.2.1 Environmental Dimension

With regard to the environmental dimension, Panigrahi et al., (2019) defines this dimension as the environmental perspective of the SSCM. Furthermore, Panigrahi et al., (2019), concluded that this

dimension is concerned with “the conservation of the environment that the SC is working in”(p. 1006). Hence, the environment mustn’t be harmed in any way by the processes and operations that comprise a SC (Panigrahi et al., 2019).

One of the main current concerns regarding this dimension is the carbon footprint and as a result the decarbonisation:

Carbon footprint

Carbon footprints are the carbon dioxide emissions that are produced by human activities, such as production. Furthermore as previously stated, there has been an increasing interest in environmental issues, primarily issues related to carbon emissions. This theme has been discussed by a great number of authors in the literature.

Significant analysis and discussion on the subject was presented by Dekker et al., (2012). The author explored literature concerning CO_2 emissions, mostly emissions from transportation. Similarly, Du et al., (2016) addressed this theme by exploring the following two main topics, management of carbon emissions and the increasing customer awareness of environmental issues.

There are several alternatives to reduce these emissions, such as adopting renewable energies and decarbonisation. Decarbonisation is considered one of the major strategies to decrease carbon emissions along the supply. Therefore, in the next section, this strategy will be further explained.

Considering that human-caused carbon dioxide emissions are one of the leading causes of climate change, it is critical for businesses to reduce its emissions due to the consequences of climate change (Ritchie & Roser, 2020).

Climate change effects can go from increasing temperatures, which leads to rising sea levels, to severe weather events and damaged ecosystems. To summarize, climate change has severe consequences not only for flora and fauna but also for humankind, placing humanity at risk (Denchak, 2019). Thus, strategies such as decarbonisation are one of the most important for mitigating its effects.

Moreover, greenhouse gases, such as CO_2, are categorized into 3 types of emissions which falls in three different scopes: Scope 1, Scope 2; Scope 3.

Scope 1 emissions are concerned with direct emissions, in other words, emissions that originate directly from the organization's facility (Hertwich & Wood, 2018). These emissions originate from sources that are controlled by organizations.

Scope 2 emissions, also categorized as indirect, are emissions that occur due to electricity consumption (Hertwich & Wood, 2018).

Finally, Scope 3 emissions are also considered indirect emissions. In fact, Scope 3 emissions are made of all the indirect emissions not included in Scope 2 emissions. To be more exact, Scope 3 emissions are “emissions that occur throughout a company’s value chain” (Bhutada, 2021).

Concluding, this thesis has the aim of exploring with greater detail Scope 3 emissions and strategies to enable decarbonisation, a theme that will be further discussed in the next subchapter.

Decarbonisation

As mentioned above, decarbonisation, as the name suggests, is the reduction of human-caused CO_2 emissions and this topic has been of great interest and research.

Decarbonisations' goal is to, in the near future, achieve net-zero emissions. Shepard, (2020) defined net-zero emissions as "achieving a balance between the amount of greenhouse gas emissions produced and the amount removed from the atmosphere".

Furthermore, decarbonisation and mainly scope 3 emissions are relevant themes since with the passing of the years and thanks to the Industrial Revolution carbon emissions have increased (Jacques, 2021).

To achieve a more sustainable business and to act in accordance with climate change, besides water, waste, and spill management this thesis has as its main focus decarbonisation related to scope 3 emissions. Decarbonisation will assist organizations' efforts in achieving a more sustainable business and tackling climate change.

In fact, Portney, (2015) states that reducing carbon emissions is a solution organizations can adopt to reduce emissions to protect against climate change as well as adopt renewable energy sources.

In short, decarbonisation is a critical strategy in supply chain management since almost every stage in a supply chain involves GHG (greenhouse emissions) (Dasaklis & Pappis, 2013).

2.2.2 Social Dimension

The social dimension of TBL, also known as "people", is concerned with guarantying that there is justice and that human rights are respected. It is concerned with the impact, positive or negative, that the organization has on its stakeholders (Kraaijenbrink, 2019).

2.2.3 Economic Dimension

Last but not least, the economic dimension, also known as "profit", is once again connected to the impact organizations have, either positive or negative, on the overall economy. These impacts can be, for example, job creation or driving innovation (Kraaijenbrink, 2019).

Furthermore, even though these dimensions are seen as the main pillars of sustainability, several authors, suggest the existence of more sustainability dimensions.

Concluding, it has been shown that to measure sustainability it is necessary to take into account the 3 dimensions: economic, environmental and social. This is supported by Moreno-Camacho et al., (2019) which stated that ”Sustainability addresses the balance of economic, environmental, and social objectives” (p. 601). Therefore, to achieve a complete analysis of sustainability it is necessary that the tool and indicators used gather information regarding all the TBL aspects.

2.3. Multi Criteria methods for Sustainable Measurement

Previous research (Ansari & Kant, 2017; Qorri et al., 2018; Taticchi et al., 2015) has demonstratedthat there are numerous approaches for measuring and analysing supply chain performance in terms of sustainability.

