UNIVERSIDADE CATÓLICA PORTUGUESA

BI Tools Efficacy:

A Managerial Standpoint

Pedro Miguel Barbosa Cerejeira Namora

Católica Porto Business School, Universidade Católica Portuguesa

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BI Tools Efficacy:

A Managerial Standpoint

Final Work in Organizational Context presented to Universidade Católica Portuguesa to obtain the master's Degree in Management with a Specialization in Business Analytics

by

Pedro Miguel Barbosa Cerejeira Namora

under the guidance of

Maria Alice Trindade

Católica Porto Business School, Universidade Católica Portuguesa

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We can only realize our greatest potential with the help and support of others around us. I've had the good fortune to know many people who have inspired, challenged, and helped me grow into the finest version of myself. These include my family, my partner, my friends, coworkers, and mentors who have helped me improve both personally and professionally.

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Finally, but as importantly, my close friends have served as an example and a motivator. I can't express enough gratitude to them for their tremendous assistance in helping me succeed. Their unfailing support and understanding have been priceless.

In conclusion, I truly believe that success depends on surrounding oneself with talented individuals. The people I've already named were crucial to my success, and I will always be appreciative of their being in my life.

Abstract

Data has become a more valuable asset for businesses in the current digital era, and the capacity to transform that data into useful insights have emerged as a competitive advantage. As a result, Business Intelligence and its function in decision-making processes are becoming increasingly significant. Companies are seeking ways to make sense of the enormous amounts of information they have access to due to the rise of Big Data, and BI offers a technology-driven process for doing so.

This master's thesis focuses on the reorganization of a Power BI dashboard for the Super Bock Group. Understanding the structure of the data system, preparing it, and designing the report are the three cycles of the Action-Research technique, which had the goal of increasing the efficiency of data processing and visualization.

The primary conclusions of this study include the value of employing additional tools in addition to Power BI, the interdependence between data preparation and report design, and the necessity of a solid dataset structure for the success of the report. The study also shows the significance of including end users in the report design process to guarantee that the report satisfies their needs and specifications. A more user-friendly and efficient report is produced when end users are involved in the report creation process, according to observations.

Finally, the study emphasizes how important it is to continuously assess the usefulness of the report, update it as needed, and maintain its applicability.

Keywords: Big Data, Power BI Dashboard, Business Intelligence, Decision-Making

Words: 9127

Resumo

Os Dados tornaram-se um bem mais valioso para as empresas na era actual digital, e a capacidade de transformar esses dados em conhecimentos úteis surgiu como uma vantagem competitiva. Como resultado, a Business Intelligence e a sua função nos processos de tomada de decisão estão a tornar-se cada vez mais significativos. As empresas procuram formas de dar sentido às enormes quantidades de informação a que têm acesso devido ao aumento de Big Data, e o BI oferece um processo orientado pela tecnologia para o fazer.

Esta tese de mestrado centra-se na reorganização e reestruturação de um Dashboard em Power BI para o Super Bock Group. Compreender a estrutura do sistema de dados, prepará-lo e conceber o relatório são os três ciclos da técnica Action-Research, que tem o objectivo de aumentar a eficiência do processamento e visualização de dados.

As principais conclusões deste estudo abrangem o valor da utilização de ferramentas adicionais para além do Power BI, a interdependência entre a preparação dos dados e a conceção do relatório, e a necessidade de uma estrutura sólida do conjunto de dados para o seu sucesso. O estudo também mostrou a importância de incluir os utilizadores finais no processo de concepção do relatório para garantir que satisfaça as necessidades e especificações. Um relatório mais fácil e eficiente é produzido quando os utilizadores finais estão envolvidos no processo de criação do relatório, de acordo com as observações.

Finalmente, o estudo sublinha a importância de avaliar continuamente a utilidade do relatório, atualizá-lo conforme necessário, e manter a sua aplicabilidade.

Palavras-Chave: Big Data, Power BI Dashboard, Business Intelligence, Tomada de Decisão.

Palavras: 9127

List of Abbreviations

AI – Artificial Intelligence

BI – Business Intelligence

B2C – Business to Consumer

CRM - Customer Relationship Management

DV – Data Visualization

DSS - Decision Support Systems

ERP - Enterprise Resource Planning

EIS - Executive Information Systems

IS – Information System

IT – Information Technology

IoT - Internet of Things

SBG – Super Bock Group

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First Chapter

1. Introduction

This dissertation was written during an internship at Super Bock Group, where the company proposed a review, improvement, and delivery of an unfinished Power BI report. This dashboard intends to keep track of beverage volumes sold to a specific chain of B2C stores, comparing them to similar periods in the past and analyzing if there is improper reselling of products.

This report will be useful for both the company and the client analyzed, and it is meant to be daily updated and consulted to signalize discrepancies in volumes when they occur, being able to identify the exact location, time and products sold improperly. Ultimately this improves surveillance and control over sell-out sales, improving, over time, the business margins, and the client´s relation.

This master thesis intends to demonstrate all the processes, from analyzing the data required to the best method to connect and prepare it for reporting and the actual construction of the dashboard. Immediately after completion, other similar reports were made so it was possible to evaluate this metric in the various distribution channels.

This established the bridge to another report that will also be included in this dissertation that helps register the medium demand of a determined product, by operation, client, distributor, etc., being useful to plan Revenue Growth Management for the company, namely constructing campaigns to increase sales in certain markets of interest.

Super Bock Group, SGPS, SA, founded in 1890, is the largest Portuguese beverage company whose main activity is based on Beer and Bottled Water. Its portfolio also includes soft drinks, ciders, and wines segments, the production and commercialization of malt and the Tourism business.

I was integrated into the Business Partner Commercial team, which is part of the Management and Planning Control department, and the reports constructed were only possible due to the cooperation between the Business Intelligence Commercial department and the Information Systems department.

1.1. Report Restructuring Goals

The primary goal of this dissertation is to demonstrate the process of creating an effective Power BI dashboard and the managerial implications of its adoption on normal business operations.

To accomplish this, three sub-objectives were chosen:

1. Understand the company's data structure, software and methodology, key individuals, and data protection rules.
2. Conducting research, experimenting with various approaches, and determining the best methods to organize and process data to meet managerial objectives.
3. Creating accurate dashboards that load quickly, automatically update every day and influence business choices.

Finally, it is anticipated that this effective deployment procedure will be extended to other dashboards with various managerial aims, where there is full interaction between management and information systems, allowing Power BI to completely replace older, obsolete technologies.

1.2. Research Methodology

In terms of the methodology used to achieve the proposed goals, Action Research was chosen over other options to inspire project execution and all the data was provided by the company.

Action research is an empirical style of work in which researchers and participants, who are representatives of the issue being researched, collaborate, and participate in the conception and construction of a communal problem (Thiollent, 2022). In general, it seeks to address a research issue within an organization (Eden & Huxham, 1996).

Furthermore, researchers using this approach deal with study subjects and organizational difficulties rather than hypotheses (Checkland & Holwell, 1998).

Coughlan and Coghlan (2002) add to these remarks that action research has the following characteristics: "research in action," rather than "action research," is participative and synchronous to the action; it results in a sequence of events and an approach to issue solving. It is also vital to highlight that the above-mentioned features should be addressed from the beginning of the research, that is, it should be designed as such.

The selection considered its practical aspect, as analyzing the results drives new ways of improving. That is, it seeks change through action, research, and reflection on what has been done. Essentially, this methodology is optimal for a case study for seeking both action and research.

The action-research methodology is comprised of cycles, each of which includes a phase of planning, action, observation, and reflection, which leads to the development of a new plan. The cycles inherent to this case study are highly correlated with the objectives:

1. Understand the data structure.
2. Prepare and Arrange Data.
3. Construct the report.

In this case, each cycle is dependent on the previous ones, and only each one is successfully fulfilled and understood it is possible to move to the next. That doesn´t mean the next cycle is going to work, and the processes may need to be reformulated upstream.

1.3. Dissertation Structure

There are five chapters in this dissertation. The current chapter, Chapter 1, identifies the context in which this study was developed and how the reconstruction itself originated, as well as an outline of the goals to be achieved, the technique used, and the structure of this research.

The second chapter gives a theoretical framework related to Information Systems (IS), Business Intelligence (BI), and Data Visualization (DV), areas that are essential to understand the project and its goals.

The third chapter provides context for the internship, explains why the report needed improvement, and goes into detail about the goals. It also includes a theoretical explanation of the methods used.

