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XTraN Reports and Dashboards

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Abstract

There is a huge amount of data generated every day in the world. All companies deal with data, whether it is a lot or a few. As the amount of data managed by a company increases, so does the need to have an efficient management of these data, this is where Business Intelligence (BI) comes in, helping to manage data in a way that adds value to the business.

The main objective of this work is to use Business Intelligence to improve the quality of services provided by a fleet management company named Tecmic, through reports and dashboards. XTraN is the professional Tecmic fleet management solution, the reports and dashboards will be used internally by the company's workers to have a more general picture of the events. It was possible to observe which vehicles had the most failures, the delays of the messages sent by the vehicles to the control station over time, to analyze the GPS signal quality over time, to identify the company's bottlenecks and have the possibility of improving them.

A comparison was made between the leading BI tools on the market, and from the study made, Microsoft Power BI tool was the one that best suited the needs of XtraN, consequently, it was the chosen tool to create the reports and dashboards.

Keywords

Business Intelligence; Microsoft Power BI; Data Warehouse; Extract Transform and Load (ETL); Data Analysis;

Resumo

Há uma enorme quantidade de dados gerada todos os dias. Todas as empresas lidam com dados, sejam muitos ou poucos. À medida que aumenta a quantidade de dados geridos por uma empresa, aumenta também a necessidade de ter uma gestão eficiente desses dados, é aqui que entra a *Business Intelligence (BI)*, ajudando a gerir os dados de forma a agregar valor ao negócio.

O principal objetivo deste trabalho é utilizar *Business Intelligence* para melhorar a qualidade dos serviços prestados por uma empresa de gestão de frotas denominada Tecmic, por meio de relatórios e painéis de controlo. O XTraN é a solução profissional de gestão de frotas da Tecmic, os relatórios e painéis de controlo serão utilizados internamente pelos colaboradores da empresa para ter uma visão mais geral dos eventos. Foi possível observar quais veículos tiveram mais falhas, os atrasos das mensagens enviadas pelos veículos para a estação de controle ao longo do tempo, analisar a qualidade do sinal GPS ao longo do tempo, identificar os estrangulamentos da empresa e ter a possibilidade de melhorá-los.

Foi feita uma comparação entre as principais ferramentas de BI do mercado, e a partir do estudo realizado, concluiu-se que a ferramenta Microsoft Power BI é a que melhor se adequa às necessidades do XtraN, consequentemente, foi a ferramenta escolhida.

Palavras Chave

Business Intelligence; Microsoft Power BI; *Data Warehouse*; *Extract Transform and Load (ETL);* Análise de dados;

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Acronyms

ETL Extract Transform and Load

BI Business Intelligence

OLAP Online Analytical Processing

ERP Enterprise Resource Planning

CRM Customer Relationship Management

SQL Structured Query Language

HR Human Resources

SSAS SQL Server Analysis Services

DAX Data Analysis Expressions

MDX Multidimensional Expressions

CSV Comma Separated Values

MD Multidimensional Models

SAAS Software As A Service

SAP Systems Applications and Products in Data Processing

MS Microsoft

API Application Programming Interface

iOS iPhone Operating System

AI Artificial Intelligence

IT Information Technology

ID Identity

GPS Global Positioning System

DIFF Difference

SME Small and Medium-sized Enterprises

SWOT Strengths, Weaknesses, Opportunities, Threats

1

Introduction

Contents

Nowadays, a massive amount of data is produced every minute [1] – in every operation that is carried out at the cashier in a store, when entering a hospital, when uploading a video or a photo on social networks, when shopping online, when checking in at an airport, when registering on a website, when processing a document or when sending email, these are some examples of actions that we take in our day-to-day life and leads to the production of data. An operation that seems simple often leads to the production of a lot of data. It is increasingly urgent to find an efficient way to store the data and more importantly to find an efficient way to manipulate this data.

1.1. Motivation

A large amount of data by itself does not convey any meaning, becomes difficult to handle and does not add much value to the business. It is necessary to manipulate the data to extract useful and relevant information for a particular business. Business intelligence comes to meet this need and to support better business decision making.

The main objective of this work is to use Business Intelligence to improve the quality of services provided by a fleet management company named Tecmic in its XTraN solution, through reports and dashboards, to help in decision making, recognize failures in the systems, know the bottlenecks of the company, analyze trends, reduce the time of analysis of a problem and in this way, with the same amount of resources, provide a more efficient system.

XTraN is the professional Tecmic fleet management solution. XTraN combines the equipment installed in vehicles, a modern GPS location, communication techniques and a complete management software, offering a complete solution for the professional management of employees and vehicles in many activity sectors. Whenever an in-depth analysis of its activity is carried out, weaknesses are discovered that need to be addressed. XTraN provides managers with the necessary tools for performing this analysis and based on this, improving their operational efficiency. All information of interest collected from the fleet flows through XTraN, eliminating the need for voice communications. All data and messages exchanged are archived within the system for later offline analysis. And it is on these data that the analyzes in the present work were carried out. Figure 1.1 shows the XTraN Architecture, each component of this architecture is in [2], service orders arrive to a PDA terminal, the information is sent and stored in Xtran control center, a service planning is made, which consists of automatically assigning services to different vehicles and fleet teams, the optimization and ordering of routes to comply with services and schedules. Then, a dispatch of service is made, which consists of sending services through the platform to the consoles installed in the fleet vehicles, and the complete service information: address, client and remarks. And then the service coordinates are sent to the dispatch and navigation consoles located in the vehicles, which allows real-time monitoring of the services status.

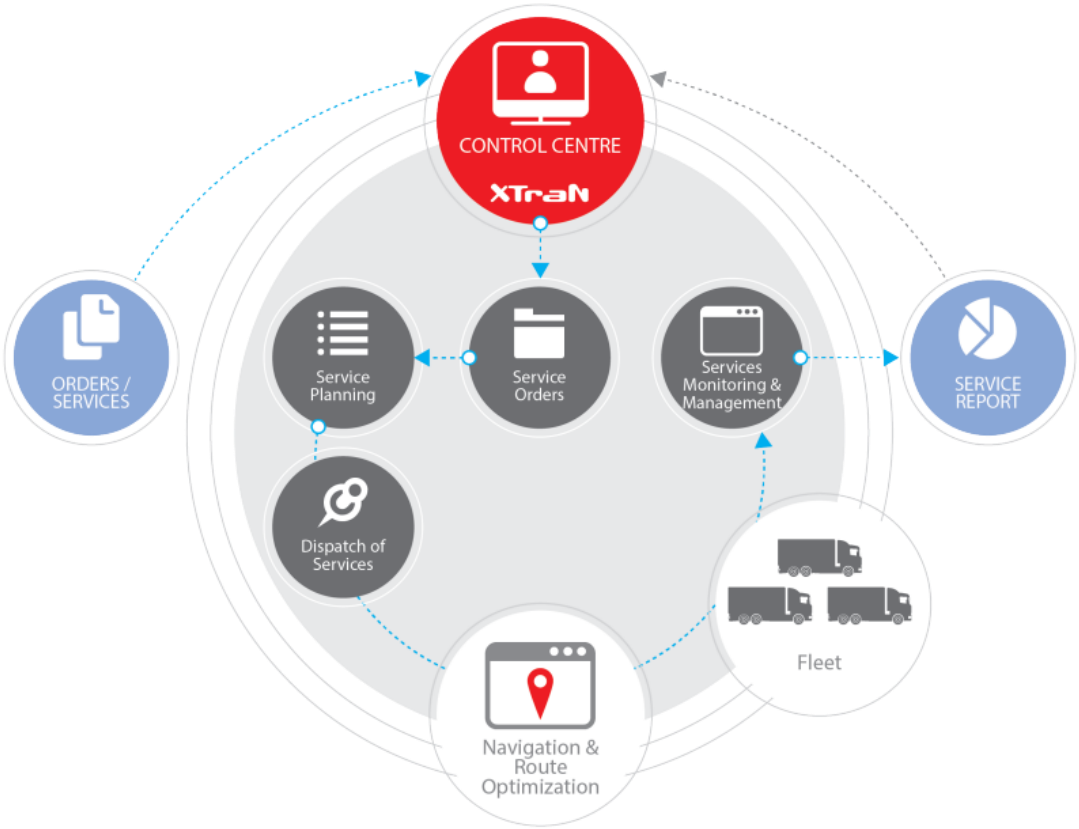

Figure 1.1: Xtran Architecture [3]

1.2. Stakeholder

The entity that has requested this project is the Tecmic - *Tecnologias de Microeletrónica, S.A.* Founded in 1988 [3], where in the beginning, the area of expertise was hardware and communications equipment. Today Tecmic also operates with software through the development of desktop applications, as well as mobile applications for navigation consoles/terminals by Global Positioning System (GPS), and web applications. Tecmic main area of business is the professional vehicle fleet management that allows its customers to increase the productivity and efficiency of their operations [4]. Also operates with mobility, asset and team management, waste collection management, passenger transport management, emergency and public safety, and electronic security management.

1.3. Organization of the Document

This document is organized as follows: chapter 2 is the theoretical background. Chapter 3 is the related work. In chapter 4, the implemented solution. And in chapter 5 the results of the data analysis in the company sample data. Chapter 6 draws the conclusions and suggests the future work.

2

Theoretical Background

Contents

2.1. Business Intelligence

Business intelligence (BI) is a technology-driven process for analyzing data and show actionable information to help corporate executives, business managers and other end users make more informed business decisions. BI have a wide variety of tools, applications and methodologies that enable organizations to collect data from internal systems and external sources, prepare it for analysis, develop and run queries against the data, and create reports, dashboards and data visualizations to make the analytical results available to corporate decision makers as well as operational workers. The potential benefits of business intelligence programs include accelerating and improving decision making; optimizing internal business processes; increasing operational efficiency; driving new revenues; and gaining competitive advantages over business rivals. BI systems can also help companies identify market trends and spot business problems that need to be addressed [5]. The Figure 2.1 shows the architecture of Business Intelligence which is made up of data sources, Extract Transform and Load (ETL) process, optimized data storage (Data Warehouse and Data Mart), BI technologies that can be presented in different ways according to the defined purpose.

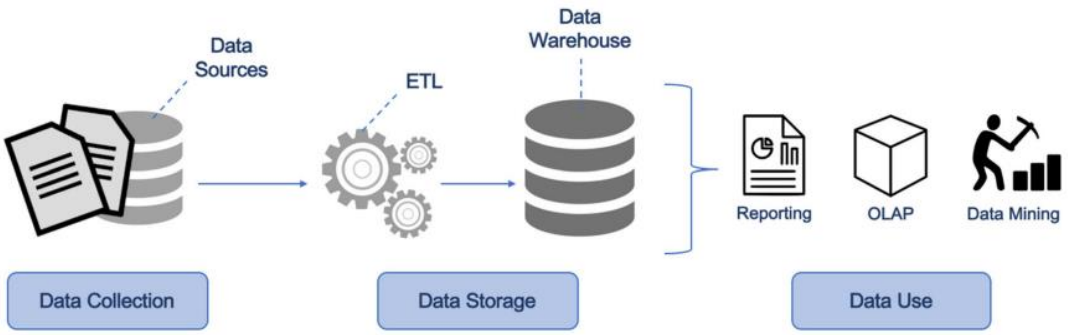

Figure 2.1: Architecture of Business intelligence [6]

2.2. Data Warehouse and Data Mart

A Data Warehouse is a central database created for storing and organizing data from many disparate systems in one usable format, to make the data readily accessible for reporting, analysis, and planning. Making the data from all those sources useful and accessible for the organization.

A Data Mart is a more specialized tool with a similar purpose; it is a functional database that pulls particular information out of the overall Data Warehouse or even directly from source systems to answer specific queries. For example, a manufacturing location may need to compile some specialized data unique to the process used to make a particular product. The overall data warehouse is too big and complex do that job, so a smaller version — a data mart — can be created for this one manufacturing location [7].

Data Warehouse databases usually have a star schema with one fact table in the middle and many dimensions tables, as can be seen in the Figure 2.2. A fact table contains the specific measurable, quantifiable, or numeric data, the primary data to be analyzed, for example a sales table. A dimension table contains the aspects of data items, for example a table that describes the products details. The star schema is simple to understand and involves fewer joins than other data warehouse schemas which makes it optimized for querying large data sets.

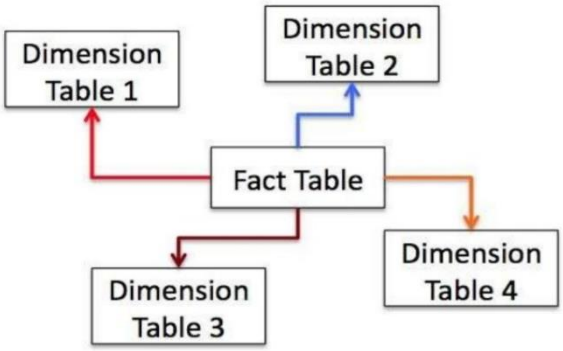

Figure 2.2: Star Schema

2.3. Data Sources

The data used in Business Intelligence tasks comes from different sources, which contains data of varying quality, use inconsistent representations, codes, and formats. Thus, the problems of integrating, cleansing, and standardizing data in preparation for BI tasks can be challenging [8]. Data sources can be an Operational System, Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), SQL Databases, files, and spreadsheets.

Organizations use ERP software to automate business processes and gain a central hub for insights and controls. A modern ERP system draws on a central database that collects inputs from departments including finance, manufacturing, operations, sales and marketing and human resources (HR). Thanks to that central database, stakeholders gain cross-departmental insights that they can use to analyze various scenarios, perform financial planning and analysis and teasing out process improvements that can translate to major efficiency gains, cost savings and better productivity as people spend less time searching for needed data [9].

CRM is the building of a customer-oriented culture by which a strategy is created for acquiring, enhancing the profitability of, and retaining customers, that is enabled by an IT application; for achieving mutual benefits for both the organization and the customers [10].

2.4. ETL

Extract Transform and Load (ETL) is a phase of BI that integrate and increase the value of data according to a set of rules, transforms data from heterogeneous sources to a common and clean format. It consists of 5 modules: data extraction, data validation, data cleaning, data conversion and data loading. ETL is a transfer process of data from data source to the target data warehouse and an important step of data warehouse implementation [11]**.**

2.5. BI Technologies

OLAP: Online Analytical Processing is a technology that performs multidimensional analysis at high speeds on large volumes of data from a data warehouse, data mart, or some other unified, centralized data store [12]. OLAP systems are composed of OLAP Cubes, which add dimensions to the database. The Figure 2.3 shows an example of a cube, with 3 dimensions (region, product and Q), each cube of the spectrum represents one value in each of the dimensions.