A recent study by Qorri et al. (2018), concluded that out of all of the multi-criteria decision-making (MCDM) techniques, the analytical hierarchy process (AHP) is a good option. According to the authors, this tool is useful for selecting and prioritizing metrics to utilize in supply chain performance measurement.

Similarly, Taticchi et al., (2015) suggest that MCDM, is one of the main decision tools that can support managers in SC decision making.

Furthermore, on a literature review of 15 years, SSCM Ansari & Kant, (2017) supported the past statements by identifying that out of 286 papers 29 used MCDM, and within these 29, 8 used AHP.

Additionally, considering mathematical tools the authors observed that after linearprogramming, Fuzzy logic was the most used.

There are also methods to guide the selection of sustainability indicators. Specifically, Sardain et al., (2016), identified three methods of selecting indicators: Participatory methods (Bottom-up),Top-down approaches (expert-led), and expert-led and stakeholder-led approaches.

Participatory methods focus on bringing stakeholders into the process of selecting indicators,while top-down approaches fail to bring stakeholders into the process and only count on experts to make this decision.

Expert-led and stakeholder-led combines a bottom-up and a top-down approach, which means that decisions about indicator selection are made by both stakeholders and experts.

There are numerous methods that measure/monitor performance (dashboard), some are best suited to a specific dimension, such as LCA which is best suited to the environmental dimension. These and other tools are discussed in the next section.

Summarizing, after a thorough review of the literature regarding the best methods to make decisions about sustainability MCDM seems to be a recurrent suggested and used method. However, there is still the need to apply these methods in a more user-friendly approach through various tools.

2.3.1. Tools to monitor and measure Sustainability

As previously said, the company in study doesn't have a method to visualize its progress and measurement towards sustainability. Therefore, it was conducted a literature review focusing on finding the methods available to do so.

Sardain et al., (2016) state that there isn't a common ground regarding the best tool to measure and monitor sustainability, however the authors do present comparisons of some of the existing methods. For example, the authors highlight the utilization of composite indexes and dashboards as two approaches to measure sustainability.

The authors talk about the positive and negative aspects of both approaches, highlighting that composite indexes may result in the loss of information due to its process of summarizing and aggregating indicators. However, Sardain et al., (2016), concluded that this approach has certain advantage such as its ease of communicating/relaying information to the public.

On the other hand, according to the authors, using dashboards as an approach to measure sustainability solves the loss of information, which occurs in composite indexes, because the specificity of each indicator is retained. This approach also leads to an easier and complete understanding of the sustainability scenario.

Nonetheless, this approach also comes with its disadvantages. When not developed correctly this type of approach may lead to an unorganized dashboard with too much information, hampering its interpretation.

Concluding, there are several methods that can monitor and measure sustainability. In this section, two of the most used approaches were explained. Furthermore, taking into consideration what the authors discussed and the fact that, there is still the need to use more user-friendly tools it can be argued that a dashboard is the optimal choice for this project.

2.4. Final Remarks

Decarbonisation has been shown to be essential for achieving sustainability and achieving sustainability goals. Furthermore, decarbonisation is largely concerned with transportation emissions, and it has been proved that transportation is one of the most difficult aspects to decarbonize (Prieto & Hall, 2013). This, combined with the increasing GHG emissions proves the importance of studying this topic, its relevance, and a gap in the literature since decarbonizing is a complex strategy.

Another essential point taken from this literature review is that it will be beneficial for the company to adopt a more sustainable approach to how they manage cleaning products packages. As suggested by Korhonen et al., (2018), one of the benefits companies can expect is the "improved image that helps green marketing of products and services" (p. 41).

Besides, literature on sustainability strongly suggests that sustainability concerns are growing, and an increasing number of businesses are implementing greener strategies in an effort to become more sustainable.

Following a thorough review of the literature on this subject, it was possible to observe that previous studies were primarily focused on manufacturing industries and did not consider the social dimension. Moreover, during this research no studies were found were dashboards were used in the sustainability service sector context. Therefore, there was a gap found regarding studies on the service sector.

Finally, because sustainability is such a broad topic, numerous possibilities can be pursued. Sustainability is an interesting topic, and businesses must take action in this area because, as previously stated, stakeholders are more concerned with sustainability, and resources are depleting.

CHAPTER 3

Methodology

The research methodology chosen for this project was Design Science Research (DSR), specifically Johannesson & Perjons (2014) methodological framework for DSR. This method, according to the author, consists of five iterative activities shown in table 3-1.

DSR is the right choice for this project's research methodology since DSR's goal is to develop an artefact with the purpose of, for example, overcoming a problem. In this project, the artefact is a dashboard with a set of indicators to aid in the monitoring and improvement of sustainability.

To summarize this overview of the framework, according to Johannesson & Perjons (2014), for a project to be considered a DSR, a project must meet three conditions: develop new and of general interest knowledge through research strategies, secondly, this knowledge must be connected to an existing knowledge base (to ensure the legitimacy of the results), and thirdly the results must be shared with researchers and other professionals. Furthermore, the activities that represent the DSR process are presented in table 3-1.