The fourth chapter displays all the preliminary assessments performed on the base reports, as well as all the issues discovered. It describes all the processes of improvement among the different business reports, concluding with the finalized versions attesting to its efficiency.

The final chapter, Chapter 5, distinguishes the goals achieved, summarizes all the conclusions drawn, identifies the major contributions of this work, both to analysts and end-users and recommends improvements to the structure, the analysis and visualization of Data.

Second Chapter

2.Literature Review: From Data to Decision

The value of Data is unmeasurable - *"In God we trust, all others bring data."* - W. Edwards Deming – when it relies on its interpretation and provides actionable business decisions. - *"Data is the new gold, and insights are the new currency."* - Mark Benioff, CEO of Salesforce.

Today's business world is highly competitive, and the ability to make informed decisions quickly and accurately is essential for success. The ability to access, analyze, and visualize data quickly and effectively can be a key factor in helping management make better decisions (Adegbola, O. et al, 2019)

The present chapter serves as the theoretical underpinning for this master thesis. It approaches previous research on this topic, key concepts and ideas for better comprehension and insight into what the future holds.

The purpose of this literature review is to provide an overview of the various ways in which BI has evolved, and how it relates to management and decision-making. The intent is to show that BI can help companies make better decisions and that its use in organizations has been evolving.

It focuses on three primary areas of interest: IS, BI and DV – through Power BI - starting with the definition of the concepts, a brief history, and the relation between each one and the decision-making process in a managerial context. Lastly, this literature review also explores the future of BI regarding Artificial Intelligence (AI) and Blockchain.

2.1. Information Systems

An Information System "*collects, processes, stores, analyzes, and disseminates information for a specific purpose*" (Prince & Rainer, 2021, p.7). It can be traced back to the beginning of civilization when people started using paper as a medium to record business transactions. This form of record-keeping was first introduced by merchants who needed a way to keep track of their receipts during trade (Hirschheim & Klein, 2012).

IS have been in use since the 1960s, with the development of computer technology. During this era, IS were mainly used for data processing and storage, such as in the form of batch processing and data entry systems (Sharda et al., 2023)

In the 1970s, IS began to be used for decision support and management, with the development of Decision Support Systems (DSS) and Executive Information Systems (EIS) (Sharda et al., 2023; (Power, 2008).

In the 1980s, IS was used for competitive advantage, with the development of Enterprise Resource Planning (ERP) and Supply Chain Management systems (SCM) (Sharda et al., 2023; Wong et al., 2012).

With the advent of the internet and web-based technologies in the 1990s, IS was useful for e-commerce and Customer Relationship Management (CRM) (Sharda et al., 2023; Berry et al., 2002).

Today, IS plays a vital role in the functioning of organizations, from small businesses to large corporations, and continues to evolve with advancements in technology such as cloud computing, mobile technology, and the Internet of Things (IoT) (Sharda et al., 2023; Korte et al., 2021).

The correlation between IS and BI is critical for organizations to effectively gather, process, and analyze data for decision-making. (Sharda et al., 2023; Laudon & Laudon, 2016). IS provides the infrastructure and technology for the collection and storage of data, while BI provides the tools and techniques for the analysis and interpretation of that data (Sharda et al., 2023; Laudon & Laudon, 2016). Research has shown that the integration of IS and BI leads to improved decision-making, increased efficiency and productivity, and a competitive advantage for organizations (Al-Darras & Tanova, 2022; Wong et al., 2012).

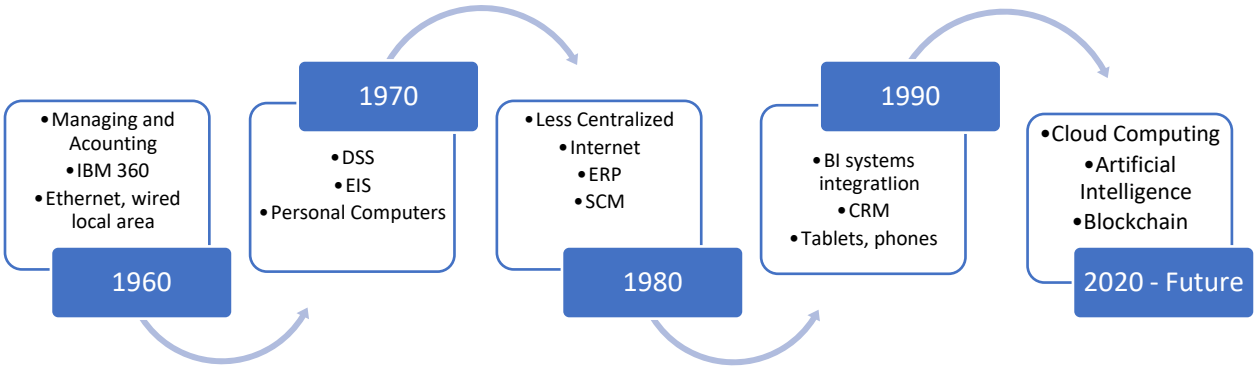

Figure 1: Evolution of Information Systems and Business Intelligence

2.2. Business Intelligence

BI is a broad term used to describe the methods and systems used to collect, analyze, and present data for making better decisions (Davenport, Harris & Morison, 2010).

It is an umbrella term that covers a range of technologies and applications designed to help businesses gain insight into their operations and make informed decisions (Sharda et al., 2023).

BI encompasses a variety of data analysis techniques, such as data mining, data warehousing, and reporting, as well as a range of software applications that enable businesses to analyze and visualize data (Xie & Zhang, 2018).

BI has its roots in the decision-support systems of the 1960s and 1970s (Al-Darras & Tanova, 2022; Richards et al., 2017). However, it wasn't until the 1990s that BI began to be used more comprehensively to support decision-making across an organization (Laudon & Laudon, 2016; Er, 1988).

The development of data warehousing, online analytical processing (OLAP) and data mining techniques were key enablers of this evolution (Sharda et al., 2023; Han et al., 2011). With the advent of big data and the increasing availability of data sources, BI has become increasingly important for organizations (Al-Darras & Tanova, 2022; Loshin, 2012). Businesses are increasingly looking to data-driven decision-making as a means of gaining a competitive edge, and BI is the foundation of this (Sharda et al., 2023). The increasing availability and accessibility of data, combined with the power of modern computing, have enabled businesses to gain insight into their operations in ways that were not possible before (Xie & Zhang, 2018).

BI has become an essential tool for management and companies, providing data-driven insights that can inform decision-making and drive business growth (Davenport, Harris & Morison, 2010). For example, data analysis can reveal patterns and trends in customer behaviour that can be used to optimize marketing strategies (Xie & Zhang, 2018). Similarly, data analysis can reveal operational inefficiencies and opportunities for cost savings (Davenport, Harris & Morison, 2010).

Today, BI is used to gather, store, access, and analyze data to support decision-making at all levels of an organization, from operational to strategic (Laudon & Laudon, 2016; Al-Sai et al., 2022). The use of BI has also been extended to the cloud and mobile platforms, making it more accessible and providing new opportunities for real-time decision-making (Sharda et al., 2023; Wiener et al., 2020).

By leveraging data analytics, businesses can gain insight into their operations and identify areas for improvement (Sharda et al., 2023). DV is an important part of BI, providing a visual representation of data that can help decision-makers gain insight (De Vos, 2020). BI provides the data and analysis, while DV, through tools like Power BI, presents that information in a clear and easily understandable format (Microsoft, 2020; Few, 2013). This allows decision-makers to interpret the data and make informed decisions quickly and accurately (Al-Darras & Tanova, 2022; Bach et al., 2022).

2.3. Data Visualization

DV is the representation of data in a graphical format, such as charts and graphs, which allows for easy comprehension and interpretation and it has been used for centuries, dating back to early human civilizations (Few, 2013). However, it wasn't until the advent of computer technology that DV became more sophisticated and widely used (Few, 2013; Tufte, 1983). With the advent of personal computers in the 1980s, DV software such as Excel and SAS became available for personal use (Sharda et al., 2023).

In the 2000s, web-based DV tools such as Tableau and QlikView emerged, making DV more accessible to a wider audience (Sharda et al., 2023; Gartner, 2018).

Power BI, a product of Microsoft, is a tool for DV and BI that allows users to connect to various data sources, create interactive visualizations, and share them with others (Microsoft, 2020). It was launched in 2013 and has since become a popular tool for organizations to use in data analysis and decision-making, due to its ease of use and ability to create visually appealing and informative graphics (Al-Darras & Tanova, 2022; Bach et al. 2022). It also offers integration with other Microsoft products such as Excel and SharePoint, making it a valuable tool for organizations already using these products (Microsoft, 2020; Wieder & Ossimitz, 2015).