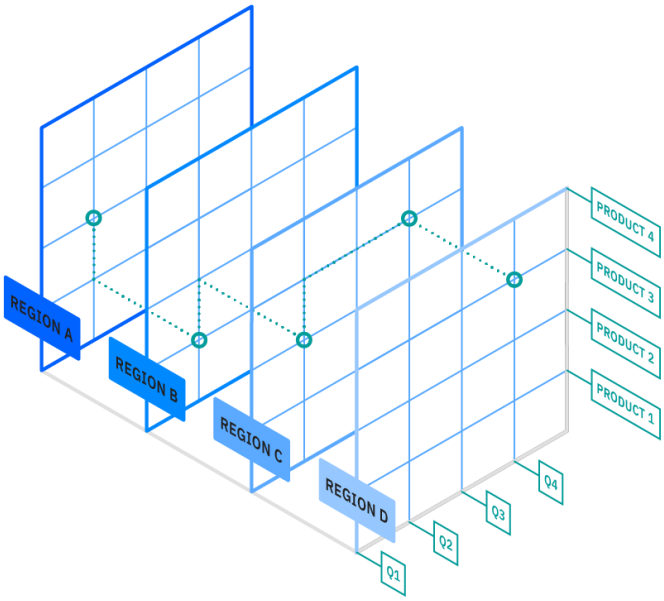

Figure 2.3: OLAP Cube [12]

Data Mining: is the process of using complex mathematical algorithms to search for patterns in large amounts of data and making predictions. The more numbers fed into those math formulas, the greater the accuracy of the predictions [7].

Data Visualization: is the graphical representation of an information. The major goal of data visualization is to provide to the user a qualitative and easy understanding of the information contents. It is the process of transforming objects, numbers and concepts into a form that can be easily interpreted by the human eyes [13]. Reports and dashboards are two ways data can be visualized.

2.6. Microsoft Power BI

Microsoft Power BI is a collection of software services, apps, and connectors that work together to turn unrelated sources of data into coherent, visually immersive, and interactive insights. In the Business Intelligence Architecture, Microsoft Power BI is a data visualization tool and allows information sharing between collaborators.

2.6.1. Power BI Suite of Tools

In this section are the definitions and terminology of the most prominent components of the Power BI platform. Figure 2.4 shows some of these components.

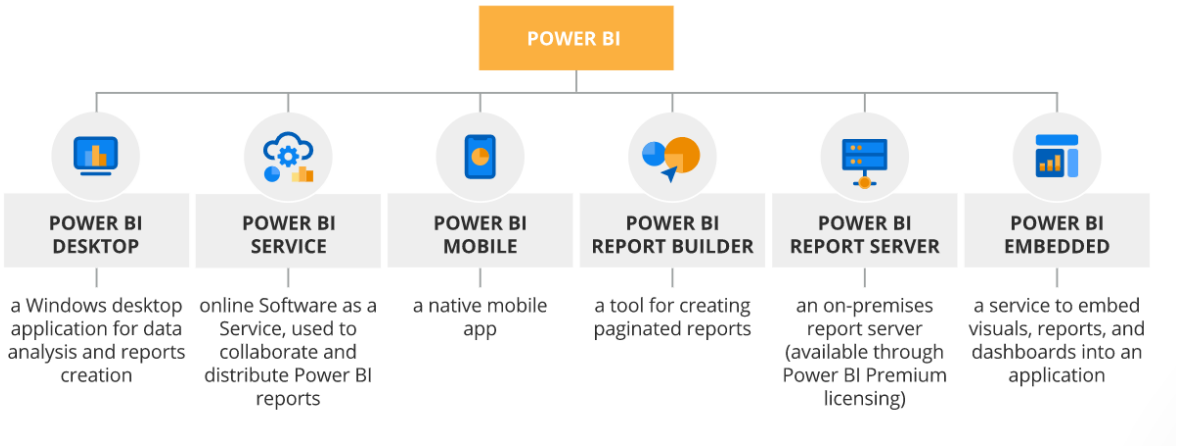

Figure 2.4: Power BI suite of tools [14]

Power BI: The collection of software, services, applications, and connectors which facilitate the creation of reports and dashboards and the visual analysis of information.

Power BI Desktop: is the authoring tool of choice for connecting, transforming, and modeling data, as well as for creating interactive reports. Power BI Desktop saves files in the .pbix format. Power BI Desktop can produce template files in the .pbit format.

Power BI Service: is a cloud-based service which supports collaboration, sharing, enterprise distribution, creation of dashboards, and additional functionality such as alerts. It can serve as a central location to consolidate distribution of datasets for content creators and reports, dashboards, and apps to consumers.

Power BI Workspace: is a collaboration area within the Power BI service. A workspace is a distinct area, separate from My Workspace, dedicated to a specific team, subject area, or project. Reports are published to a workspace so that colleagues can view the content, collaborate, and contribute as appropriate.

Power BI App: is a set of packaged content in the Power BI service for the purpose of distributing related reports and dashboards to a larger base of consuming users. One Power BI app may be published for each workspace.

Power BI Mobile Apps: are native applications for iOS and Android for viewing content on a mobile device.

Power BI Windows Application: is available from the Microsoft Store. It is an alternative for consuming content which has been published to the Power BI service and is particularly useful for rotating reports on display monitors.

On-Premises Data Gateway: is an agent installed within the corporate network to allow secure access to organizational data stored on-premises or within a corporate network.

Power BI Premium: is an offering that provides dedicated resources for reports, dashboards, and datasets within the Power BI service. This provides organizations more predictable performance, larger storage volumes, larger dataset sizes, higher refresh rates, and incremental data refresh. Premium also enables widespread distribution of content without requiring a Pro license for each read-only user.

Power BI Report Server: is an alternative to the Power BI service for deploying Power BI reports within an on-premises data center, as opposed to the cloud-based Power BI service. Power BI reports are deployed and delivered in an on-premises portal alongside Reporting Services paginated reports, Excel reports, and Mobile reports. The intention of Power BI Report server is not feature parity with the Power BI service – its intention is to be a straightforward report portal.

Power BI Embedded: is a product intended for software vendors and developers that allows them to embed reports and dashboards into applications - without the time and expense of building and maintaining visual analytics features themselves. Power BI Embedded is the companion capacity offering to Power BI Premium and is an Azure resource that runs on an hourly meter.

Power Platform: A collection of services including Power BI, Power Apps, Power Automate, AI Builder, and Power Virtual Agents [15].

2.6.2. Power BI Usage Scenarios

When a company decides to implement Power BI, it needs to make an in-depth analysis of its needs, the structure of the company, who will be the direct actors in the implementation and in the use of the tool, to correctly define an architecture that fits the intended objectives, to properly choose the licenses to acquire and create a system that really adds value to the business.

Power BI has many standardized usage scenarios, one of them can be chosen, or can be mixed or can be modified some according to what is intended. *For practical reasons only two usage scenarios will be explained here. Information in more details can be found at the Whitepaper* [15].

First scenario – Personal BI: Personal self-service BI scenarios, content is created for personal use, with no sharing or collaboration involved. The content author generally has a lot of freedom and flexibility. The Figure 2.5 shows the diagram of Personal BI scenario.

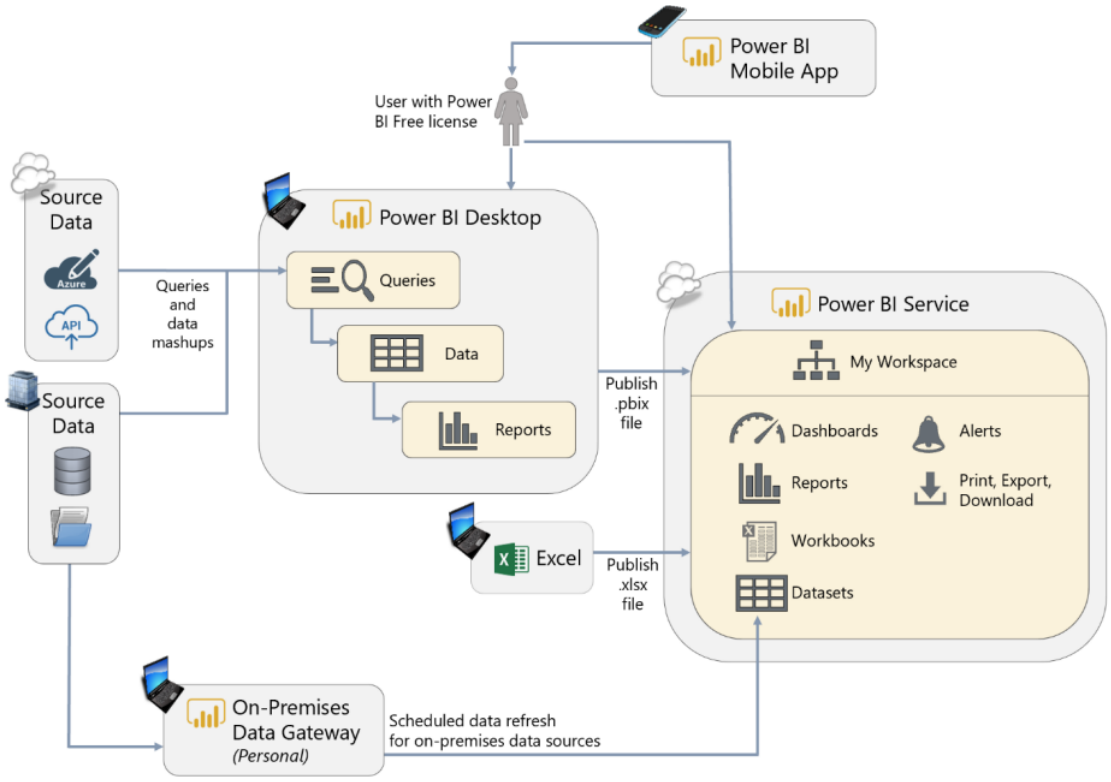

Figure 2.5: Personal BI scenario [15]

Second scenario – Enterprise Content Distribution: Very large enterprise BI implementations often employ a “top-down” approach because it is common for the Power BI content to be largely created and maintained by a centralized IT / BI team. Enterprise-level reporting scenarios commonly have a significantly larger number of read-only users who consume content, compared to a much smaller number of authors who create content to publish for others. A common way to cost-effectively support

organizational/enterprise level reporting is via the use of Power BI Premium. The Figure 2.6 shows the diagram of Enterprise Content Distribution scenario.

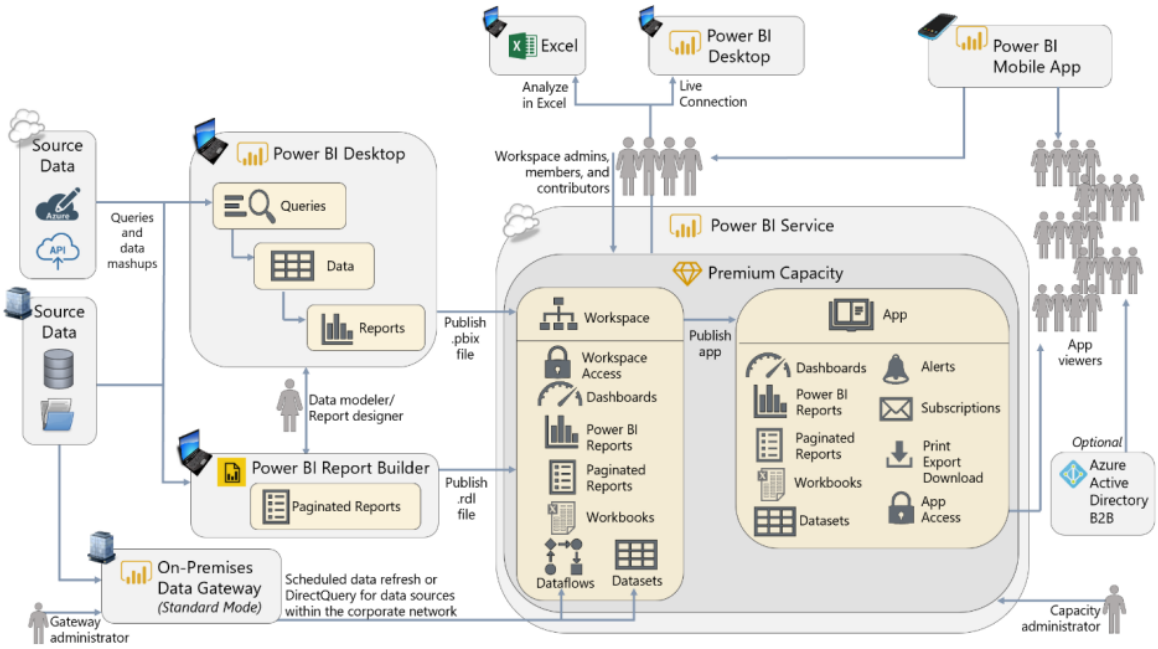

Figure 2.6: Enterprise Content Distribution scenario [15]

2.6.3. Drill-Down, Drill-Up and Drill-Through

Drill-down is a feature on Power BI that reveal more detailed information about a data point. It is from more general information to more specific information.

Drill-up is a feature on Power BI that reveal more general information about a data point. It is the inverse of drill-down, and it is from more specific information to more general information.

The drill-down and drill-up are only possible with the use of hierarchy. Hierarchy is the data categorization and the establishment of different levels. For example, a total sales amount can be shown by country, then by region, then by city and then by store. A hierarchy should be created between country as the most general information, region, city, and store as the most specific information.

Drill-through is an option to navigate to a destination target page in the report that focuses on a specific entity that was selected.

2.6.4. Power Query

Power Query is a data transformation and data preparation engine. Power Query comes with a graphical interface for getting data from sources and a Power Query Editor for applying transformations. Because the engine is available in many products and services, the destination where the data will be stored depends on where Power Query was used. Using Power Query, you can perform the extract, transform, and load (ETL) processing of data. Figure 2.7 shows how Power Query relates to data sources on the left and data analytics software on the right. And the Table 2.1 shows the utility of Power Query [16].