Table 3.1 - DSR Framework Activities adapted to Iberlim case (Source: Johannesson & Perjons, (2014)

Explicate Problem →	**Define Requirements** →	**Design and Development** →	**Demonstrate** →	**Evaluate**
Iberlim wants to become more sustainable. It lacks a comprehensive method of measuring/ monitoring sustainability which hinders its sustainability progress.	Develop a dashboard with a set of indicators to aid in the pursuit of greater sustainability. The dashboard will enable monitoring and assessment of sustainability. Requirements were identified during meetings with the company.	Selection of a tool to develop the dashboard. Research of optimized dashboard visuals. Testing different visual graphs for KPI's. Development of a dashboard prototype according to guidelines/principles.	Data was inputted in the dashboard. The dashboard was then presented to Iberlim and the advisors.	Feedback on the utility, design and functionality of the dashboard was provided by Iberlim and the advisors. Then different iterations were completed to adjust the dashboard.

Johannesson & Perjons, (2014) affirm that DSR has its origins in areas of information systems and after analysing the further reading suggested by the authors, it was decided to follow the guidelines set forth by Hevner et al. (2004). According to Hevner et al. (2004), developing and implementing an artefact is needed to understand and solve a problem and the seven guidelines were derived from this statement. Table 3-2 shows how this project fits into these guidelines.

Table 3.2 – Hevner guidelines adapted to Iberlim's case (Hevner et al. (2004))

Guideline	Description
1: Design an Artefact	The proposed artefact is a dashboard to measure and monitor sustainability
2: Problem Relevance	Iberlim lacks a method to assess its sustainability and to wants/needs to improve its current sustainability
3: Design Evaluation	Employees of iberlim and the advisors of the project were interviewed/participated in a focus group. Participants evaluated the dashboard during these interviews, pointing out positive and negative aspects as well as potential improvements. This resulted in various dashboard iterations and improvement.
4: Research Contributions	Developing and providing a dashboard to assess the company's sustainability, which Iberlim lacks at the moment.
5: Research Rigor	The project met the 3 conditions for it to be considered a DSR project. It followed Johannesson & Perjons, (2014) DSR framework activities. The dashboard development followed guidelines set by Stephen Few and the Gestalt visual perception principles
6: Design as a Search Process	It followed Johannesson & Perjons, (2014) DSR framework activities. The process to find a new and optimal solution for the problem involved the use of iterations.
7: Communication of Research	Submission of an article to a highly ranked journal.

Furthermore, the development of the dashboard followed guidelines set forth by Few, (2006) and the Gestalt visual perception principles. In terms of the visuals of the dashboard, Gestalt visual perceptions and Stephen Few colour guidelines were applied and are shown in table 3-3 and 3-5 respectively. These principles aided in the dashboard's design by organizing the data and the visual representations.

Table 3.3 - Gestalt Principles of Visual Perception (Few, 2006)

Principle	Definition
Proximity	"Objects that are located near one another as belonging to the same group"
Similarity	Humans "tend to group together objects that are similar in color, size, shape, and orientation"
Enclosure	Objects are perceived "as belonging together when they are enclosed by anything that forms a visual border around them (for example, a line or a common field of color)."
Closure	Open structures are perceived as "closed, complete, and regular whenever there is a way that we can reasonably do so."
Continuity	Objects are perceived "as belonging together, as part of a single whole, if they are aligned with one another or appear to form a continuation of one another."
Connection	Humans "perceive objects that are connected in some way, such as by a line, as part of the same group"

Once the dashboard is complete, the next phase is evaluating the dashboard, this phase consisted of interviews/meetings. These interviews/meetings, in the fifth activity "Evaluate", consisted of presenting the proposed dashboard and discussing if the participants had any opinions or suggestions to add. In each interview the participants were asked the following set of questions:

- Are there any improvements that can be done?;
- If yes, which improvements?;
- What are the most positive aspects of the proposed dashboard?;
- What are some of the negative aspects of the proposed aspects?.

Once the meetings were concluded, the answers collected were inputted and organized in a table, which its template is shown in table 3-4. The data/feedback collected during the meetings is presented in table 4-1.

Table 3-4 - Table Template of Evaluation activity answers

	Answers
Positive aspects	-
Negative aspects	-
Proposed Improvements	-

In the "Answers" column the participants' opinions and suggestions were registered. The answers were obtained via online meetings/focus group with Iberlim's employees, as seen in table 3.4.

Table 35 - Color Guidelines (Stephen Few, 2006)

Nº	**Guideline**
1	Keep bright coolers to a minimum, using them only to highlight data that requires attention.
2	Except for content that demands attention, use less saturated colors such as those that are predominant in nature (for example, the colors of the earth and sky).
3	Use a barely discernible pale background color other than pure white to provide a more soothing, less starkly contrasting surface on which the data can reside.