Table 1 below emphasises the comparison between these three BI tools:

Service	**Power BI**	**QlikView**	**Tableau**
Ease of Use	+	-	-
Integration with other products	+	-	-
Built-in Data Connectors	+	+	+
Flexible Data Model	-	+	-
Data Discovery and Self-Service	-	+	-
Visualization Options	-	+	+
Data Storytelling	-	-	+
Community Support	+	+	+
Cost of Ownership	+	-	-
Big Data Support	+	-	-

Table 1: Comparison between BI Tools – retrieved from PowerBI, QlikView and Tableau official websites

Additionally, research has shown that the use of Power BI can improve the efficiency and accuracy of decision-making in organizations (Bach et al., 2022; Al-Emran et al., 2016).

2.4. Future of IS, BI and DV

The future of IS, BI, and DV is closely tied to the advancements in technology, particularly AI and Blockchain.

As AI becomes more prevalent, it will play a larger role in the analysis and interpretation of data. For example, according to a study by Accenture (2016), AI-driven analytics can improve the accuracy of predictions made by BI systems by up to 60%.

Also, Gartner (2020) predicted that by 2025, 40% of physical experience businesses will show improved financial results and outperform competitors through automation and virtual networks.

Similarly, Blockchain technology is poised to revolutionize data storage and sharing, making it more secure and accessible (Deloitte, 2018). It allows for the creation of tamper-proof and decentralized databases that can be shared among multiple parties, which is relevant for BI because it can ensure data integrity and security, therefore Blockchain has the potential to increase efficiency and reduce costs in the BI process (Deloitte, 2018).

Overall, IS, BI, and DV will continue to evolve and play a crucial role in the data analysis and decision-making processes of organizations. Companies are increasingly seeking to leverage data-driven insights to gain a competitive edge, and the combination of AI and Blockchain will enable them to do so in new and more powerful ways.

In Figure 2, we can see the top blockchain technologies used by the top 100 institutions (Lim, M. 2021)

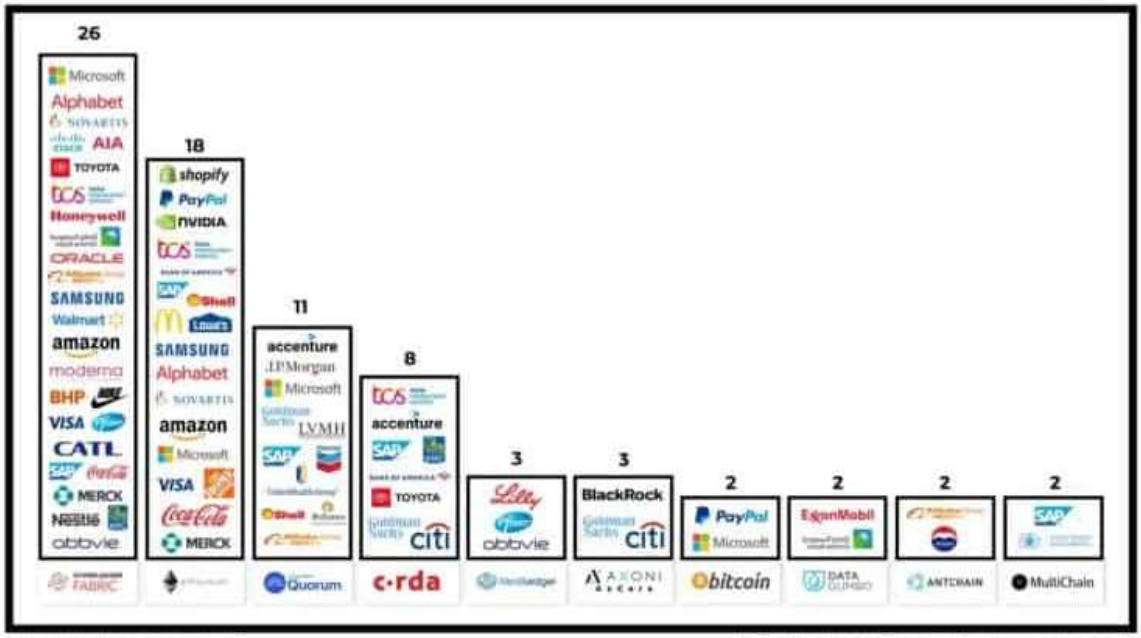

Figure 2 - Presence of Blockchain among top 100 organizations

Third Chapter

3.Research Methodology

"Methodology is the foundation on which the house of knowledge is built. It's the scaffolding that keeps us from falling into the trap of false certainty." – Steven Covey

The preceding chapter was critical in providing a theoretical framework for key concepts connected to the research upon which this dissertation is built. The third chapter now explains the approach used in the reported restructuring and it comprehends three sections: project goals in subchapter 3.1, research contextualization in subchapter 3.2 and finally, a theoretical description of the chosen method in subchapter 3.3.

3.1. Project Goals

The goal of this dissertation is to demonstrate an enhancement to one of the company's reports based on BI tool updates, notably Power BI from Microsoft. After achieving this, the objective is to use the same methods and learnings to develop needed Power BI reports allowing Super Bock Group to provide better and faster managerial decisions.

Because this dissertation is presented in the format of an Internship Report, it does not address a specific research topic considering literature gaps.

This report has as its main purpose to achieve the following articulated objectives:

1. Improve the connection to data sources through Data Flows and implement measures directly in the Cube.
2. Rule out unnecessary information and add monthly updates to Excel sources or direct Data inputs.

3. Formalize steps on Power Query, guaranteeing the absence of redundant information and inefficient queries.
4. Optimize DV, mostly according to managerial inputs given.

The internship took place at Super Bock Group, which will be discussed in section 3.2. The dataset that underpins the report was not automatically refreshed and implied a long hard work of updating various Excel files. Moreover, the amount of data and computation needed for constructing the dashboard was limiting its efficiency and practicability.

As a result, Super Bock submitted the topic "Improvement of Power BI" believing that it was necessary to modernize the methodologies employed in its reports to continue to extract knowledge from them.

3.2. Research Contextualization

The Super Bock Group headquarters are in Leça do Balio, district of Porto and it's the largest Portuguese refreshing drinks company, with a multi-brand and multi-market strategy, whose core activity is based on the Beer and Bottled Water businesses. All this information was retrieved from the official website: https://www.superbockgroup.com/

They are also present in the segments of soft drinks, wines, production, and commercialization of malt and the Tourism business, holding two assets of reference in the region of Trás-os-Montes: Vidago and Pedras Salgadas - Thermal and Recreational Parks.

Its creation dates to 1890 with the birth of "Companhia União Fabril Portuense das Fábricas de Cerveja e Bebidas Refrigerants" (CUFP), which had a beer production capacity of no more than 400,000 litres per year. In 1977, UNICER - União Cervejeira E.P. is born, a company that results from the merger of CUFP with COPEJA (Santarém) and Imperial

(Loulé). Finally, in 2017 and on the day Super Bock celebrated its 90th anniversary, UNICER changed its name to Super Bock Group (SBG). It's nowadays a majority Portuguese-owned company, with the following shareholder structure:

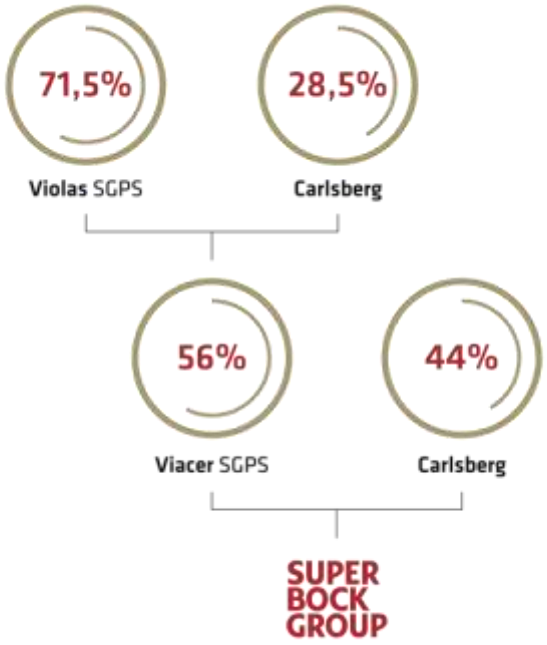

Figure 3 - SBG Shareholder structure - https://www.superbockgroup.com/

The current CEO is Dr. Rui Lopes Ferreira and the company has about 1,300 employees in more than 13 sites in Portugal and is present in more than 50 countries worldwide.