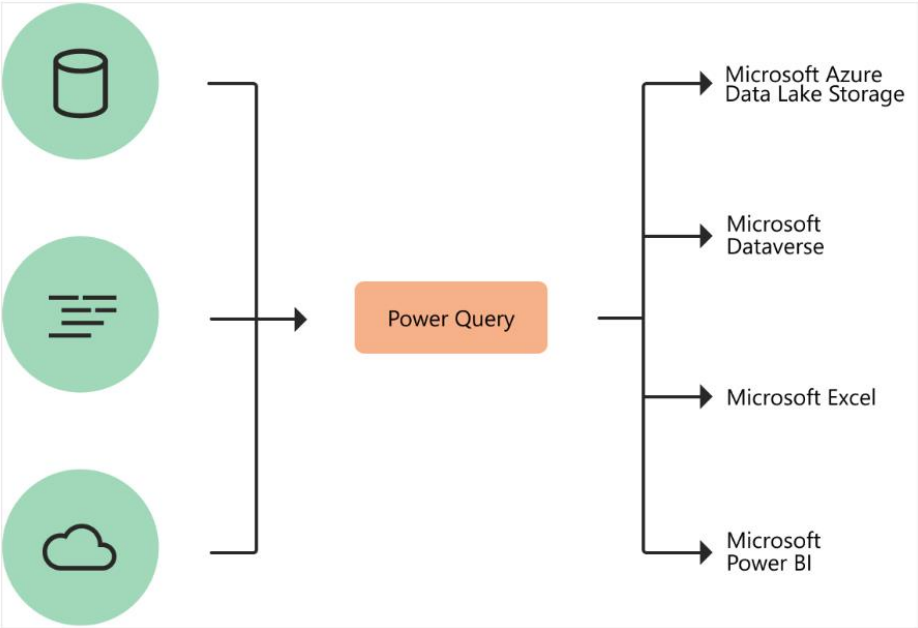

Figure 2.7: Power Query [16]

Existing challenge	How does Power Query help?
Finding and connecting to data is too difficult	Power Query enables connectivity to a wide range of data sources, including data of all sizes and shapes.
Experiences for data connectivity are too fragmented	Consistency of experience, and parity of query capabilities over all data sources.
Data often needs to be reshaped before consumption	Highly interactive and intuitive experience for rapidly and iteratively building queries over any data source, of any size.
Any shaping is one-off and not repeatable	When using Power Query to access and

Existing challenge	How does Power Query help?
	transform data, you define a repeatable process (query) that can be easily refreshed in the future to get up-to-date data. If it is needed to modify the process or query to account for underlying data or schema changes, you can use the same interactive and intuitive experience you used when you initially defined the query.
Volume (data sizes), velocity (rate of change), and variety (breadth of data sources and data shapes)	Power Query offers the ability to work against a subset of the entire dataset to define the required data transformations, allowing you to easily filter down and transform your data to a manageable size. Power Query queries can be refreshed manually or by taking advantage of scheduled refresh capabilities in specific products (such as Power BI) or even programmatically (by using the Excel object model). Because Power Query provides connectivity to hundreds of data sources and over 350 different types of data transformations for each of these sources, you can work with data from any source and in any shape.

Table 2.1: Power Query Usefulness **[16]**

2.6.5. Data Modeling

Data modeling is the process of analyzing and defining all the different data the business collects and produces, as well as the relationships between those bits of data. Data modeling concepts create visual representations of data as it's used at business, and the process itself is an exercise in understanding and clarifying the data requirements.

By modeling the data, it is documented what data exists, how to use it, and what the requirements are surrounding usage, protection, and governance. Through data modeling, the organization:

- Creates a structure for collaboration between IT team and business teams.
- Exposes opportunities for improving business processes by defining data needs and uses.

- Saves time and money on IT and process investments through appropriate planning up front.
- Reduces errors (and error-prone redundant data entry), while improving data integrity.
- Increases the speed and performance of data retrieval and analytics by planning for capacity and growth.
- Sets and tracks target key performance indicators tailored to the business objectives [17].

In this chapter was described the BI architecture and important concepts to understand the Microsoft Power BI tool.

3

Related Work

Contents

In this chapter, a comparison is made between the Business Intelligence tools on the market, and what is the choice made by some Portuguese companies operating in the transport sector.

Microsoft Power BI is used by many thousands of companies around the world. Microsoft has been consistently ranked a leader on Gartner's Magic Quadrant for Analytics and Business Intelligence Platforms, as can be observed in the Figure 3.1.

Figure 3.1: Magic Quadrant for Analytics and Business Intelligence Platforms 2022 [18]

Gartner highlights the following 12 capabilities as prime examples: security, governance, cloud-enabled analytics, data source connectivity, data preparation, catalog, automated insights, data visualization, natural language query, data storytelling, natural language generation and reporting. These capabilities are fundamental sources of differentiation between the propositions of the platforms. By assessing each of them closely, Gartner has separated each vendor into four categories: leaders, challengers, visionaries, and niche players [19].

Some features of leading tools are as follows and will be described in the next sections: Power BI offers data preparation, visual-based data discovery, interactive dashboards and augmented analytics, it is available as a SaaS option running in the Azure cloud or as an on-premises option in Power BI Report Server, Power BI Desktop can be used as a stand-alone, free personal analysis tool; Tableau offers a visual-based exploration experience that enables business users to access, prepare, analyze and present findings in their data; Qlik allows users of all skill levels to combine data and explore information without the limitations of query-based tools [20].

In the present work, only the leading tools on the market are of interest. In the next sections, a comparison will be made between these 3 tools, namely Power BI, Tableau and Qlik.

3.1. Key Features of Microsoft Power BI

Visualizations: Visual representation of data plays a central role in Business Intelligence. Microsoft Power BI offers numerous visualizations such as Stacked/Column Bar/Cluster chart, Line Chart, Ribbon Chart, Area Chart, Funnel Chart, etc. These visualizations can be leveraged by businesses to create dashboards and reports easily. Figure 3.2 shows in the right side the possible visualizations.

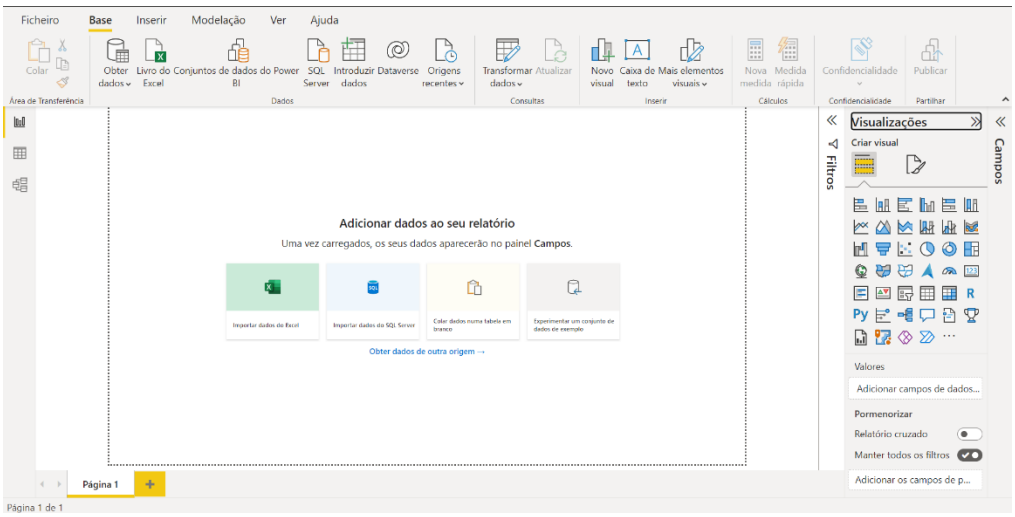

Figure 3.2: Power BI Desktop Visualizations

Data Sources: Microsoft Power BI houses support for a vast number of structured/unstructured On-premises/Cloud-based data sources such as Microsoft Excel, Microsoft Power BI Datasets, Microsoft Azure, MySQL, Microsoft SQL Server, Oracle, Text/CSV, JSON, etc. Figure 3.3 shows the connection between Power BI and a SSAS Database – SQL Server Analysis Services, a multi-dimensional OLAP server.

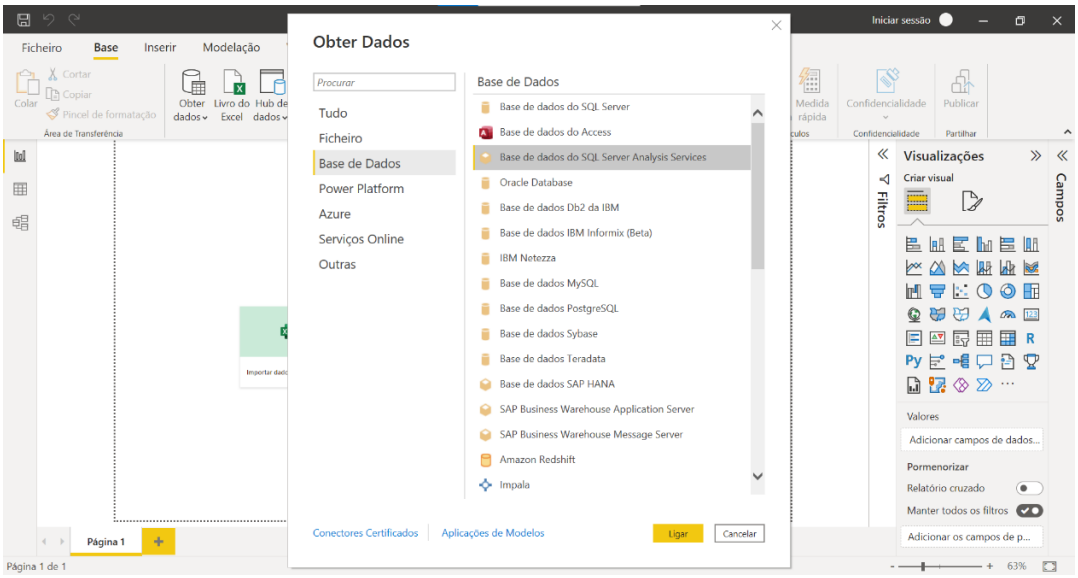

Figure 3.3 (a): Power BI connection with a Data Source

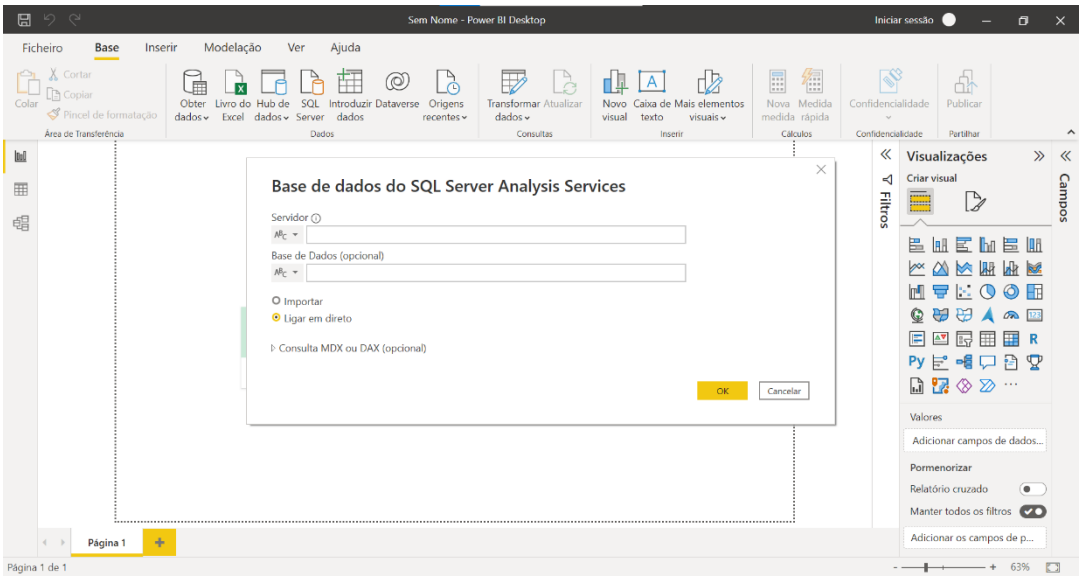

Figure 3.3 (b): Power BI connection with a Data Source

Customizable Dashboards: Microsoft Power BI allows users to create customized dashboards using numerous visualizations that can offer meaningful insights into the data.

DAX: stands for Data Analysis Expressions, is a programming language that is used throughout Microsoft Power BI to create calculated columns, measures, and custom tables. It is a collection of functions, operators, and constants that can be used in a formula, or expression, to calculate and return one or more values. DAX can be used to solve several calculations and data analysis problems, which can help to create new information from data that is already in the model [21]. Microsoft Power BI houses support for more than 200+ DAX functions that can be used to perform analytics-specific functionalities [22]. Expression 3.1 shows an example of a DAX, this expression returns total number of rows in the Sales table, which the Amount column is greater than 100. CALCULATE and COUNTROWS are two of the many DAX functions.

$$CALCULATE\ (COUNTROWS\ (Sales), Sales[Amount])\ >\ 100)$$

Expression 3.1: DAX Example

3.2. Key Features of Tableau

Tableau is one of the most powerful and fastest-growing Data Visualization and Business Intelligence tool available in the market. It allows users to easily transform raw data into a format that can be understood by anyone. The Figure 3.4 shows the Tableau in Salesforce.

Data Sources: Tableau offers easy and direct integration with a large number of data sources. These data sources include Spreadsheets, On-premises Files, Relational and Non-Relational Databases, Data Warehouses, Big Data sources, Cloud-based data sources. The different kinds of data connectors supported by Tableau are Cloudera, Hadoop, Google Analytics, Google Sheets, Amazon Athena, Microsoft SQL Server, Salesforce, Dropbox, and many more.

Data Visualizations: Tableau supports numerous types of data visualizations. These include simple visualizations such as a Bar Chart or Pie Chart to complex visualizations such as Gantt Chart, Bullet Chart and Boxplot. Tableau also has a lot of pre-installed information on geographical data such as Postal Codes, Cities and Administrative Boundaries. This allows users to make extremely detailed and informative maps using Tableau. The various kinds of maps available in Tableau are Heat map, Point distribution map, Choropleth maps and Flow map.

Mobile Dashboards: Tableau allows users to create their Dashboards and Reports in such a manner that it is also compatible with mobile. Tableau houses functionalities that allow users to create

customized mobile layouts for a dashboard specific to their mobile device. The customization gives the users the ability to add new phone layouts and interactive offline previews.

Vector Maps: This provides the necessary clarity while zooming in and out when exploring any geospatial data. The labels and icons resize themselves automatically and can appear or fade away automatically as per requirements.

Nested Sorting: It can perform sorting within multiple dimensions. This type of intuitive Nested Sorting helps users easily spot trends in data.

Data Highlighter: The Data Highlighter is a well-known tool that is used for data exploration. It lets users seamlessly search for and visually locate specific data without changing the context of the data in any way.

Workbook Formatting: It allows users to apply their own personal style or design across the entire workbook easily with a few clicks.

Custom Territories: Tableau incorporated a tool that lets users easily aggregate data based on geographies to build their own custom territories [22].

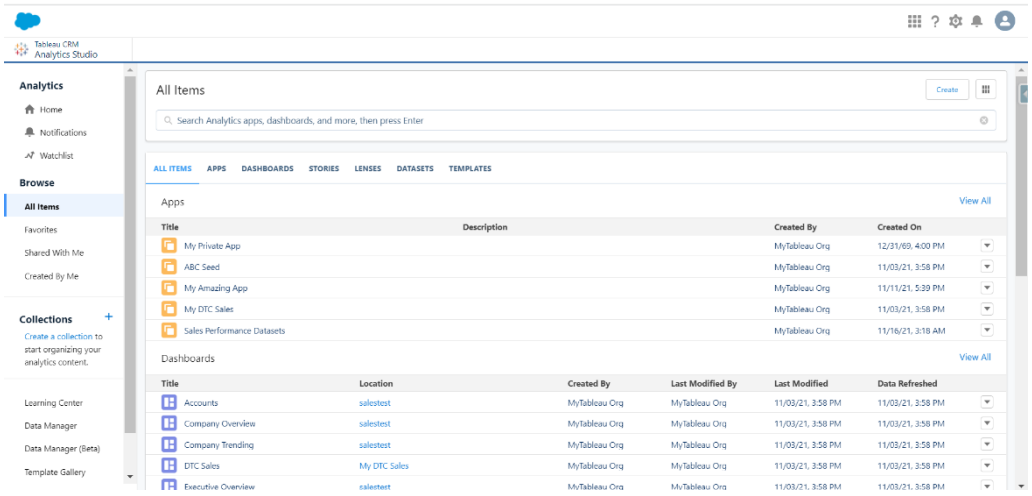

Figure 3.4: Tableau in Salesforce

3.3. Key Features of Qlik

Qlik is one of the best self-service analytics tools, it is a user-friendly and interactive tool that allows users to create reports and dynamic dashboards using the data imported from different sources. The Figure 3.5 shows the main features of Qlik Sense platform.