CHAPTER 4

Proposal and Evaluation

The proposed dashboard was created as a solution to the company's previously described challenge. It was the result of an iterative DSR process, with each iteration taking place in semi-structured meetings. These meetings provided an opportunity to examine the dashboard's features and layout, validating and improving them as a result.

There were two meetings and three interviewees in total, with each meeting lasting approximately 45 minutes. The dashboard, as well as its navigation and functionalities, were presented first in both interviews.

The next subchapters depict each iteration and its conclusions.

4.1. First DSR Iteration

As previously mentioned, a DSR process was followed in which 3 iterations were performed to analyse and improve the dashboard. The prototype of the dashboard was populated with fictitious data for the interviewees to see how it would function once real data is inputted.

The following sections describe the steps taken in the first iteration: Design and development, Demonstration and Evaluation.

4.1.1. Design and Dvevelopment

As previously seen in table 3-1., this stage of the process entails a research and analysis of the optimal design and platform, and the development of the dashboard itself. Therefore, it was necessary to conduct an analysis/research of different dashboard designs.

Through this research it was possible to grasp the importance of design on the overall utility of this type of tools. It provided insights on the organization and optimization of a dashboard.

Specifically, the research led to a study of guidelines and principles that need to be kept in consideration when developing a dashboard, these are presented in the next section. These guidelines and principles were already introduced in chapter 3 and are showcased below in the construction/organization of the dashboard.

Guidelines and principles

Regarding the research of best practices in the development of dashboards, colour and visual perception principles were found to be critical.

In fact, as identified by Stephen Few, (2006), one of the most crucial mistakes in dashboards is the poor use of colours. The author presented some guidelines, as seen in table 3-5, to overcome this mistake and aid in the design of the dashboard. For the prototype, the organizations colours, blue and white, were used as a base. In figure 4.1, it is possible to see the application of the authors' guidelines, through the use of soft colours and only using bright colours to emphasize the different types of fuel.

Figure 4.1 - Fuel Section of the Mobility Page

The usage of hues that predominate in nature, such as shades of blue and green, was another rule adhered to. Furthermore, the background colour chosen, light grey, adheres to the guideline of using a background colour other than white.

Regarding visual perception of the dashboard, Gestalt visual perceptions principles were applied. The seven principles that must be kept in mind are identified in table 3-2 and in the figure above there are some of these principles in action, for example, the principle of proximity directing the viewers to scan the data from left to right.

Moreover, along the dashboard the enclosure principle is applied by ensuring that groups of KPI's that belong together are divided from the others trough lines. This is also visible in figure 4.1.

4.1.2. Demonstration

The demonstration phase intends to find how the artefact, in this case, the dashboard, can be used to address the company's challenge. Since the company's challenge is the lack of methods to measure and monitor its sustainability, the dashboard would have to be a solution for that.

To test its applicability, the dashboard was populated with fictitious data. This enables the interviewees to have a clear view of how the artefact would function once real data was inputted. The demonstration of the artefact was done via semi-structure tings, where the navigability and functionalities were explained and presented. More specifically, each aspect and page of the dashboard was detailed and explained.

The dashboard is divided into four pages: Energy; Mobility; Water; Products. These correspond to the groups of the different KPIs in study. One of the functionalities available is the ability to choose to view all the years from a KPI or a specific year. Additionally, there is also the possibility of choosing which energy category to analyse and view, this is visible in figure 4.2.

Another crucial aspect of the dashboard is its navigability; on the home page, there are buttons for each of the pages, and each page has a header with tabs with the different pages. These buttons enable easy navigation by taking users directly to the page for that particular theme when they click them. These aspects are visible in figures 4.2 and 4.3.

Figure 4.2 - Energy Page

Figure 4.3 - Homepage

4.1.3. Evaluation

In this stage of the process interviews/meetings were conducted to obtain feedback on the dashboard. During these meetings it was done a presentation of the dashboard and its functionalities, the feedback was obtained by following the questions presented in chapter 3.

Table 4.1 shows the feedback from the first iteration and a summary of the responses is presented to better explain these results: There were two positive aspects, two negative aspects, and seven proposed improvements. Most of the proposed enhancements are related to visual and information aspects; therefore, the dashboard will be easier to navigate and analyse. In other words, the enhancements enable a more user-friendly dashboard.

Table 4.1 - Feedback from 1st Iteration

	Answers
Positive aspects	Simplicity; The use of buttons for navigability.
Negative aspects	KPI missing from the product page; In the water page the red graph creates confusion.
Proposed Improvements	*Water:* Change the title of the water consumption graph.
	Water: Remove the red graphic from the water page.
	Water: In the water page add an indication that 85 000 is the goal.
	Water: Opt for keeping the upper graph, relating to water consumption.
	Mobility: Add a legend to the gasoline and diesel graphs
	Mobility: Change the title of the electric vehicle graph.
	Product: Add the missing KPI graph.