SBG is an award-winning company known for its excellence in point-of-sale activation programs and has received 9 prizes, including 4 gold, 3 silver, and 2 bronze, in the POPAI awards. Unicer's 2010 Management Report was recognized by the Red Dot Awards in 2011, and the company's 125th-anniversary book "Unicer, a long history," won the Grand Prize of the Year and the Grand Prize in the "Books" category at the Papies'15 awards in 2015.

The beer brand Super Bock was the first Portuguese beer to receive quality certification in 2002 and in 2012, Carlsberg and Super Bock beers were distinguished by the Carlsberg Group as the beers with the highest quality. Super Bock also received 36 gold medals, 32 of them in a row, in the international Monde Selection da la Qualité competition.

Additionally, the water brand Água das Pedras was the first Portuguese water brand to receive the ITKY Superior Taste Award in 2009 and 2011 and 2012, Água das Pedras was awarded the Superior Taste Award by the International Taste & Quality Institute. In 2012, Pedras Salgadas Spa & Nature Park project was the grand winner of ArchDaily's Building of the Year 2012 award in the "Hotels and Restaurants" category and in 2014, the Pedras Salgadas Spa & Nature Park was distinguished as Best Resort in the Travel+Leisure Design Award. The Vidago Palace Hotel also received a distinction in the World Luxury Hotel Awards 2014.

This company's facilities have an open space where the major departments are placed. They are classified as either support or operational. Environmental quality and safety, internal audit, finance, facilities and equipment management, information technologies and systems, human resources, and management planning and control are all included in the first category. Operational departments, on the other hand, are more concerned with production and the market. Commercial, purchasing, engineering, innovation, logistics, and marketing are all part of it. Even though each department has its own set of duties, there is a lot of contact between them daily, including frequent meetings to verify that the goals are matched.

3.3. Method

The methodology chosen to achieve the restructuring goals proposed in subchapter 3.1 was Action Research (Lewis, 1946). This methodology was chosen as it allows for the simultaneous analysis of results and the identification of new ways to improve and it is particularly suitable for addressing complex, real-life problems in organizational settings (Carr and Kemmis, 1986).

Action research is defined as comparative research on the conditions and effects of various forms of social action and research leading to social action (Lewis, 1946). According to some authors, action research is a cyclical process that consists of four phases: planning, acting, observing, and reflecting (McTaggart, 1991). As a result, it is feasible to infer that this technique is fundamentally practical and responds to the requirement to solve real-world situations. Lewis's notion is explained by McTaggart (1991) using the spiral of cycles seen in Figure 4 (adapted from: https://www.semanticscholar.org/paper/The-Action-Research-Planner-Kemmis-McTaggart/5e41ddd62bfaab5fdc0c45ae13cfdfaa16f54888)

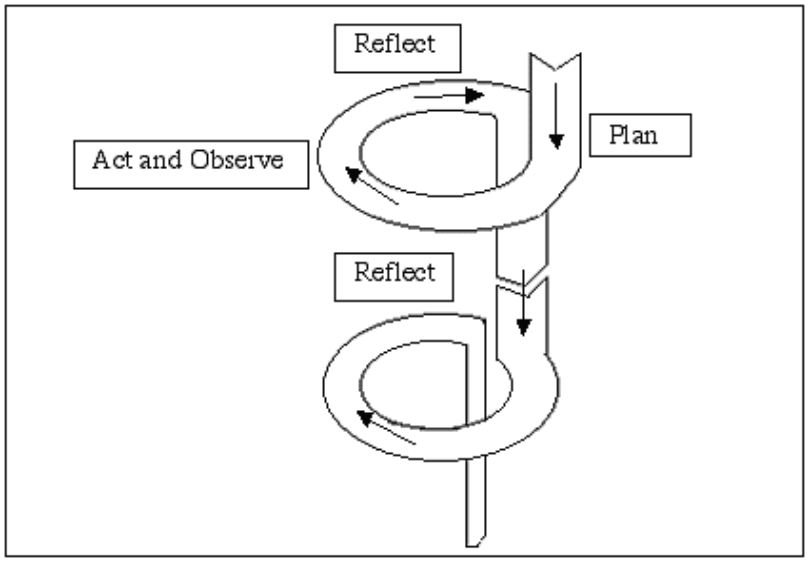

Figure 4 – Action Research Cycles

In the developed project, the spiral of cycles consists of three cycles, as can be seen in the adapted model presented in Figure 5.

The first cycle, named Understand Data Systems Structure, aimed to design a big picture of the IS and how information is stored (Inmon, 1992; Kimball, 1996). The goal was to see which model, Inmon's or Kimball's, the company was adopting and to trace a plan for an efficient flow of data.

The second cycle, Data Preparation, focused on data analyses to see if it fits the needs of the report or not and on commenting on the reasoning behind the steps applied. This phase also involves data cleaning, data transformation and data integration (Baumfield et al., 2013).

The third and last cycle, named Design Report, aimed to understand what information needs to be displayed and evaluate measures and the report's layout. This plan was connected to Few's approaches how to build a report, highlighting the most important information and using appropriate visuals (Few, 2006).

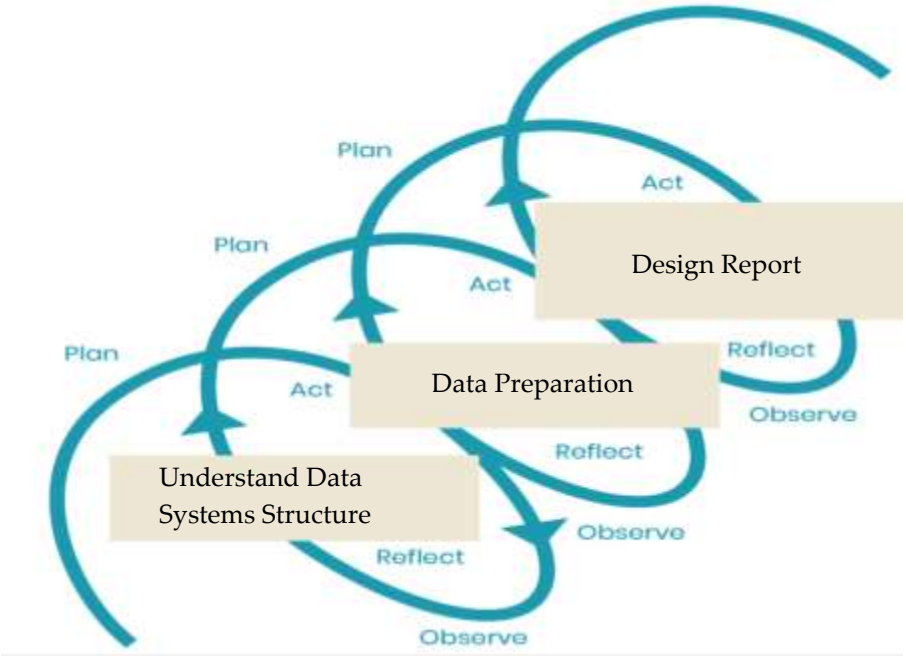

Figure 5 - Action Research Adapted

Fourth Chapter

4. PowerBI Dashboard

"Strive not to be a success, but rather to be of value." - Albert Einstein

This chapter will go into depth on the practical application of the Action Research technique that was utilized during the report restructuring at SBG, whereas the previous chapter offered a theoretical underpinning for the methodology employed throughout that process. The three significant stages of the reorganization are represented by the subchapters that are being considered here. In this regard, subchapter 4.1 concentrates on comprehending what was done in the base report, analyzing its performance, both in terms of processing and data interpretation, and concluding aspects that can be improved; subchapter 4.2 explains what changes were made, their justification, and how they were accomplished; and finally, subchapter 4.3 presents the final report, comparing it to the base one and providing genuine evidence of improvement.

After all, these steps are deserving of examination to uncover possible changes, the three cycles of action research—understanding the data system, preparing data and designing a report—will be covered across the subchapters. It is important to emphasize that each cycle received more than one turn and that just moving on to the next cycle does not eliminate the need to make any adjustments to the prior one. It was rather normal to go back a cycle while creating the report.