Associative Model: Qlik use an associative model where the entire data that is loaded into Qlik, be it from any data source, can be linked and associated. Figure 3.6 shows the Associative Model Architecture, this allows the user to create connections through any key pair relationship without having to follow a traditional hierarchy of data. As a result, users can find patterns and connections quicker than through a traditional BI architecture [23].

Figure 3.5: Qlik features [24]

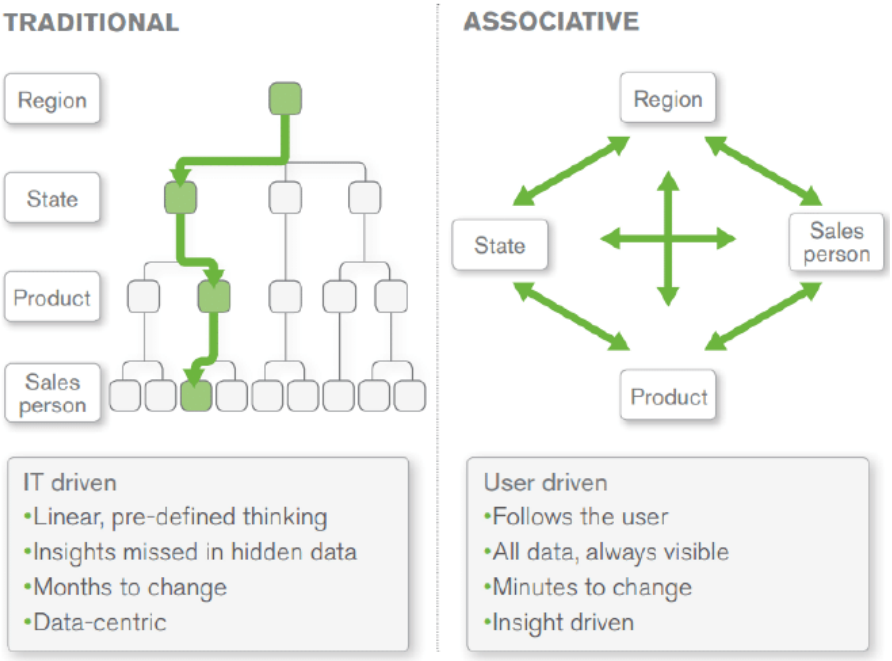

Figure 3.6: Qlik Associative Model Architecture [23]

Visualizations and Analytics: the visualizations are very interactive and respond quickly to any selection made by the user. The graphics are of high aesthetic standard and the visualizations are flexible as they change and adjust as the size of the screen changes.

Self- Service Creation: Qlik provides drag and drop features which bypasses all the dealing with scripts and queries.

Centralized Sharing and Collaboration: Qlik can share Qlik reports and applications with other users operating individually or a group of users through a centralized and unified hub.

Data Storytelling and Reporting: With the help of this feature, Qlik provides intelligent and in-context commentary for the data analytics visuals being displayed. In this way, the whole data story is created by the software to build a picture and give a perspective on the data that is presented for the analyst.

Mobility: Qlik applications can be accessed by the mobile devices and can solve problems on the go, as they arise.

Embedded Analytics, Custom Applications, and Extensions: The Qlik analytics applications offer a standard API where could be created custom guided applications. The user can also use extensions for analysis and add plug-ins like visual basic into the Qlik application [25].

Conversational Analytics: is possible through Insight Advisor Chat, that is a chat-based interface to search for insights in any app the user have access. The Figure 3.7 shows that.

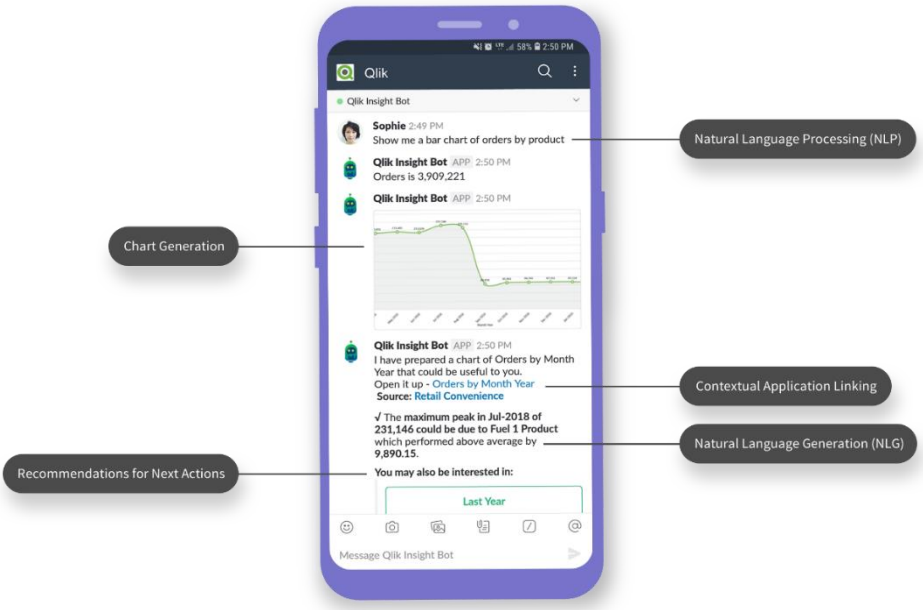

Figure 3.7: Qlik Insight Advisor Chat [26]

3.4. Power BI and Tableau Comparison

Market. Tableau has a market share in the **data visualization** of 16.96% with 63364 customers, according to Slintel, while Power BI has a market share of 14.95% with 55881 customers (in April 2022). It is worth noting that Power BI was released in 2015, 12 years after Tableau be founded, and it has quickly risen in popularity because of its ease of use and Microsoft affiliation. In the Data Visualization category, Tableau Software stands at 1st place by ranking, while Microsoft Power BI is at the 2nd place [27], this can be seen in the Figure 3.8. While for the classification in the **Business Intelligence** tools, Power BI is in the first place, as can be seen in Figure 3.9.

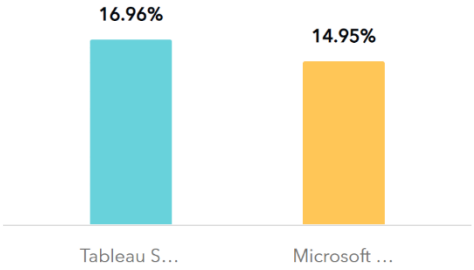

Figure 3.8: Tableau and Microsoft Power BI market share in the Data Visualization (in April 2022) [27]

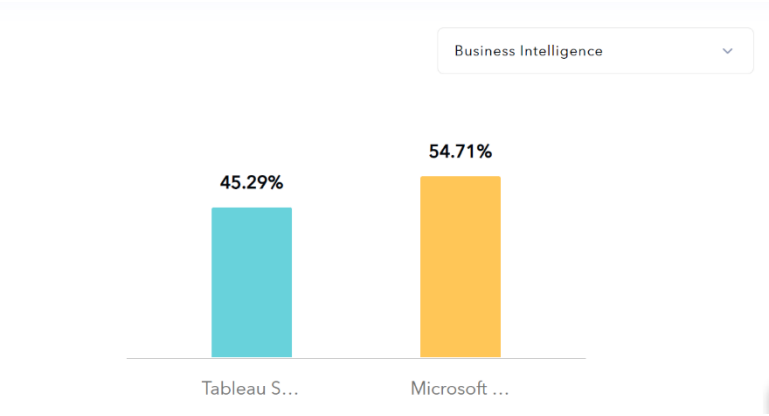

Figure 3.9: Tableau and Microsoft Power BI market share in the Business Intelligence (in April 2022) [27]

Learning. For newer users and those who are not data analysts, Power BI is typically thought to be easy to use. Tableau is preferred by more experienced data analysts due to its higher learning curve.

Pricing. Power BI is often less expensive than Tableau. The Power BI Pro plan is $9.99 per month for each user. The equivalent Tableau package costs $70 per month per user.

Tableau has a free tier called Tableau Public that is hosted on Tableau's Public Cloud. It is more suitable for people who are learning Tableau since it does not allow users to make reports private or store them in their local system. This means that anyone with Internet access can view these reports. Most businesses use Tableau to analyze sensitive business data and hence, it is not ideal for them to make their reports publicly available.

Microsoft Power BI offers a free tier with basic functionality. To access the advanced features, businesses must purchase Microsoft Power BI Pro.

Based on the pricing for both tools, it can be concluded that Microsoft Power BI is a cheaper option as compared to Tableau. Microsoft Power BI is now also included in the Workspace Suite that most organizations rely on for workspace management. Hence, from a financial point of view, Microsoft Power BI is the best option.

Community. Tableau has a thriving Data Science community of over 220,000 users. A big community forum and over 500 global user groups are available. Tableau also offers conferences and virtual events such as Tableau Live discussion panels all over the world. When it comes to customer assistance, Power BI is more limited, with a smaller community forum.

Highlights.

- Tableau it is appropriate to manage huge data quantities. Power BI usually manage smaller data volumes than Tableau.
- Tableau is known for its visually appealing data visualizations, while Power BI is favored for its capacity to work with many data sets.
- Tableau requires time and expertise to understand, whereas Power BI is simpler to pick up and utilize.
- Tableau is best suited for seasoned data analysts, but Power BI can be utilized by both experts and beginners.
- Tableau employs MDX – stands for Multidimensional Expressions, is a query language for OLAP databases – for dimensions and measures. Whereas Power BI uses DAX for calculated columns and measures (which affects speed and reporting capabilities) [22].

3.5. Power BI and Qlik Comparison

Market. Comparing the customer bases of Microsoft Power BI and Qlik we can see that Microsoft Power BI has 61871 customers, while Qlik has 2278 customers (in September 2022). In the Data Visualization category, Microsoft Power BI stands at 2nd place by ranking, while Qlik is at the 28th place [28]. This can be seen in the Figure 3.10.

Deployment. Both Qlik and Power BI can be deployed on-premises and on-cloud.

Devices Supported. Qlik is compatible on devices such as Windows, Android, iPhone, iPad, Mac, and web-based platforms. Power BI is supported on Windows devices, Android, iPhone, iPad, and web-based platforms. Power BI is not supported on MAC devices.

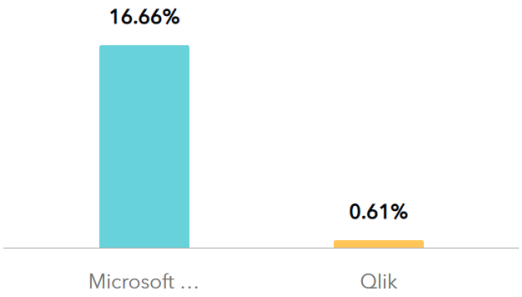

Figure 3.10: Qlik and Microsoft Power BI market share in the Data Visualization (in September 2022) [28]

Pricing. Qlik offers a free trial and a free version to the users. It has a quote-based pricing model where the customer needs to purchase a license for use. Its subscription starts from $30 per month.

Company Size. Qlik is generally used in any scale (small, medium, and large) enterprises and freelancing companies. Power BI is majorly used in medium-scale and large-scale enterprises.

Technical Customer Support. Qlik provides technical help and support to its customer round the clock via e-mail, phone, training, live support, and tickets. Power BI extents all kinds of customer support except for e-mail and live support options.

Usability. Qlik has better usability than Microsoft Power BI as it is a very simple, easy to use tool. All the functionalities and controls are simplified so much so that a user of any skill set can work on it. Power BI, on the other hand is also an easy-to-use tool but is more so for those users who are experienced in Microsoft tools like Excel and Power Pivot. To use Power BI to its full potential one must know the DAX language very well.

Return of Investment. Both the tools are worth investing in as customers are highly satisfied from them [25].

3.6. Power BI, Tableau and Qlik Comparison

Table 3.1 shows comparison between the leading BI tools.

	Qlik	Tableau	Power BI
Cost	Qlik is a paid software that costs $30 per user/month, with different offers for corporate clients. You can also get a free trial period for using the program. For self-study, there is a free introductory course on their official website.	Tableau is a $70 per user/month paid software, with different offers for corporate clients. You can also get a free trial period for using the program. For self-study, there are training videos on their official website. There is an adaptation of reports for different forms of presentation.	There are three versions of Power BI: Basic (free), Pro ($9.99 per user), and Premium ($20 per user and $4,995 per capacity). Complete documentation of the product's features and functions is published on the official website. There is an adaptation of reports for different presentation forms.
ETL	Qlik has its data processor, which allows you to use "unprepared" data and transform it during loading.	Tableau allows you to combine several tables, get rid of empty or unwanted values, add calculated fields (amounts, number, and average).	Power BI fully implements internal ETL, which allows you to import, transform, and download data.
Relations between tables	Qlik creates keys between tables based on common field names. The Data Model Viewer gives a complete understanding of the loaded tables and the relationship structure between them.	In Tableau, by default, the link is also built by fields with the same names, but this can also be edited in the section "Editing links."	In Power BI, relationships between tables are built by default by fields with the same names; you can also edit, delete, or create new relationships in the "Data Model" section.
Measurements and indicators	In Qlik, the user initially sees a list of all loaded fields, can distribute all the fields into dimensions and indicators using the Master Items functionality.	Tableau automatically determines which fields are dimensions and indicators in all loaded tables (string in dimensions, numeric in indicators).	With Power BI Desktop, you can access SSAS multidimensional models, commonly referred to as SSAS MD.