The positive aspects emphasize some of the already existent aspects of user-friendly functionalities, including easy navigation. Simplicity, ease of readability and analysis, and the choice of types of graphs contribute to the user-friendly aspect and the positive aspects.

The negative aspects relate to visual and informational aspects. The interviewees made the observation that the visual representation used for the water graph, as well as the use of the colour red, makes it difficult to analyse.

In general, the 7 improvements include changing the title of the graph and adding a legend. The final suggested improvement is the addition of a graphic visualization of a missing KPI.

4.2. Second DSR Iteration

In the first DSR iteration the meetings lead to the proposal of improvements to the first prototype, depicted above in table 4.1. The improvements were implemented after analysing the meeting notes regarding the proposed improvements. The following sections describe and present the improvements made.

4.2.1. Proposal of the Dashboard

The dashboard was edited in this new iteration based on feedback and proposed improvements. The majority of the changes are related to improving clarity and readability, clarifying some of the graphics titles and legends. Furthermore, by removing the red graph, one of the improvements, the dashboard will adhere to Stephen Few, (2006) colour guidelines, as seen in table 3-5. These improvements increase the dashboards user-friendly functionalities and easiness in analysing and navigating it.

4.2.2. Demonstration

This section shows the changes made to comply with the proposed improvements. For instance, in figure 4, the red graph has been eliminated, and the top one of the two water consumption graphs has been chosen. The addition of a legend stating the target for water consumption was another improvement. Figures 4.4 and 4.5 show these improvements comparing the 1st and 2nd iterations.

Figure 4.4- Water Page 1st iteration

Figure 4.5 - Water Page post 2nd iteration

Additionally, figures 4.4 and 4.5 show the improvement regarding the title change of the water consumption graph. The title changed from “Annual water reduction in litters” to “Annual water variation in litters”.

The Mobility page improvements are concerned with adding legends and changing the titles of graphs. Changes include changing the title of the electric vehicle table from "Electric vehicle utilization" to "Number of electric vehicles” and adding legends to the fuel graphs. Figures 4.6 and 4.7 compare the first and second iterations.

Figure 4.6 – Mobility Page 1st iteration

Figure 4.7 - Mobility Page post 2nd iteration

Concerning the product page improvement, it is proposed to include a graph relating to the ratio of concentrated products used by the company. Figures 4.8 and 4.9 show comparisons of the first and second iterations.

Figure 4.8 - Product Page 1st Iteration

Figure 4.9 - Product page post 2nd iteration

4.1.6. Evaluation

After the proposed improvements were applied, a new version of the dashboard originated. It was, therefore, necessary to carry out another phase of evaluation.

In this second iteration, the evaluation of the dashboard was done once again through semi-structured meetings. More specifically, the meeting was conducted with Luis Fragoeiro, member of Iberlim's quality, environment, and safety department.

4.3. Third DSR Iteration

The last proposed improvement to the dashboard regards the meaning of each indicator. In other words, it was discussed the possibility of having the indicators organized by their importance. With this improvement in mind, the Multi Criteria Decision Making process (MCDM) was followed and to do so several meetings were held.

After structuring the problem and the model, the next step of the MCDM process was to define the good and neutral levels. This step was presented through an online meeting with a member of Iberlim's Quality, Environment and Safety Department.

It is important to note that it was not possible to obtain data on all indicators. Therefore, it was decided that the dashboard should be filled with fictitious data, as mentioned earlier.

The next meeting was about organising the list of indicators according to their importance for the company. The meeting was held with 3 members of Iberlim associated with the sustainability department. During this meeting, the participants gave each indicator "points" from one to one hundred, as can be seen in Table 4.3.

The following thought process guided the point distribution: *Given that the increase from Neutral to Good in the "Reduction in energy use as a direct result of conservation and efficiency initiatives" criterion is worth 100 points. How many points do you allocate for moving from Neutral to Good in the criterion "Reduction in water use as a result of water-saving initiatives?".*

Table 4.3 - Indicator Points given by the organization

Indicator	Weights	Standardization
Nº de equipamentos com classe energética A adquiridos nos últimos 5 anos	65	6,99%
Redução no consumo de energia como resultado direto de iniciativas de conservação e eficiência.	100	10,75%
Redução no consumo de água como resultado de iniciativas focadas na redução do consumo de água	100	10,75%
Nº de Veículos elétricos	75	8,06%
Nº de carregadores	20	2,15%
Nº de lugares de estacionamento para bicicletas e motas.	20	2,15%
Litros de combustível consumidos por ano (para cada tipo de combustível)	100	10,75%

Nº de veículos movidos a GPL	50	5,38%
Nº de veículos com mais de X anos	65	6,99%
Redução nas emissões de CO2 como resultado de iniciativas focadas nessa redução	100	10,75%
Nº de produtos comerciais com informação socioambiental	85	9,14%
Nº de Produtos concentrados	85	9,14%
Nº de Máquinas diluidoras	65	6,99%
TOTAL	**930**	**100%**

Afterwards, with the points given by the company the ponderations for each of the indicators were calculated. The ponderations are shown in table 4.3. Below, in equation 1, there is the formula used to calculate the ponderations.

$$K_{indicador\ y} = \frac{Points\ given\ to\ \text{"indicador y"}\ by\ the\ particpants}{\sum of\ the\ points\ given\ to\ each\ indicador} \text{ (Equation 1)}$$

Once the ponderations were calculated, another page was added to the dashboard containing the top 3 most important indicators, as shown in figure 4.10. Each of the 3 indicators have a button that guides the user to the respective theme page. For example, the first indicator, regarding the energy consumption, has a button, shown in blue that will guide the user to the energy page.