4.1. First Approach

At the time the previous dashboard was created, SBG only had this type of Data available on other platforms, where automatization and Data updates within 24h weren´t possible. The Power BI dashboard was linked only to a master excel file and a Direct Query to the "Master Data Calendar". The excel needed manual updates from different sources and was susceptible to human errors. The Power Query Editor showed a Data Source Error. The model view of the dashboard was the following:

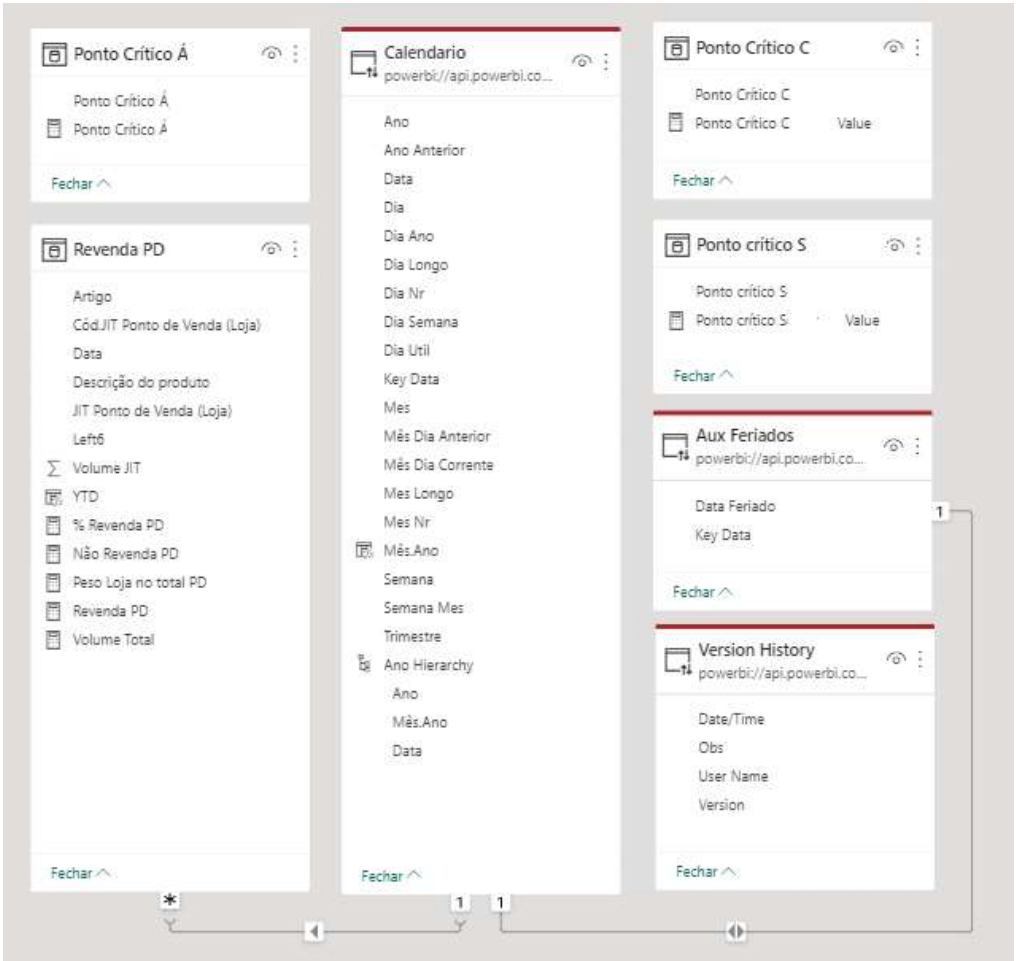

Figure 6 - Power BI - Model View of the Base Report

There were 7 tables available, 3 of them linked through Direct Query to a DataFlow common to other Data Sources. The other 3 were Parameters created for analysis purposes and the remaining table was from the excel file mentioned before. There were only two connections present: a) 1 to many, only one direction, linking "Calendario" to "Revenda PD" through the column "Data"; b) 1 to 1, in both directions between "Calendario" and "Aux Feriados", through the column "KeyData".

Below, in Table 2, it´s described in more detail each table purpose:

TABLE	**PURPOSE**
CALENDARIO	Master Data Calendario of the company with a KeyData column that is the Primary Key, allowing to have information about Day, Week, Month, Year, and Trimester.
AUX FERIADOS	Auxiliary Table of Calendario to exclude and catalogue Holidays
VERSION HISTORY	This is a control table for the ISD (Information Systems Direction) to assure the correct usage of Master Data Calendario
REVENDA PD	It has all the information needed for the dashboard, Volumes, Products and Selling Stores info
PONTOS CRITICOS "A","C" E "S"	These are parameters created to adjust the volume criteria of a specific product "A", "C" and "S", so the analysis could be done without the need to always update the measure at the source.

Table 2 - Dashboard Table's Purpose

It´s noticeable the few interactions the main Data has and how the structure is not ready to incorporate new Data easily without the need to manually adjust the measures and include new conditions to queries. In the next Table, we find the purpose of every measure and column present in "Revenda PD"

MEASURE/COLUMN	**PURPOSE**
ARTIGO	Column with the numeric code of each product
CÓD. JIT PONTO DE VENDA	Column with the numeric code of each Selling Store
JIT PONTO DE VENDA	Column with the description of each Selling Store
DESCRIÇÃO DO PRODUTO	Column with the description of each product
DATA	Column with purchases' dates in Data Format
LEFT6	Column created using the "LEFT" language to extract the first 6 letters of each row of the column "Descrição do Produto" – used for "Revenda PD measure" and parameters "Ponto Critico"
VOLUME JIT	Column with the volume of each purchase

MEASURE/COLUMN	**PURPOSE**
VOLUME TOTAL	Measure to sum values of "Volume JIT" according to the grouping done by "Left6"
YTD	Column created to attribute to each row the description of "YTD N" and "YTD N-1", meaning the transaction in that row is classified as being Year-to-Date of the current year or the year before.
REVENDA PD	Measure that uses "CALCULATE", "SWITCH", "FILTER" and "COUNTROWS" to retrieve the reselling volumes according to parameters and the product grouping by "Left6".
NÃO REVENDA PD	Measure that calculates the opposite of the previous one, simply by subtracting it from the "Volume Total"
% REVENDA PD	Measure that calculates the percentage of reselling volume
PESO LOJA NO TOTAL PD	Measure that gives the reselling volume reflection on the total volume of each selling store

Table 3 - Measures and Columns Purpose

As mentioned in the Introduction, the objective of this dashboard is to show possible reselling volume, making it possible to adjust the criteria for that reselling. There weren´t a lot of previous records of what each measure or column is supposed to retrieve from the Data, so it was a question of exploring, trial, and error to understand the purpose and figure out a better way to achieve it.

Several tools assist in gaining knowledge about the data working directly with the Power BI file. One of them is DAX Studio, which specialized in performance analysis. Upon inspection, the time the query took to run was absurd, it showed errors in the main measure "Revenda PD" and couldn´t be refreshed, so every Visual in the dashboard beside the parameters was not working.

There is a command in DAX Studio called View Metrics under the ribbon "Advanced" that provides data and metrics about the model and enables a thorough inspection of it. Even if not all the tables were loaded into the model, they nevertheless affect the speed of the report as more queries are executed. In this way, the cells with the largest numbers in each column, which reflect the tables with larger weights in each variable, are highlighted in blue (Figure 7).

Table-Column	Rows	Cardinality	Col Size	Data	Dictionary	Hier Size	% Table	% DB	Encoding	Data Type
Revenda PD-Volume JIT	1 451 811	2 770	187 312	70 272	94 864	22 176	3,55%	3,51%	HASH	Double
Revenda PD-Data	1 451 811	456	1 661 424	1 637 472	20 288	3 664	31,46%	31,13%	HASH	DateTime
Revenda PD-JIT Ponto de Ve	1 451 811	417	1 527 298	1 489 576	34 378	3 344	28,92%	28,61%	HASH	String
Revenda PD-CódJIT Ponto c	1 451 811	417	1 503 092	1 489 576	10 172	3 344	28,46%	28,16%	HASH	Int64
Ponto Crítico Águas com Gá	17	17	352	144	136	72	57,14%	0,01%	VALUE	Int64
Revenda PD-Artigo	1 451 811	13	1 628	136	1 380	112	0,03%	0,03%	HASH	Int64
Ponto Crítico Cerveja-Ponto	11	11	320	136	136	48	54,79%	0,01%	VALUE	Int64
Revenda PD-Descrição do p	1 451 811	11	17 900	136	17 668	96	0,34%	0,34%	HASH	String
Ponto crítico Somersby-Pon	9	9	312	136	136	40	54,17%	0,01%	VALUE	Int64
Revenda PD-Left6	1 451 811	3	17 338	136	17 170	32	0,33%	0,32%	HASH	String
Revenda PD-YTD	1 451 811	3	364 716	347 536	17 148	32	6,91%	6,83%	HASH	String

Figure 7 -View Metrics in DAX Studio

The next step was to get involved in the dataset. Realizing it was a heavy data collection of all purchases every day, merging from different databases than ours (clients, suppliers) therefore it required a lot of adjustments directly in the Dataflows of Data the company uses. Moreover, there's a significant concern about data privacy and access to it in SBG, so it took some time to get involved with the team the Information Systems Direction, being able to gain insights and achieve the goal. Below in Figure 8 is how the base report was presented.