	Qlik	Tableau	Power BI
Visualization	Qlik allows the user to extend his visualization capabilities using extensions (readymade extensions can be found on the Qlik Branch resource or using open standards such as HTML5).	Tableau offers a broader variety of out-of-box visualizations such as box-and-whiskers, Bullet-graphs, Gantt charts. Each chart is separated into a separate object, which makes it easier for the user to change the presentation of the diagram (just a table, a table-heatmap, a chart with one axis, a chart with two axes, etc.).	Power BI has many visualization libraries ranging from map points to nested graphs, histograms, and more. There is also a store of visual elements with modified visualization elements. It should be noted that the user can create his visual element and publish it in this store after receiving approval from the creators.
Drill-down / Drill-up	In Qlik, to fall into the lower level (drill-down), it is necessary to select one value of the upper level, after which the diagram is rebuilt in the context of the new dimension. Can be selected a higher level to the hierarchy created to see a less detailed information (drill-up)	There is no drill-down function in Tableau. Instead, hierarchies are created, the user, by clicking on “+” or “-” can collapse/expand the object, that is, work on the principle of a pivot table.	In Power BI, you navigated through data levels using up and down arrows. Moreover, a single arrow shows a transition to one level, and a double arrow - to the lowest level of hierarchies.
Data choice	In Qlik, the selection of a value on one tab / specific object will be valid for the entire document - on all tabs; the selection will be performed, you cannot bind a filter to a particular object.	In Tableau, the opposite is true. The choice is made locally - that is, only to a specific object. To transfer the selection between sheets, you need to configure Actions on each sheet, which will select the necessary values upon activation.	Power BI makes it easy to combine queries, create groups and data selections into a new or existing table.

	Qlik	Tableau	Power BI
Data relevance	Qlik has a configurable auto-update for datasets.	Tableau implements configurable auto-update of datasets.	There is a configurable auto-update of datasets in the cloud version of Power BI web according to the established schedule by configuring the gateway.
Data security and privacy	Qlik allows customization of access by individual data, users, sheets, streams, and applications.	Tableau allows you to customize access to specific reports, delineation of rights for actions in responses (viewing, editing, updating, etc.).	Power BI can apply confidentiality labels to Power BI data using Microsoft Information Protection and customize roles, functionality, and access levels for workspaces, analytic reports, and datasets.
Integration	Qlik can import data from Data Warehouses, Files, SAAS, SAP, Relational Databases, etc.	In Tableau, data loading is implemented by connecting to Data Stores, Databases, files, etc.	Power BI is integrated with other products from Microsoft (Office 365, etc.), with R and Python. It is possible to connect almost any data source (streaming data, cloud services, Excel workbooks, SQL Server databases, MySQL, MS Azure, and other third-party applications) and combine them. Power BI has a simple API for integrating into its own applications.
Convenience	Supports multiple platforms (web and mobile).	Work in Tableau is carried out in the web version.	Power BI is easy to use and has an intuitive interface. Supports multiple platforms (web, desktop, and mobile).

Table 3.1: Comparison of Quik, Tableau and Power BI features [29]

3.7. Companies Operating in the Transport Sector

This section describes some companies that operate in the same sector as Tecmic – the transport sector in Portugal – and its Business Intelligence solutions.

3.7.1. Wegho

Wegho is a platform that provides services to homes and offices, each having a team of 2 or 3 suppliers, that travel using Wegho's vehicle fleet. Wegho currently offers services in different areas such as cleaning, painting, plumbing, electrical and fitness. Wegho currently targets both B2C and B2B channels and its services are available in Porto and Lisboa, Portugal. Most of the vehicles are equiped with GPS modules, provided by CarTrack - a company specialized in vehicle location systems. The GPS modules transmit location data and events to a CarTrack server [30].

Wegho has a framework that, in addition to performing real time location, trips history, schedule services, also do reports using Microsoft Power BI for their daily analysis.

3.7.2. HFIL Cargo

HFIL Cargo is a small Portuguese company that operates in the road transport of goods sector, based in the municipality of Vagos, in the district of Aveiro. It is a company that carries out an economic activity essentially linked to general cargo transport services, which operates in European space, mainly in Portugal, Spain, France, Holland and Germany. HFIL Cargo has created a Balanced Scorecard to pursue the consolidation of the company's vision, using Microsoft Power BI, which allow to transform HFIL Cargo data into coherent, visually interactive and attractive information [31].

3.7.3. Sodicentro

Sodicentro is a company of the Auto-Industrial Group, official distributor and repairer of Mercedes-Benz and Smart cars, new and used, in Coimbra and Leiria [32]. Based on [33], was created a tool with Microsoft Power BI, to analyze the fleets of vehicles, used by the service that provides substitution vehicles for clients, with the aim of coming up with improvement strategies and tools that support fleet management while reaching the expected goals of reducing costs and identifying new business opportunities.

3.7.4. Pelichos, Lda.

Pelichos is characterized as an SME specialized in the transport of goods by road. With a 100% own fleet, equipped with the latest technological innovations in the area, Pelichos provides service

throughout Continental Europe, with a special focus on countries such as Portugal, Spain, France, Luxembourg, Germany, Belgium, the Netherlands, Switzerland, Austria and Czechia, with light vans and trucks. Microsoft Power BI was used to develop dashboards for transport logistics planning [34].

In this chapter, a comparison was made between the leading BI tools on the market in terms of the price practiced by each one, their learning curve and some of their functionalities. It was also seen some BI solutions adopted by Portuguese companies operating in the transport sector.

4

Implementation

Contents

After having a clearer view of Business Intelligence, we can survey Tecmic's requirements, and find the solution that best fits the needs.

4.1. Tecmic SWOT Analysis

SWOT analysis is the evaluation of a company's strengths, weaknesses, opportunities and threats, with the aim of formulating strategies for its growth.

Strengths	**Weaknesses**
1) It is a company with a lot of experience in the market, with more than 30 years of existence. 2) Financial Solidity 3) Software as a Service (SaaS), accessible to all types of companies 4) High qualification of the commercial, development, engineering and technical assistance teams 5) Tecmic has the support of research institutions (such as Universities, for example) and Development, national and foreign, with solid alliances [3].	1) Long response time to the anomalies occurring in vehicles. 2) High amount of data stored in databases. Due to the high number of messages sent periodically by the devices. 3) Some bottlenecks in fleet management not yet discovered.
Opportunities	**Threats**
1) Evolution of business intelligence tools 2) IT companies are increasingly needed to meet the demands of the increasingly technological world.	1) Globalization: each business is now competing in every market in the world 2) Economic instability

Table 4.1: Tecmic SWOT Matrix

Through the Tecmic SWOT matrix in Table 4.1, we can see that there is an opportunity to implement BI and that is not yet being taken advantage of. Taking advantage of this opportunity, it is also possible to overcome the weaknesses described in the matrix, namely, discover the bottlenecks in the fleet management, extract relevant information from the data, and decrease the response time to anomalies occurring in vehicles and/or devices installed in vehicles.

For the implementation of our solution, we chose the Microsoft Power BI tool. It was the tool that presented the lowest cost and it also has the free version with Power BI desktop, where you can perform various operations including creating reports and share them with the team. Supports a wide variety of data sources. XtraN uses Microsoft Sql Server to create and store databases, consequently Power BI would be the most suitable choice. Users who are already used to working with Microsoft tools such as Excel, for example, would easily adapt to Power BI.

Before the implementation of reports and dashboards for XtraN, if any failure appeared in a vehicle, it was the customer who would have to contact Tecmic via email to communicate its failures, a case would be opened for the Support Team, the Support Team would go to the database, analyze the data and try to find out the reason for the failure, then communicate the solution to the customer, and if necessary, a Technical Team would move to the vehicle to solve the problem. This implied the time for the failure to be discovered by the customer, the time for contacting Tecmic, the time for researching and solving the case by the Support Team and the time for solving the failure by the Technical Team. With the existence of reports and dashboard, the Support Team run the reports periodically, with updated data and detect existing failures, solve them and, if necessary, send the Technical Team to the vehicle. There is a clear reduction in the time to solve the vehicles failures, there was also a reduction in the amount of communication needed.

4.2. Anomaly

An anomaly is a failure that can occur in the system. There are different types of anomaly such as: error while creating departures, error while loading departures, unit loading failure, driver surrender failure, and many others. For the data anomaly analysis, it was created a model in the Power BI desktop, with 2 tables connected by the column Type, Figure 4.1 shows that.

- **AnomaliesOccurred:** a table with the anomalies recorded.
- **AnomalyTypes**: a table with a description of each anomaly type.

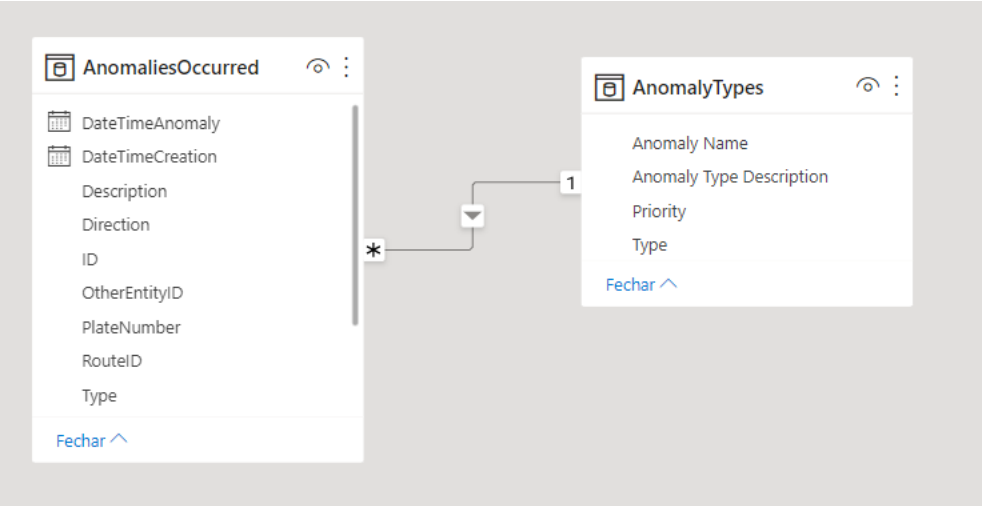

Figure 4.1: Data Model of Anomaly Analysis

Through this model, two reports were created for data analysis that will be described in the chapter 5.1.

4.3. Events

An event is a message sent from a device to the control center, the device can be a console installed in the vehicles. For this analysis it was created a model in the Power BI desktop, composed by 6 tables, as we can see in the Figure 4.2.

- **CalendarTable:** it is a table with dates.
- **SupportEvents:** corresponds to the data table, containing the business process events occurred over time.
- **SupportEventTypes:** contains the description of all types of existing events.
- **SupportGroupVehicle:** as the name says, describes the group to which a vehicle belongs to.
- **SupportGroupClient_GroupVehicle:** it is a junction table of SupportGroupClient table and SupportGroupVehicle table, to construct a many-to-many relationship between them.
- **SupportGroupClient:** describes the group of clients to which a vehicle belongs to.

When data is imported, Power BI automatically chooses the data type for each column based on the values filled in for the column, we can also change the data type manually. There are 5 differents data types: number, date/time, text, true/false and blank/null. When the number data type is detected, the summation symbol appears in front of the respective field in the table presented in the model.

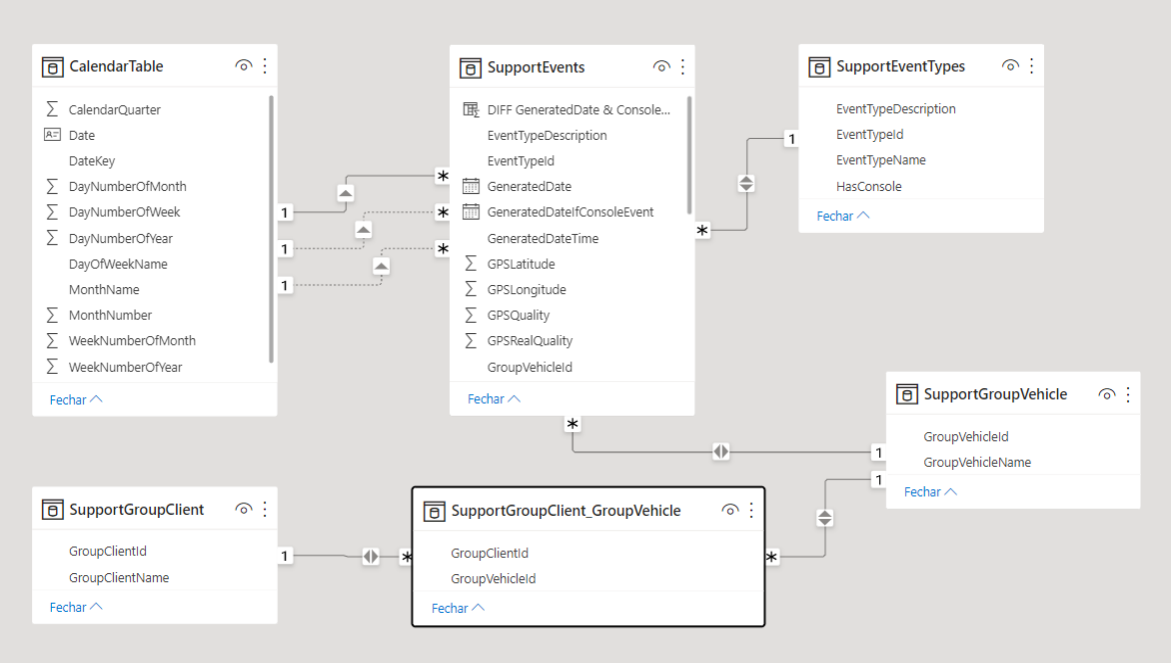

Figure 4.2: Data Model of Events Analysis

Calendar Table. It is a best practice to create a calendar table for handling dates in Power BI, so that we can obtain many advantages, such as:

- Time intelligence functions that enable the manipulation of data using time periods, including days, months, quarters, and years, and then build and compare calculations over those periods.
- Dimension table, corresponding to the question “When the event happened?”

If there is one date field in the model, a calendar table should be created, so we created a calendar table. A calendar table must contain a date column with contiguous dates, no gaps should be inserted between the dates. The date range on the calendar table must cover the data date range. In the model used in the present work, we created a calendar table named CalendarTable. The CalendarTable is related to the SupportEvents through the field Date and TecGeneratedDate, respectively, as can be seen in Figure 4.3.

The GeneratedDate field in the SupportEvents is of DateTime type, for a calendar table it is unmanageable working with DateTime type since the dates generated for a calendar table are contiguous in a certain period of time, which would result in a very high number of rows for that table, which in practice would not be very useful. So, we created a new field named TecGeneratedDate, that corresponds only to the Date part of GeneratedDate field. Although the Date field in the CalendarTable is also linked to the fields TecConsoleDate and TecProcessedDate in the

SupportEvents, only one relationship can remain active, which in our case is the relationship between Date and TecGeneratedDate.