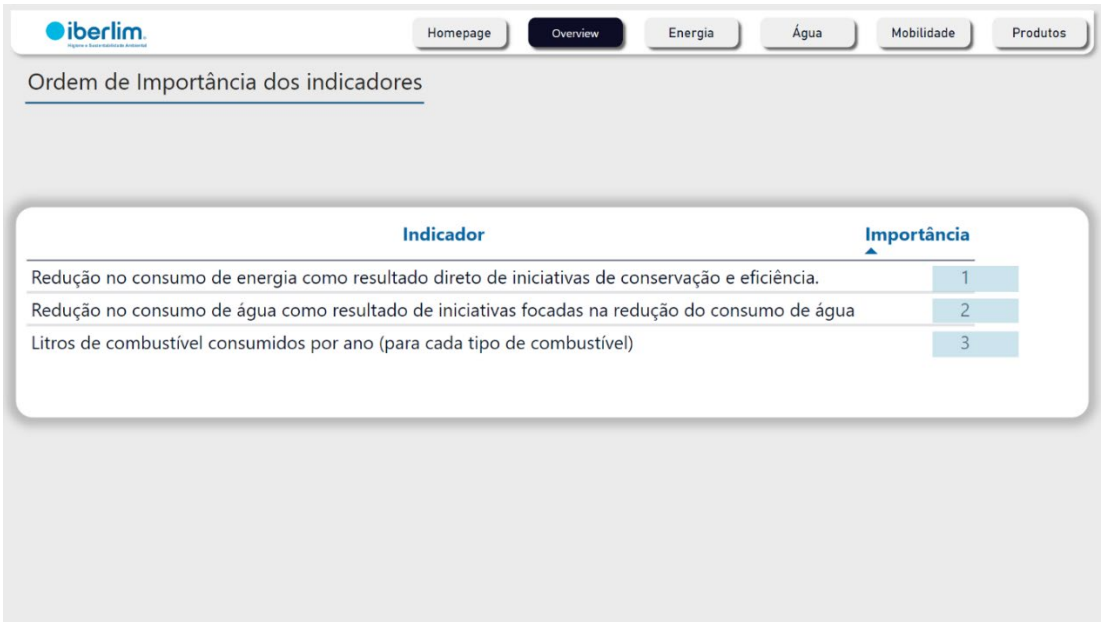

Figure 4.60 - Overview page with top 3 indicators

Through this multi-criteria analysis, Iberlim is able to quickly pinpoint its priorities and create plans for achieving its objectives, enhancing sustainability.

Next, with the improvement added to the dashboard, another meeting was held to obtain feedback from the company. The new and improved version of the dashboard was presented.

The new page was shown, and the feedback obtained was positive. The company concluded that this new page allows them to focus on the most important indicators.

Another positive aspect the company highlighted was that with the use of the buttons it will be easier to navigate and focus on each of the top 3 indicators in their respective page.

The feedback was extremely positive, and no negative aspects were indicated. Overall, the most positive aspects indicated were, once again, the dashboard's simplicity and its navigability through the use of buttons.

With the feedback obtained, there was no longer the need to improve the dashboard since the optimal solution for the artefact, according to the company, was found.

4.4. DSR Iterations Summary

To sum up, through the meetings conducted a set of improvements were obtained. These improvements led to an optimal solution of the artefact for the company.

As seen in the previous sections, there were three iterations with 8 improvements in total and all of the interviewees emphasized that the most positive aspects mentioned were the simplicity and easy navigability of the dashboard.

By following an iterative process, it was possible to obtain feedback from the early stages of the dashboard and make small changes/improvements through the process, instead of considerable changes in the end of the process.

Therefore, the benefit of an iterative process was avoiding major changes to the artefact in the end of its development, done without having any feedback or knowledge of the company's objectives and mission.

In conclusion, the iterative process enabled changes along the development of the dashboard, identification of risks and correction of aspects in each interaction, increasing therefore, the prototype development efficiency.

CHAPTER 5

Conclusions and Future work

The aim of the current research was to find out how Iberlim can monitor its sustainability, in other words, the central question for this research was as follows: *How can Iberlim monitor its processes through the adoption of more sustainable practices?*

To tackle this research, it was first necessary to review the existing literature to gather information and knowledge regarding the sector and area under study. It also looked at the different methods for measuring/monitoring sustainability. One of the conclusions from this literature review was that there is indeed a need for companies to adopt greener strategies.