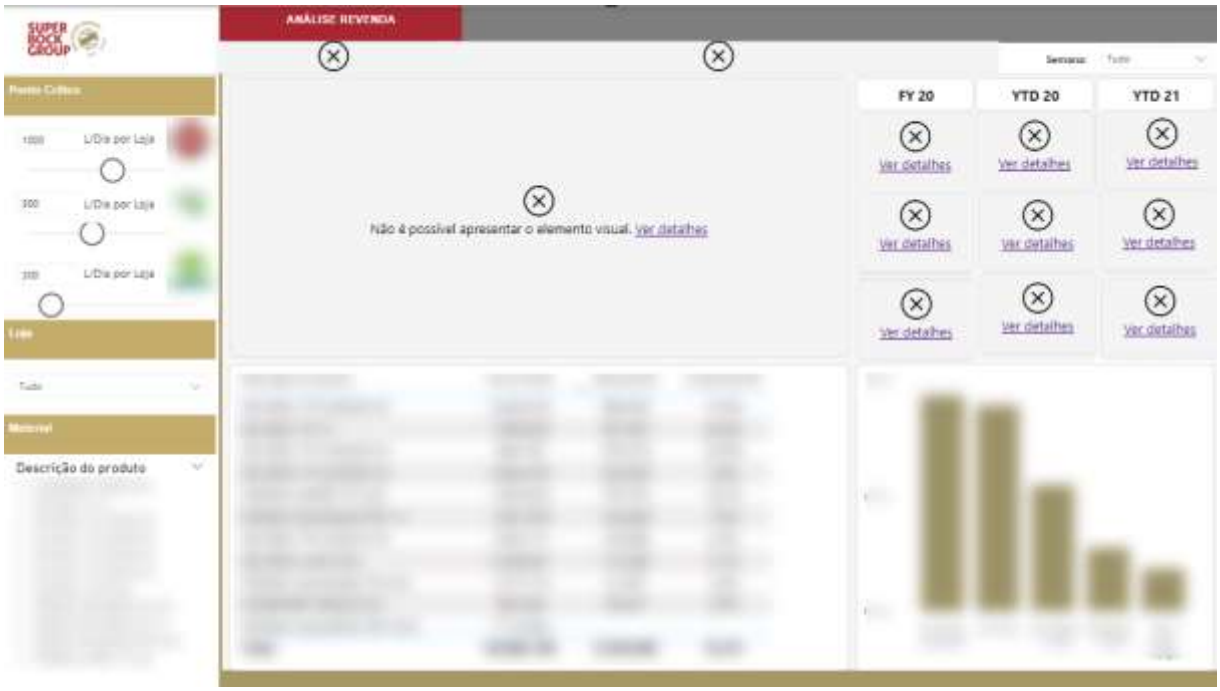

Figure 8 - Base Report

4.2. Restructuring

As I mentioned before the company has strict policies allowing access to the Datasets and especially the Data Flows, which are published on Power BI Service and granted access to use to produce dashboards for a specific number of people within the organization.

As soon as I was able to understand that the type of measures needed wouldn´t work properly if constructed in Direct Query instead of directly in the Cube linked to the Data Flow, I had to replicate all the work in a copy of said Cube so the ISD could access its impact on the queries and data structure existent. Only after this step, I was able to publish that Cube in a Workspace created specifically for the publication of this dashboard, making it updated every 24h for all the interested parties.

Now, all the data comes directly from the Data Flow mentioned and all the measures, columns and parameters are created directly at the source. This change allowed for a smother and trustworthy manipulation of Data, moreover it concentrated information not just from the one set of selling stores from the base report in question, but also from all others with whom SBG works.

Another tool that was helpful during the reconstruction and creation of efficient measures is DAX FORMATTER, available online, which allows for the bug report and formatting of all syntax. A complete list of all the measures and columns created in the new report is provided in the Appendix.

On the next page, Table 4 matches each new table with the base report and changes made, while Figure 9 presents the Model View of the updated Cube.

TABLE	**PREVIOUS TABLE**	**CHANGES**
CALENDARIO	CALENDARIO	Same table but now updated in 24h automatically
DATA ULTIMA ATUALIZAÇÃO	CALENDARIO	Now there is a table that matches the last data with a value of volume associated to retrieve a last-date update on the report
ESTAÇÕES	AUX FERIADOS	Now the Holidays are already filtered out of the calendar and the new table provides a seasonality analysis
LISTA DE PARAMETROS	VERSION HISTORY	Now, this control is done by the new table, implementing more criteria inclusion.
FCT SELL OUT JIT	REVENDA PD	This new table has just the volumes and the measures of the columns created
INSIGNIA	REVENDA PD	This new table has just the information about the selling stores
PRODUTO	REVENDA PD	This new table has just information about products and two measures to group them
PONTOS CRITICOS "A","C", "S" & "OUTROS"	PONTOS CRITICOS "A","C" E "S"	The same as before but now a new parameter for another group of products adjusted all to the new values asked.

Table 4 - Tables Changes and Matching

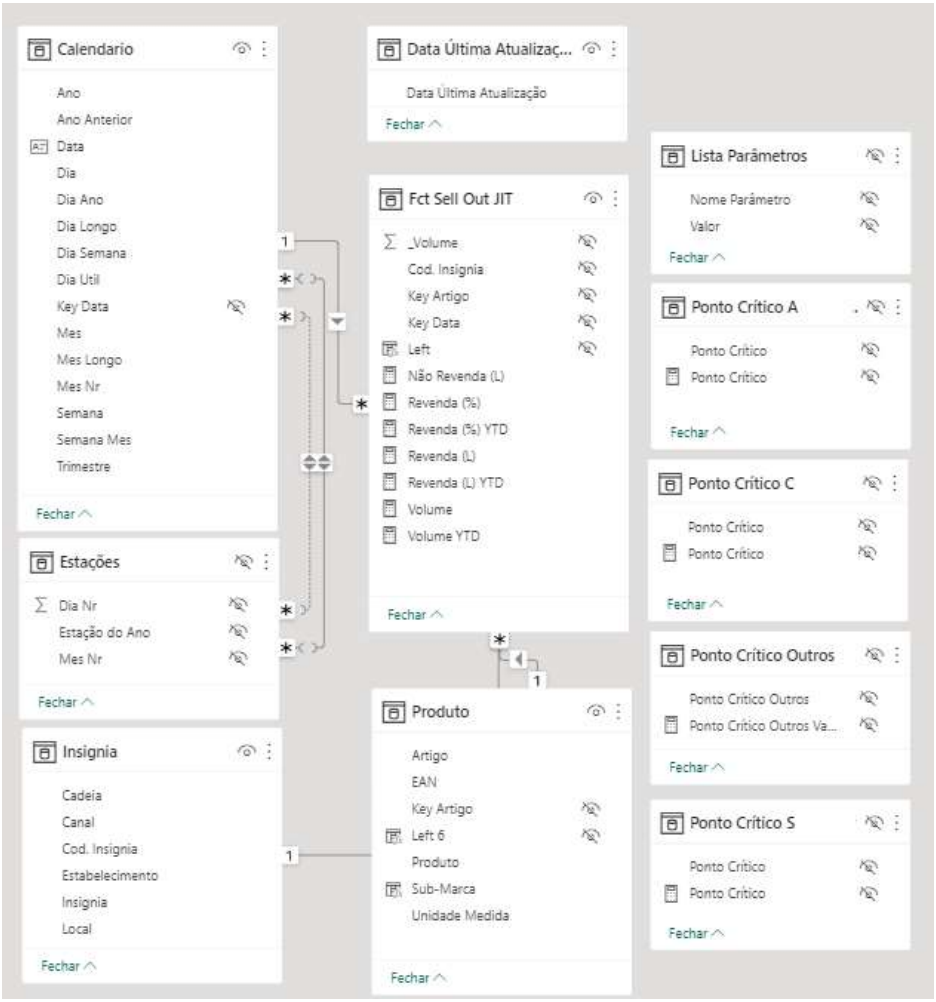

Figure 9 - Model View New Report

As you can attest all connections are done one directional 1 to many, except for the relations between "Estações" e "Calendario". Along with the restructure and reformulation of tables and measures, namely the measures "Revenda", one worth mentioning is also the YTD measures that are directly calculating the respective values, using TOTALYTD and DATESBETWEEN, allowing for better performance and DV on the Dashboard.