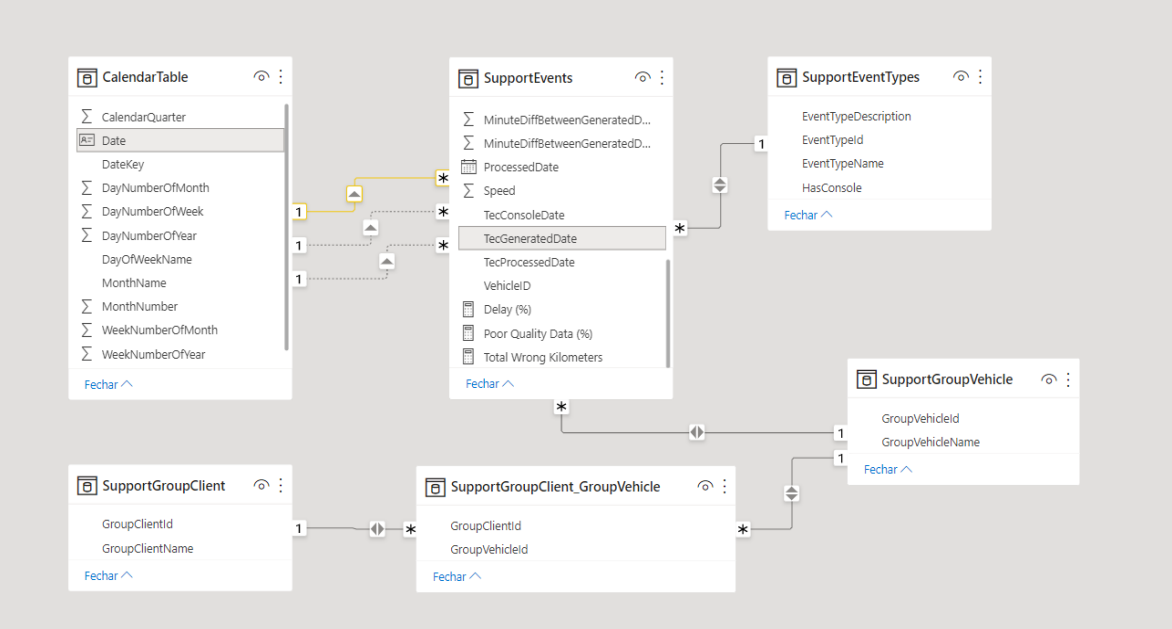

Figure 4.3: CalendarTable relationship with SupportEvents

Some relationships had to be configurated to “Both” (*Ambos*) so later the filters could take effect in both directions, Figure 4.4 shows it.

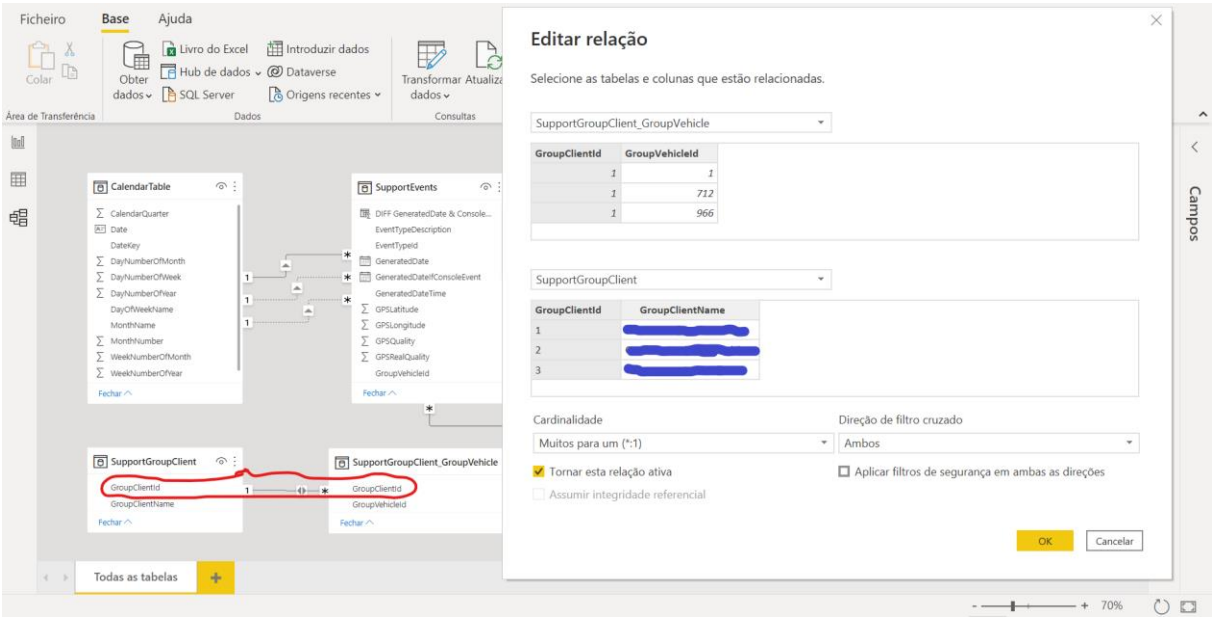

Figure 4.4 (a): Cross Filter Direction

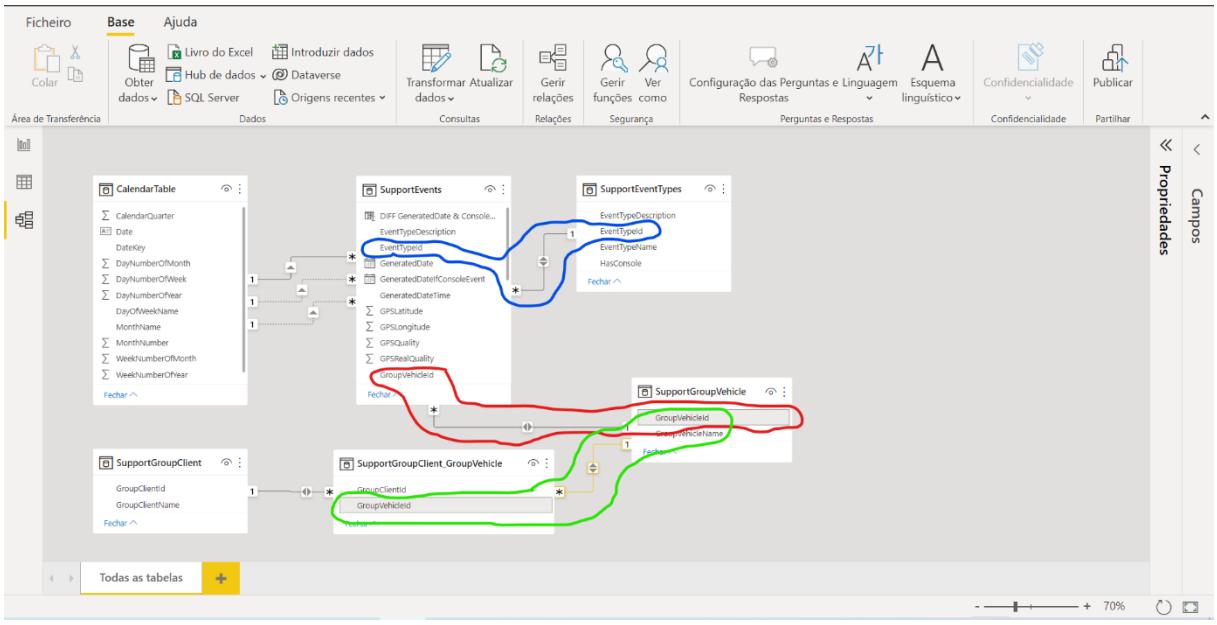

Figure 4.4 (b): Cross Filter Direction

4.3.1. Power Query Editor

Inside Power Query Editor, we did the data transformation, added new columns, and created a new table. All this was possible thanks to the M language. The Figure 4.5 shows the project data in the Power Query Editor.

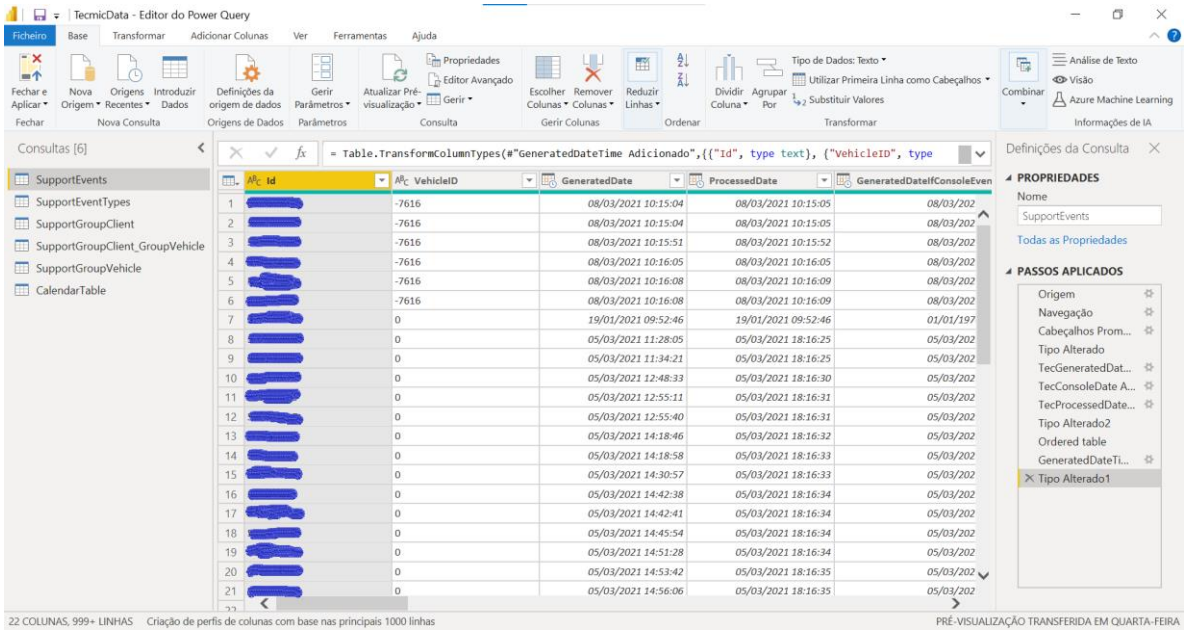

Figure 4.5: Power Query Editor

M language stands for Data Modeling, it is a programming language used to transform data before it is loaded into the Power BI model in a more compact and optimized way [35].

In the SupportEvents table we used the code shown in the Figure 4.6. As can be seen, it was created 4 new columns: TecGeneratedDate, TecConsoleDate, TecProcessedDate and GeneratedDateTime to save date and time values separately so that we can perform some operations later. We also ordered the table by VehicleID and GeneratedDate, and properly adjusted some data types. All this was made using the M language.

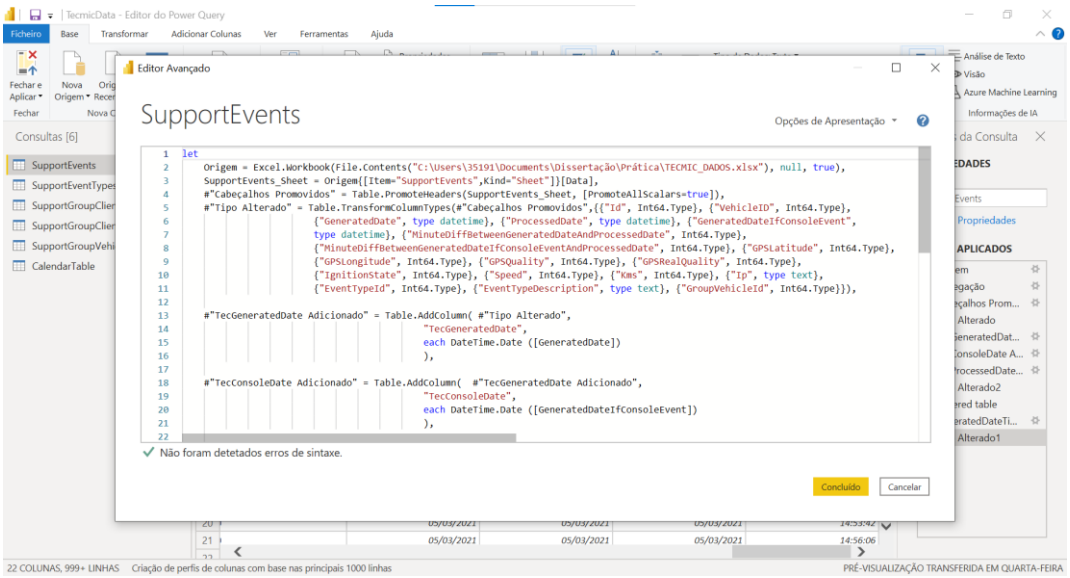

Figure 4.6 (a): SupportEvents Table Transformation

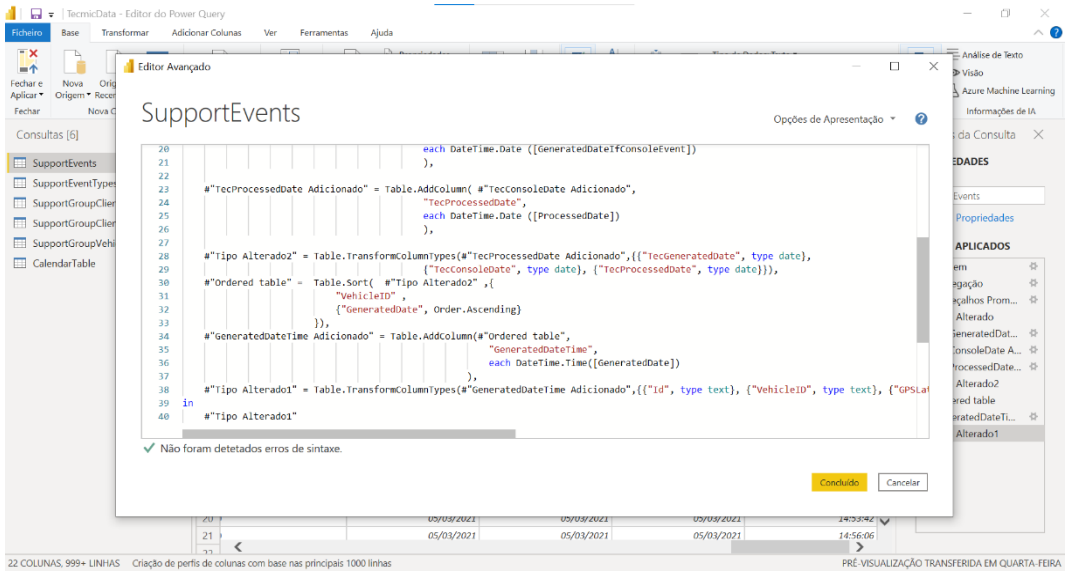

Figure 4.6 (b): SupportEvents Table Transformation

We created the CalendarTable in Power Query Editor, using the code in the Figure 4.7. As can be seen in the figure, we create a date column within the range from January 1st 2014 to January 1st 2023, and the other table columns were created from this date column with Date functions of M language.