It was also noted found that although there has been an increase in interest in SSCM research, , the service sector has been neglected. The decision to create a dashboard in this study was justified by the fact that dashboards are one of the most important methods for assessing progress in sustainability. The MCDM was selected and used since it is one of the primary tools to assist managers in decision making regarding SC. Furthermore, the MCDM helps in the selection and prioritization of metrics that were found to be important in this study.

Next, the DSR methodology, which focuses on developing an artefact to overcome a problem, was applied and several iterations were carried out.

These iterations included meetings with the thesis advisors and company' employees. Through these meetings it was possible to obtain feedback regarding the set of indicators, the dashboard, and the order of importance of the indicators. Furthermore, the PowerBi platform was used to develop the dashboard. As mentioned earlier, in chapter 3,a prototype was started with the company's goals and mission in mind. In several iterations, the prototype was modified according to feedback from the meetings.

After three iterations, the objective—to find the most efficient solution—was accomplished, since the third iteration received only positive feedback and the dashboard allowed the company to overcome the problem of not having a way to monitor sustainability.

Moreover, the indicators were chosen taking into consideration a thorough research of the existing indicators in the literature and the company's goals. Iberlim held several meetings to determine the type of indicators needed for the company's specific functions.

As for the limitations of the study, these refer to the lack of data and consequently the use of fictitious data to facilitate the demonstration of the dashboard's functions. Furthermore, the study focuses mostly on sustainability targets in the areas of energy, water, products/equipment, fleet management and decarbonisation and finally, the fact that this study is limited to a company in the service sector, although the results can be applied and modified in other scenarios and sectors,

In summary, despite the constraints mentioned above, the objectives of the study have been achieved, as a dashboard (the artefact) has been created with the different indicators that are vital for the company, allowing the measurement and monitoring of sustainability progress. With this artefact, Iberlim will be able to improve its sustainability by analysing its current situation and making strategic decisions based on this information.

Regarding future research, the dashboard should be tested and examined in the future using actual and current data and this study should be applied in other sectors. Exploring PowerBi functionalities such as data filtering by month, year, trimester, or even type of indicator, would be another area for future work.

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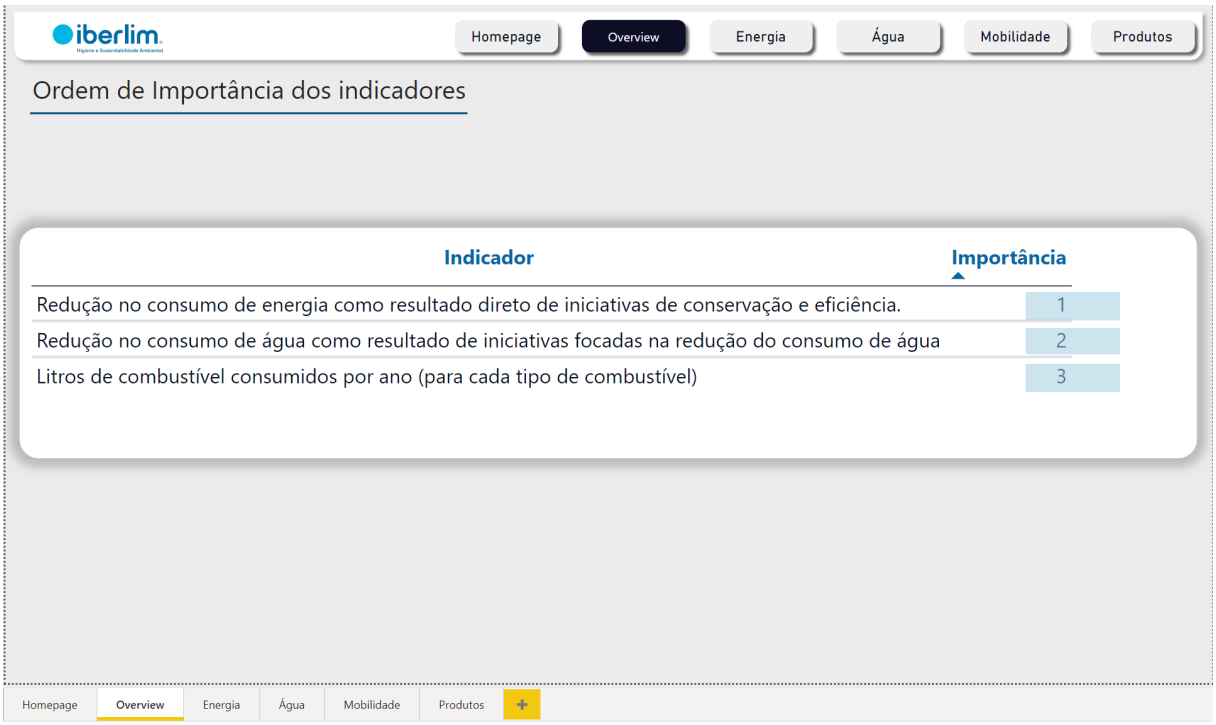
Annexes