All the metrics regarding this specific purpose are organized in subfolders "Métricas Revenda" as it's registered in figure 10:

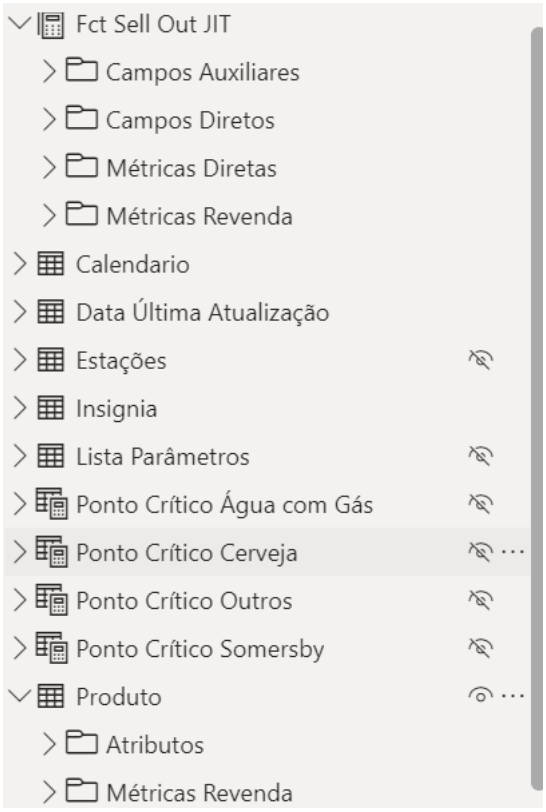

Figure 10 - Organization of new Measures

Finally, while arranging visuals and the DV of the dashboard, it was also created a mobile version of it, allowing for easy and better visualization in small devices. It took several verifications on the veracity of the results the dashboard was generating, but after approval, it was published and started being used in monthly meetings of the Internal Market.

4.3. Final Report

It is now required to analyze all the points discussed in subchapter 4.1 but with the inclusion of the changes outlined in subchapter 4.2 to truly verify the existence of improvements in the processing and interpretation of the report.

Beginning with the first cycle, "Understand Data Systems Structure," it was feasible to draw the following conclusions from the analyses: 1) the data source update, along with the new structure connections, allowed the reduction of the number of duplicate columns and redundancies in the measures; 2) It also allowed automation in updates and a much more reliable outcome; 3) Opened the way to the analysis of all the volumes sold in the most relevant group of selling stores for SBG.

Similar to Figure 7, in Figure 11 it´s possible to see the View Metrics Analysis for the new Report, marked in blue some of the heaviest columns, noticing the clear expansion of the dataset and complexity and running the queries faster and accurately.

Table-Column	Rows	Cardinality	Col Size	Data	Dictionary	Hier Size	% Table	% DB	Encoding	Data Type
Fct Sell Out JIT-_Volume	39 007 014	6 334	10 201 004	9 824 800	325 516	50 688	11,31%	11,20%	HASH	Double
Calendario-Data	1 461	1 461	63 020	2 472	48 852	11 696	18,50%	0,07%	HASH	DateTime
Calendario-Key Data	1 461	1 461	64 493	2 472	50 325	11 696	18,94%	0,07%	HASH	String
Insignia-Cod. Insignia	1 351	1 351	66 840	2 296	53 728	10 816	27,83%	0,07%	HASH	String
Insignia-Estabelecimento	1 351	1 327	85 142	2 296	72 222	10 624	35,45%	0,09%	HASH	String
Fct Sell Out JIT-Key Data	39 007 014	1 118	50 157 429	50 117 680	30 789	8 960	55,59%	55,05%	HASH	String
Fct Sell Out JIT-Cod. Insignia	39 007 014	914	17 570 480	17 522 536	40 616	7 328	19,47%	19,28%	HASH	String
Produto-Key Artigo	748	748	37 451	1 128	30 323	6 000	19,44%	0,04%	HASH	String
Fct Sell Out JIT-Key Artigo	39 007 014	748	7 718 987	7 682 664	30 323	6 000	8,56%	8,47%	HASH	String

Figure 11 - View Metrics Analysis New Report - DAX Studio

The bulk of the intricate processes in the case of the Data Preparation cycle was formalized by adding an explanation to the code. The benefit of adding a remark to an applied step's properties section is that it will automatically appear as a form of a tooltip when the applied step is hovered over, as seen in Figure 12.

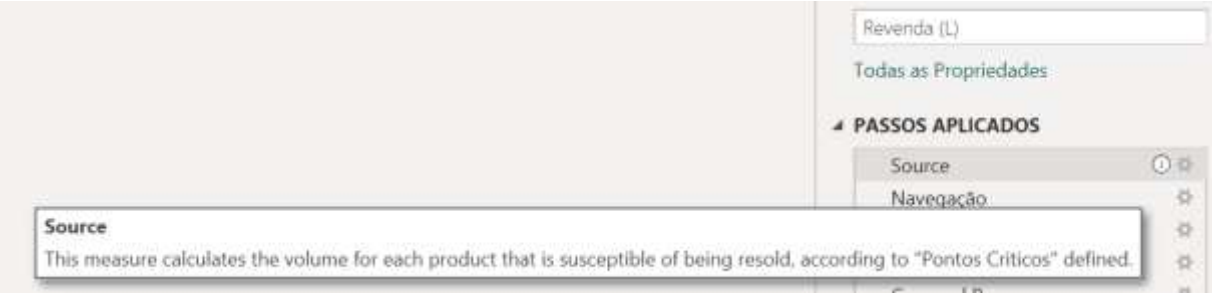

Figure 12 - Example of a Code Explanation

Despite having more tables than before and a larger dataset, all the connections are based on common primary keys that are used for all processes at SBG. This allows consistency in the Data, more flexibility to add new references and parameters to the dataset and as I mentioned, a Cube that can be used to replicate the analysis in other selling stores.

Has also occurred extreme verification of the Data itself and the output of the measures created, comparing values with the usual data sources used by the department for Data extraction and analysis such as SAP and BW.

Regarding the third cycle, Design Report, the analysis performed showed a total of 14 measures/columns/parameters compared to only 10 from the base report. Nevertheless, the response time on calculations and visual displays is very short, the dashboard works smoothly and can increase its size over time without compromising its performance.

Regarding the body of the dashboard, in the upper half, it´s possible to see the evolution over time and year to date of the mentioned volumes, through a graphic and cards, while the lower half has a table with information by row to go to detail if needed, as well as a graphic with information by selling store.

Lastly, in the following Figures 13 and 14, it's possible to preview the Design Report, a desktop, and a mobile version, respectively. On the desktop version, slicers to define parameters and filters of categories are placed on the left ribbon, while Data visuals, Year, Month and Week as well as the last update date are located on top. [1]