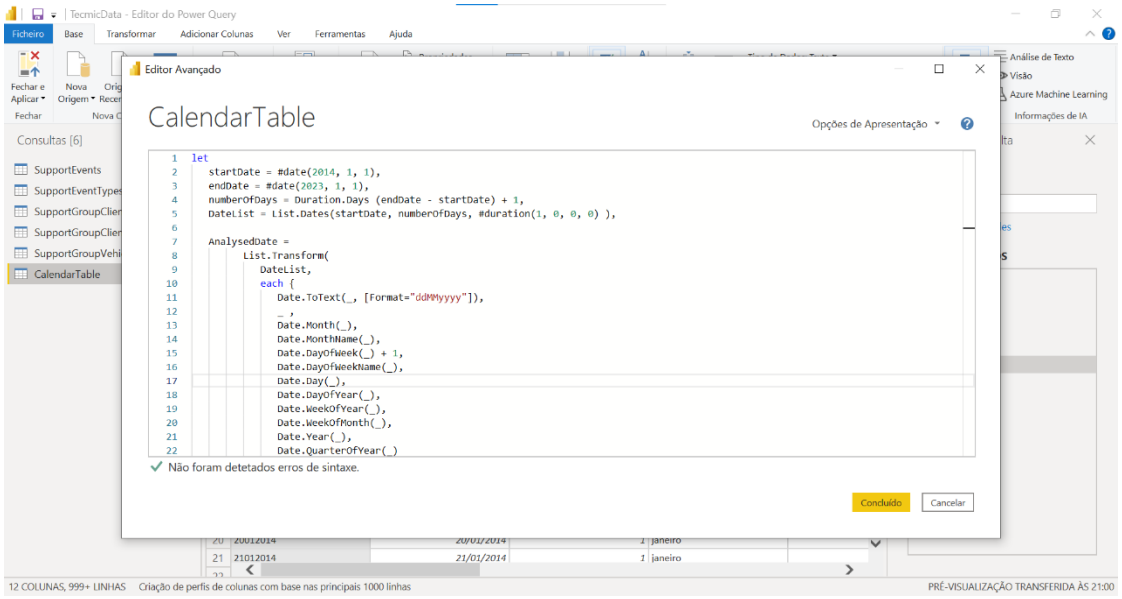

Figure 4.7 (a): Calendar Table Creation

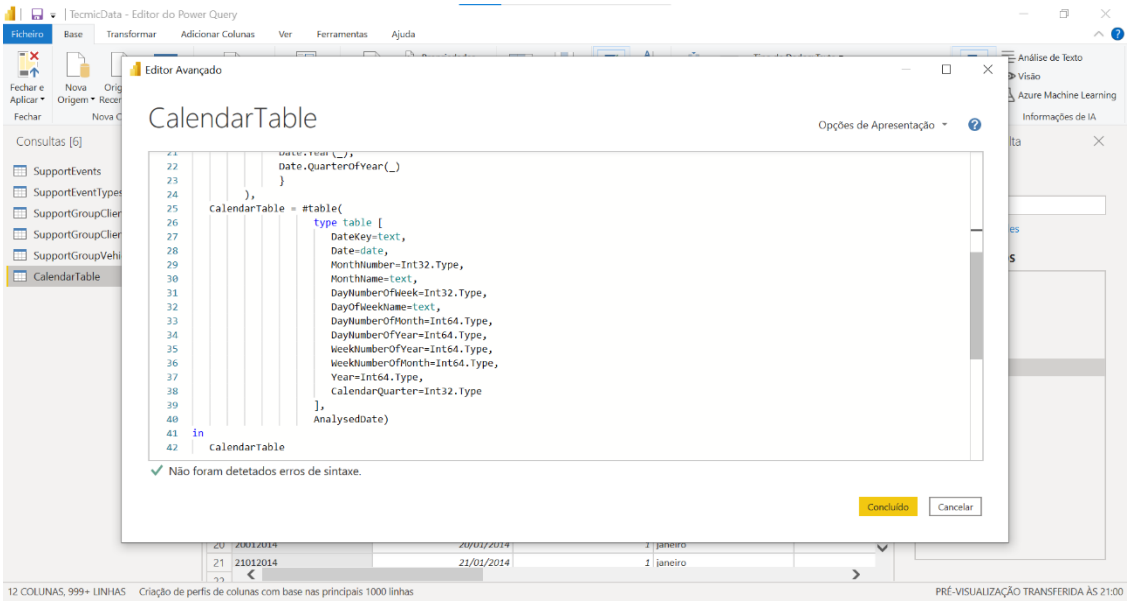

Figure 4.7 (b): Calendar Table Creation

4.3.2. New Measures and Calculated Columns

To achieve the results described in the previous sections, we had to create some measures and some calculated columns. This was made thanks to the DAX expressions. All the measures created are placed in Custom Setting folder in the SupportEvents table. As we can see in the Figure 4.8.

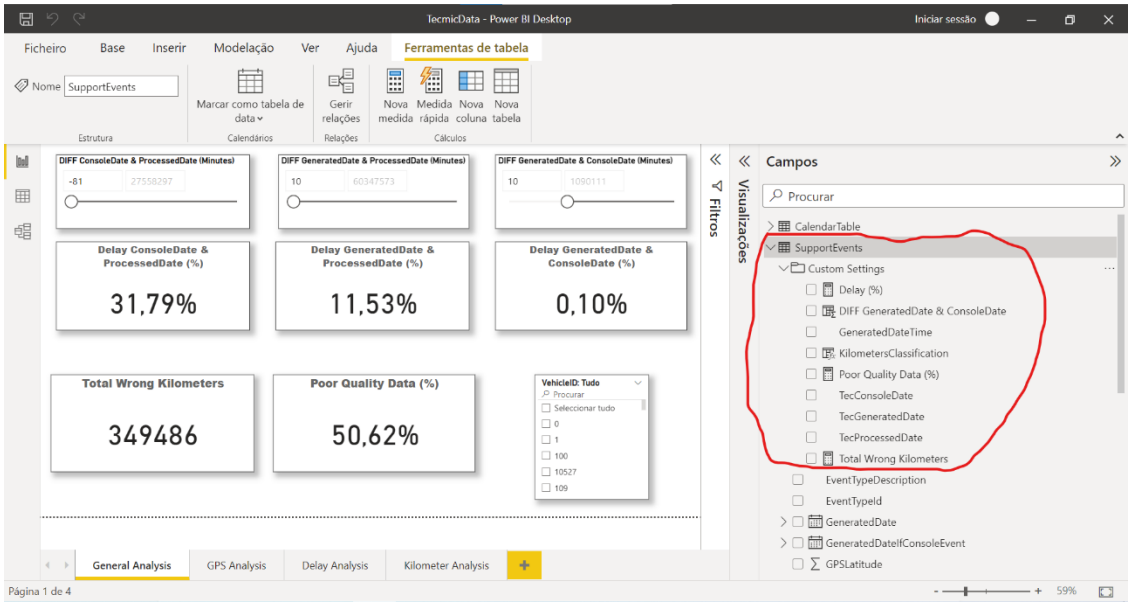

Figure 4.8: Custom Settings

Delay (%) shown in the Figure 4.9, is a measure that return the percentage of SupportEvents with GeneratedDateIfConsoleEvent year greater than 1970. When applied the filters of the differences in minutes of the dates (MinuteDiffBetweenGeneratedDateAndProcessedDate, MinuteDiffBetweenGeneratedDateIfConsoleEventAndProcessedDate and 'DIFF GeneratedDate & ConsoleDate') it returns the 'Delay GeneratedDate & ProcessedDate (%)', 'Delay ConsoleDate & ProcessedDate (%)' and 'Delay GeneratedDate & ConsoleDate (%)', respectively.

DIFF GeneratedDate & ConsoleDate shown in the Figure 4.10, is a calculated column that returns the difference between GeneratedDate and GeneratedDateIfConsoleEvent in the SupportEvents table in minutes, filtered by GeneratedDateIfConsoleEvent year greater than 1970.

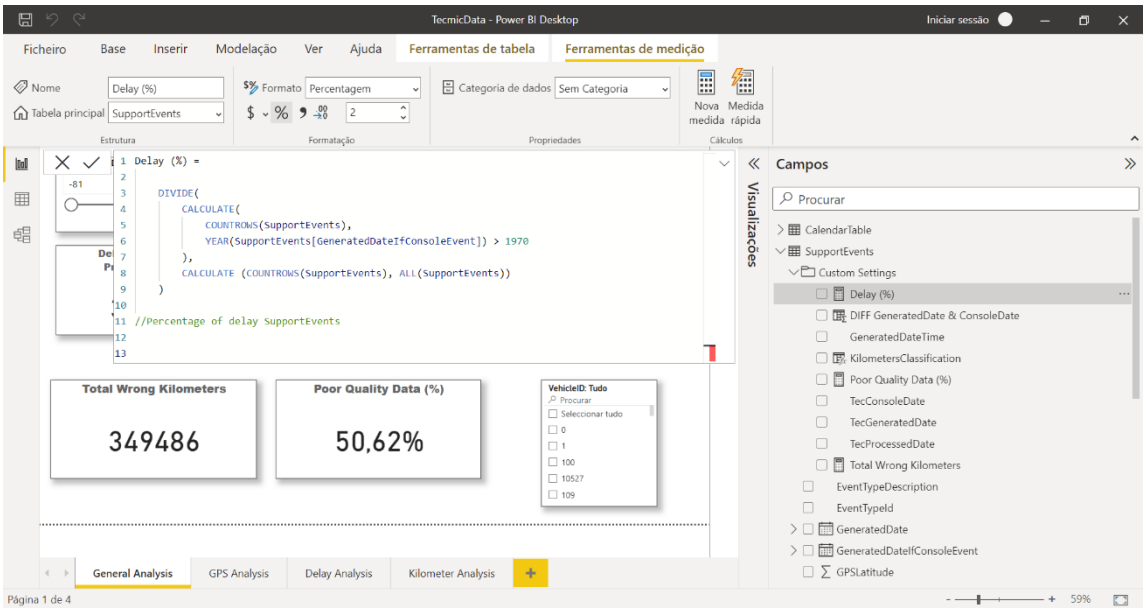

Figure 4.9: Delay (%)

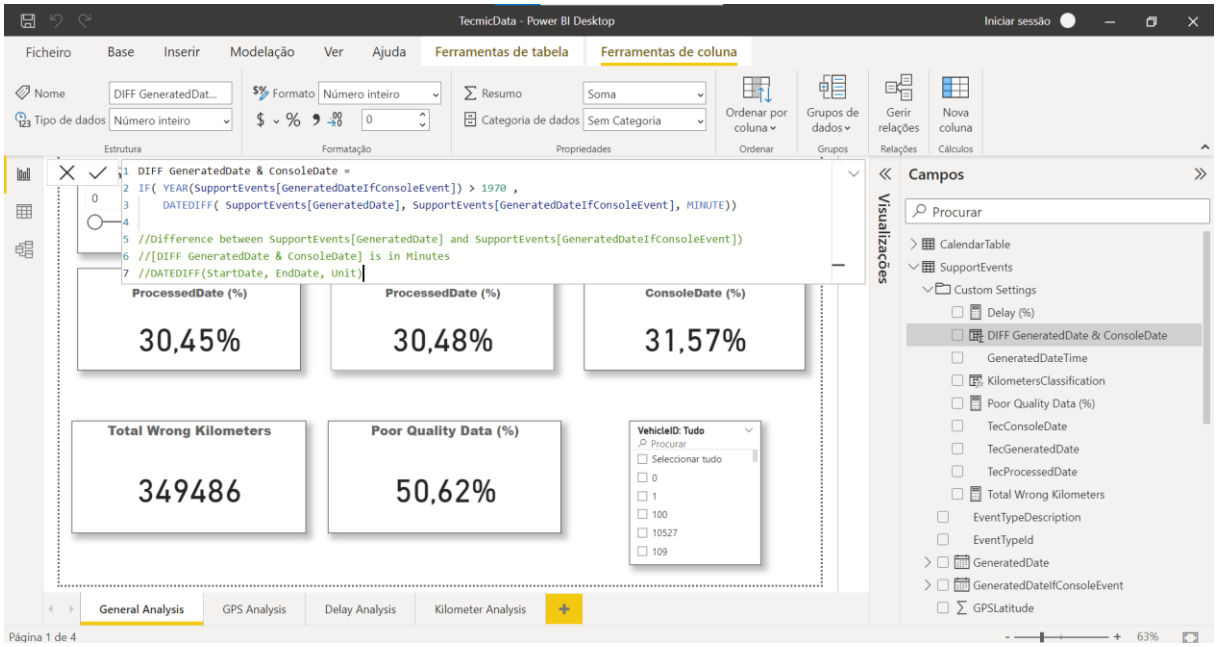

Figure 4.10: DIFF GeneratedDate & ConsoleDate

KilometersClassification it is a calculated column which classifies the kilometers of each row of the table and for each vehicle, as wrong or good. The Figure 4.11 shows the code used to accomplish this.