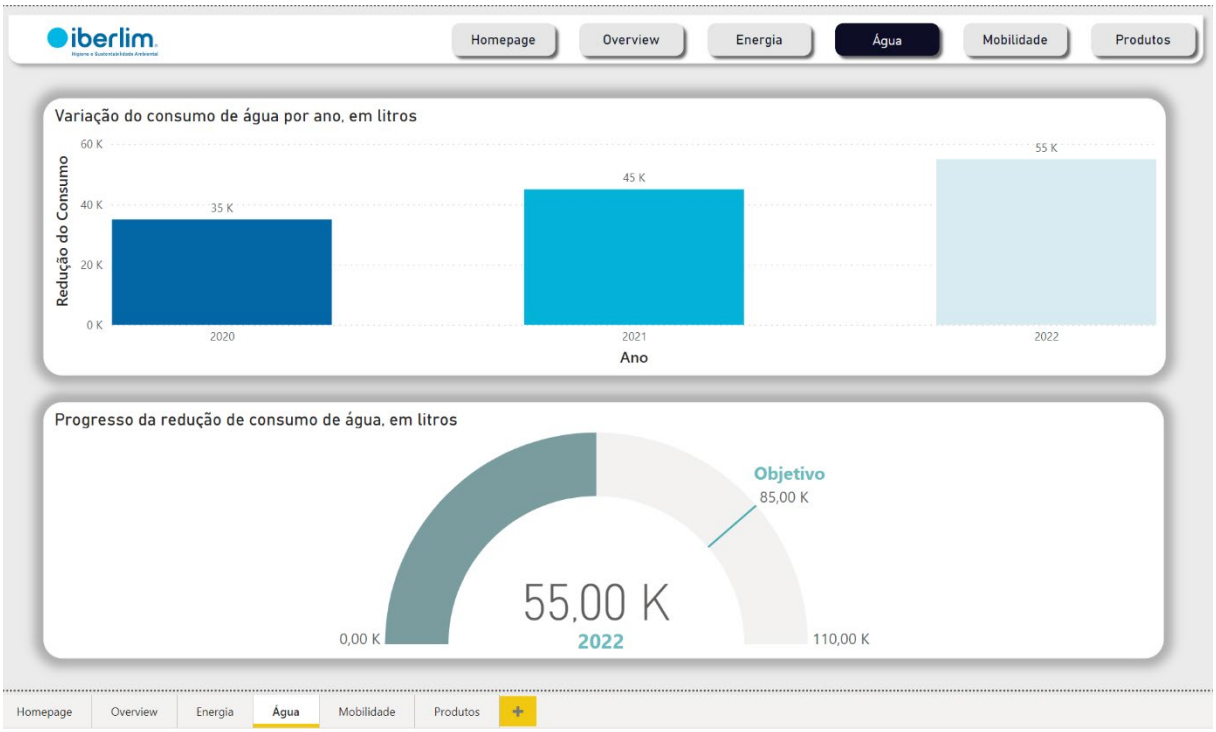
Annex A - Dashboard's Homepage

Annex B - Dashboard's Overview Page



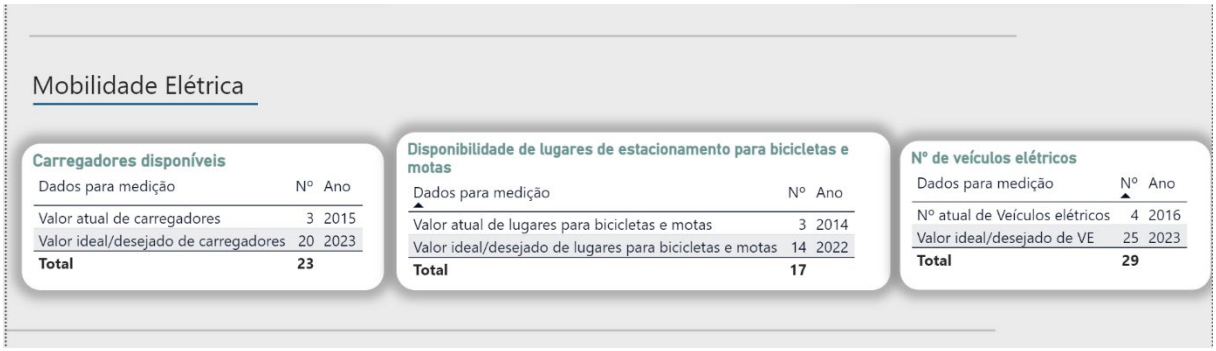
Annex C - Dashboard's Energy Page

Annex D - Dashboard's Water Page



Annex E - Dashboard's Mobility Page part 1

Annex F - Dashboard's Mobility Page part 3



Annex G - Dashboard's Mobility Page part 2

Annex H - Dashboard's Product Page part 1

Annex I - Dashboard's Product Page part 2