Figure 13 - Desktop Version New Dashboard

[1] All Data has been blurred due to Data Privacy policies required by SBG

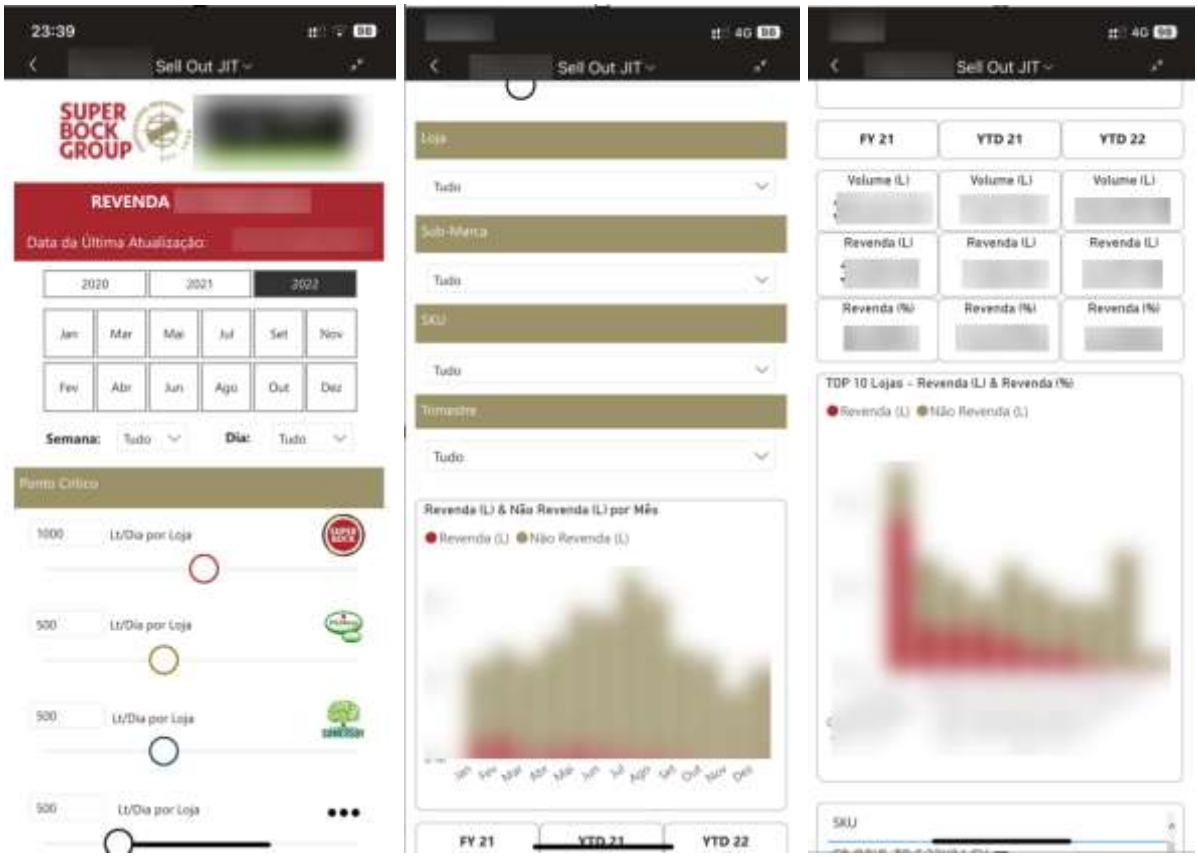

Figure 14 - Mobile Version New Dashboard

Fifth Chapter

5. Results Discussion

The final dashboard presented on the previous subchapter serves its purpose on the day-to-day operations and fulfills the main objective of this internship. On one hand, there's a stable and trustworthy data source with minimal data manipulation, updated automatically with information daily, on the other, a smooth and friendly user platform that allows data visualization and decision making anywhere, anytime and on any device.

Comparing to the initial report, the need to manual updates any information or measures on the dashboard is practically inexistent. Instead of doing a monthly actualization on all the Data, it only needs to be updated once a year to accommodate new years date references, regarding measures like "YTD", or when the managerial decisions imply changing parameters to provide different outcomes than the initial suggested.

As limitations and possible suggestions for future similar studies, the most noticeable note is regarding data access and understanding. To successfully achieve the managerial goals, it is essential, even with all data privacy restrictions, a full comprehension of the Data profile and future possible changes, so the models that are created are fitted to improve and to adapt overtime.

Finally, communication is crucial for better results, improving interaction between IT and Business teams, searching for inputs and feedback along the process and sharing progresses are of extreme relevance.

6. Conclusion

The improvement and restructuring of a report using Power BI and other BI tools is the main goal of this dissertation, along with assuring its practical application. The company SBG where the internship that served as the basis for this research took place, is the owner of the report on the issue.

The report's major conclusions and business implications are identified in the first two subchapters, respectively, and some future recommendations are offered in the last chapter.

To that end, several evaluations of the base and updated reports were conducted to find possible areas for improvement.

6.1. Final Conclusions

All the previously specified goals were accomplished, which served to improve the report's effectiveness as its primary purpose. Additionally, several conclusions were reached concerning both the design of a report and the Power BI tool after the creation of everything covered in the preceding chapter.

The quality and optimization of data when connected through BI tools such as Data Flows must be ensured so these platforms work as effectively as feasible. Disregarding this implies problems of misconnection between different tables, excessive and more complex measures, and overall compromises the efficiency of the report.

When utilized effectively, the extensive expertise of external tools linked with Power BI, in this example, DAX Formatter and DAX Studio, is crucial for ensuring accurate information processing.

As there are cycles that are extremely interwoven with one another, there is no real distinction between the layout design of the report and the preparation of the data, the adjustments were made by experimenting, publishing, and observing its behaviour, going back and forth until the goal was reached.

It is also of extreme importance to cooperate between managerial and information systems teams to achieve a comfortable level of understanding between them assuring the correct Data structure and manipulation.

6.2. Business Implications

Because of the hands-on work done during the internship, end users were able to make managerial choices right away, saving time on Excel analysis and debate while reducing the possibility of human mistakes in data manipulation. This was accomplished by automating manual updates and the construction and validation of the dataset, which led to more effective methods for updating reports and preparing data.

The formalization of procedures and the inclusion of comments in the code benefitted analysts by making it simpler for everyone to understand what was done and why, freeing analysts to concentrate on problems that needed their complete attention.

Thanks to the arrangement of graphics allowed for easy categorization and more room for meaningful information, end users were able to quickly identify the most important information. Table 5 it's a summary of the main implications:

Main Implications
Practical work during the internship
Allowing end-users to make real-time managerial decisions
Saving time in excel analysis and discussion
Lowering the risk of human errors in data manipulation
Automating manual fixes
Formalization of steps
Leaving comments in the code
Efficient data preparation and report updating processes
Placing visuals according to the report's needs
Incorporation of changes into other reports

Table 5 - Main Business Implications

6.3. Future Recommendations

Some recommendations should be taken into consideration for future similar work done in the organization:

1- Always perform the Diagnose Analysis, as it specifies when to complete each step.

2- Use the Performance Analyzer for each page to learn how long it will take to process each visual.

3- Work together with the responsible teams to achieve better performance, documenting all the processes.

4- Improve constant search for BI knowledge, tools, and all emerging fields like artificial intelligence.

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8. Appendix

Measures/Columns/Parameters	**Description**
Volume	SUM('Fct Sell Out JIT'[_Volume])
Left	RELATED (Produto[Left 6])
Revenda (L)	CALCULATE ([Volume] - COUNTROWS ('Fct Sell Out JIT') * SWITCH (SELECTEDVALUE (Produto[Left 6]), "SB ORI", 'Ponto Crítico Cerveja'[Ponto Crítico Cerveja Value], "PEDRAS", 'Ponto Crítico Água com Gás'[Ponto Crítico Água com Gás Value], "SOMERS", 'Ponto crítico Somersby'[Ponto crítico Somersby Value], 'Ponto Crítico Outros'[Ponto Crítico Outros Value]), FILTER ('Fct Sell Out JIT', 'Fct Sell Out JIT'[_Volume] > SWITCH ('Fct Sell Out JIT'[Left], "SB ORI", 'Ponto Crítico Cerveja'[Ponto Crítico Cerveja Value], "PEDRAS", 'Ponto Crítico Água com Gás'[Ponto Crítico Água com Gás Value], "SOMERS", 'Ponto Crítico Somersby'[Ponto Crítico Somersby Value], 'Ponto Crítico Outros'[Ponto Crítico Outros Value])))
Não Revenda (L)	[Volume] - [Revenda (L)]

Measures/Columns/Parameters	**Description**
Revenda (%)	DIVIDE([Revenda (L)], [Volume])
Volume YTD	TOTALYTD([Volume], DATESBETWEEN(Calendario[Data], 01-01-2021, EDATE(TODAY(),-12)))
Revenda (L) YTD	TOTALYTD([Revenda (L)], DATESBETWEEN(Calendario[Data], 01-01-2021, EDATE(TODAY(),-12)))
Revenda (%) YTD	TOTALYTD([Revenda (%)], DATESBETWEEN(Calendario[Data], 01-01-2021, EDATE(TODAY(),-12)))
Left 6	LEFT (Produto[Produto], 6)
Sub-Marca	IF (Produto[Left 6] = "SB ORI", "SB Original", IF (Produto[Left 6] = "PEDRAS", "Pedras", IF (Produto[Left 6] = "SOMERS", "Somersby", "Outras")))
Ponto Critico(s)	GENERATESERIES(200, 1000, 50)

Table 6 - Appendix - Measures/Columns/Parameters created in New Report