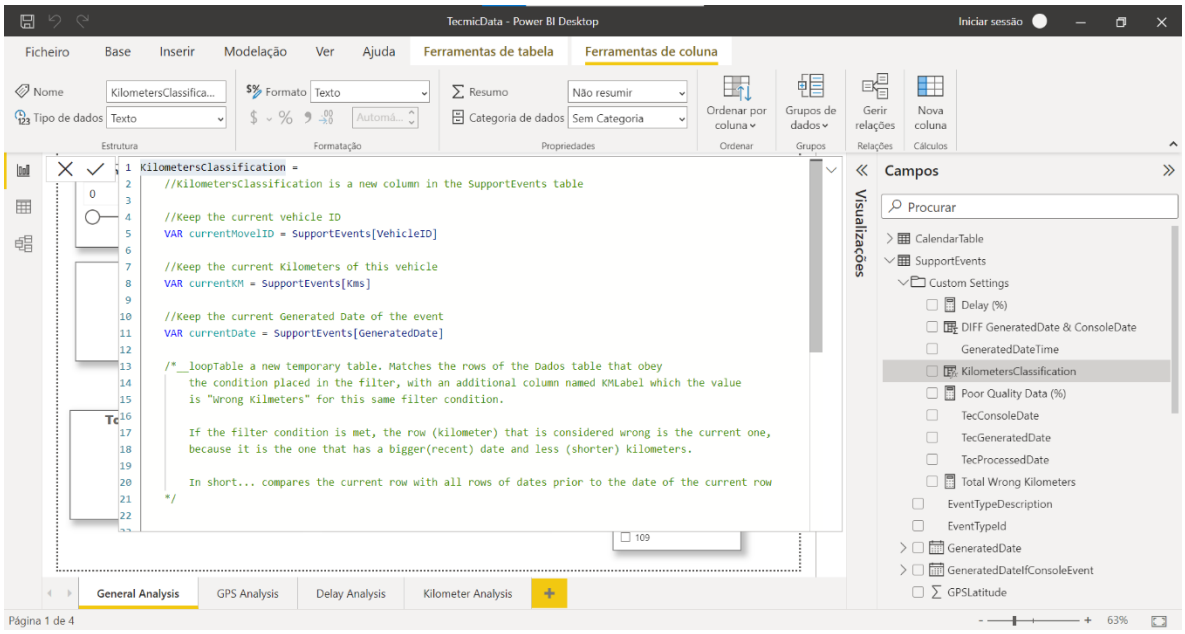

Figure 4.11 (a): KilometersClassification

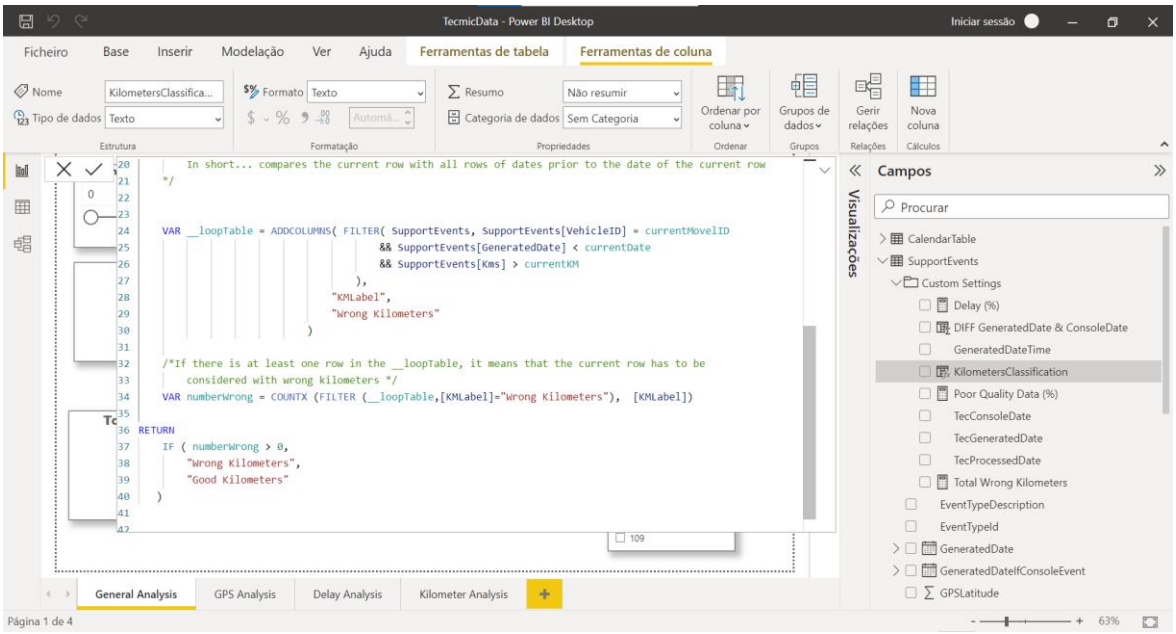

Figure 4.11 (b): KilometersClassification

Poor Quality Data (%) shown in the Figure 4.12, is a measure used to calculate the quality of data based GPSRealQuality column.

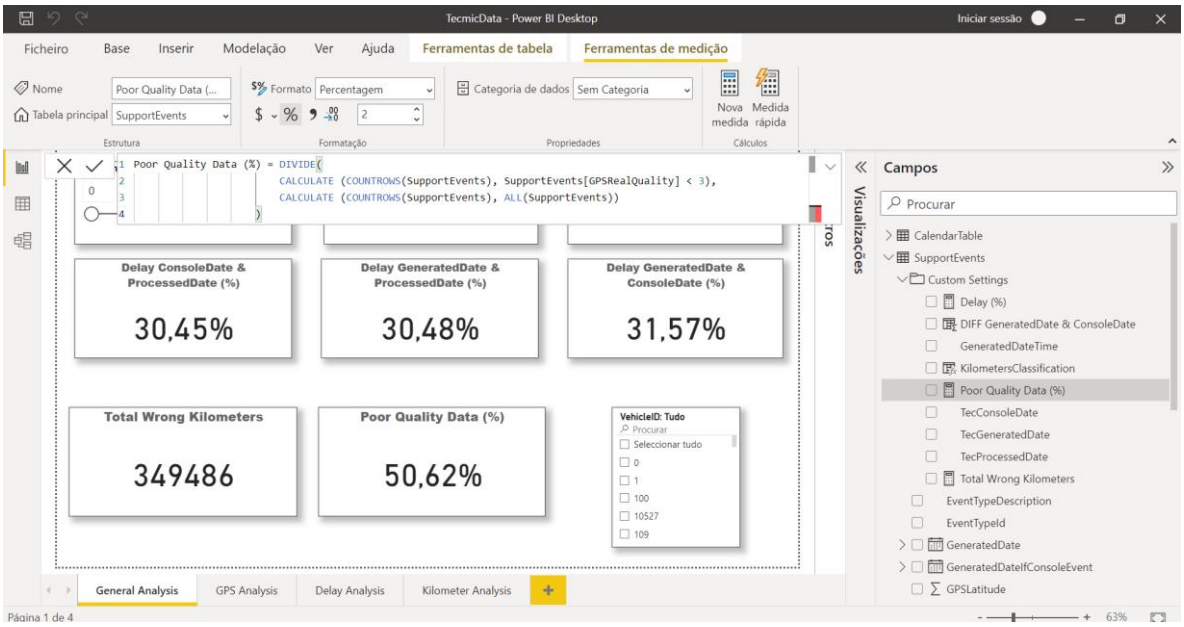

Figure 4.12: Poor Quality Data (%)

Total Wrong Kilometers is a measure the returns the total number of rows in the SupportEvents table with KilometersClassification considering the kilometers as wrong. The Figure 4.13 shows that.

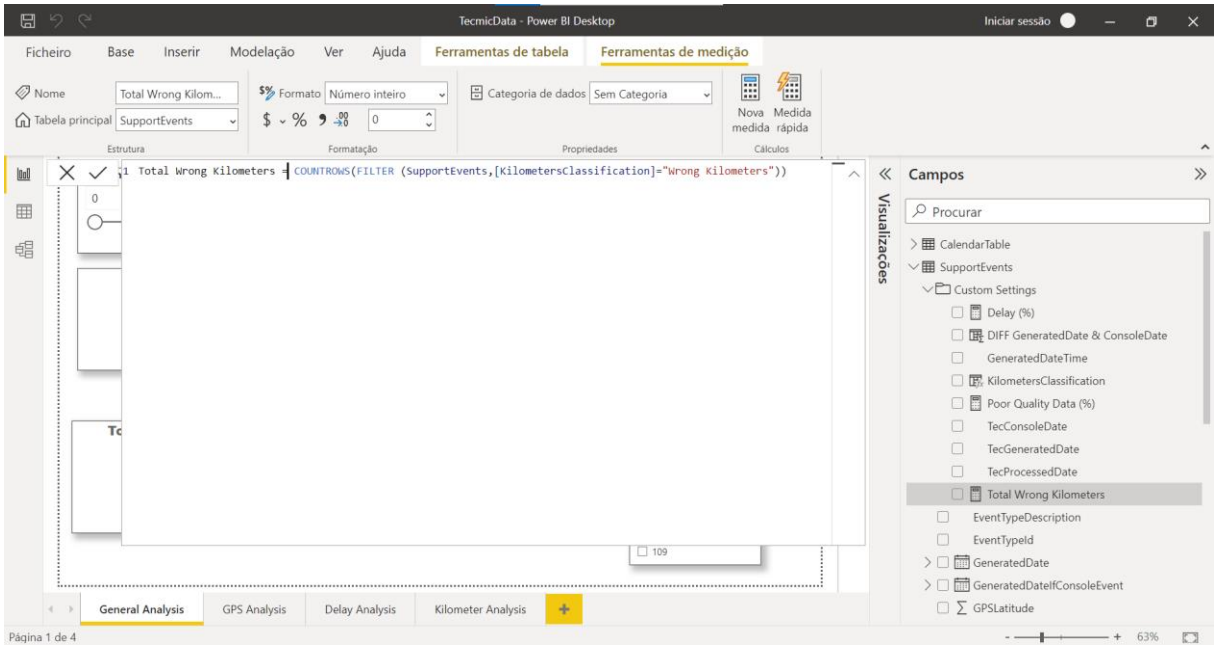

Figure 4.13: Total Wrong Kilometers

5

Evaluation

Contents

In this section is described the set of analysis performed on the data. Two analyzes were carried out: analysis on the events recorded by vehicles in the Tecmic and analysis on the anomalies of these vehicles.

5.1. Anomaly Analysis

For this analysis, data were obtained from Tecmic's database in the production environment. Two tables were extracted, one of the anomalies that occurred and another of the existing types of anomalies, to an excel file with the size of 650KB. This file was later used as a data source in the Power BI.

A report was created in which we could see the number of anomalies that occurred for each On-board equipment ID (UmID). As can be seen from the graph in the Figure 5.1, the equipment with the most anomalies has ID 241. We can also see, the occurrence of anomaly over the years for the different types of anomalies, a card with the total number of anomalies occurred (in the time of the analysis was 9978), and an option (in the top right corner) to do drill through to the graphs in the next page.

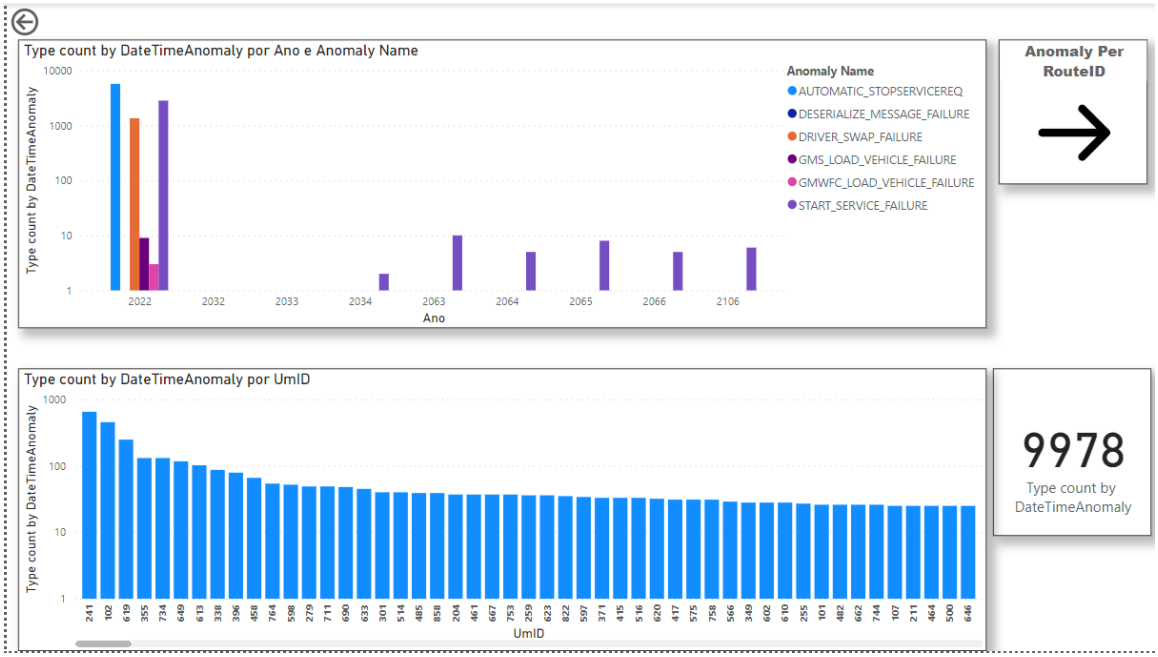

Figure 5.1: Anomaly Analysis Per UmID

Another report was created in which we could see the number of anomalies that occurred for each route code (RouteID) and UmID. As can be seen in the Figure 5.2.

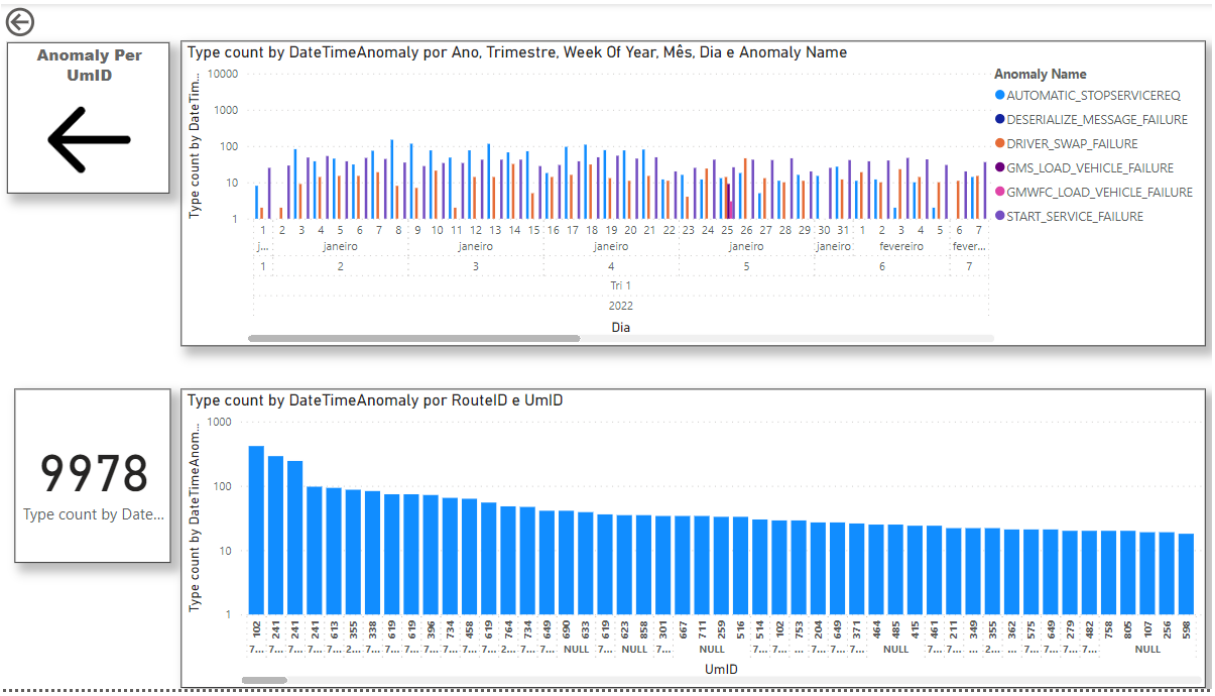

Figure 5.2: Anomaly Analysis Per RouteID and UmID

5.2. General Analysis

For the event analysis the data were obtained from Tecmic's database in the production environment. Five tables were extracted, namely: SupportEvents, SupportEventTypes, SupportGroupVehicle, SupportGroupClient_GroupVehicle and SupportGroupClient, to an excel file with the size of 48.2MB. This file was later used as a data source in the Power BI.

Given the data and the model in section 4.3, we were able to do some analysis on it, and extract relevant information. In Figure 5.3 we can observe some measures and through this we can draw some conclusions about the quality of the data. The first chart named “Delay ConsoleDate & ProcessedDate (%)”, represents the percentage of the delay between the ConsoleDate and ProcessedDate greater than a certain time threshold, above this, we put a filter in which we can determine the considered delay time threshold, in minutes. For example, we can see what percentage of data whose delay between ConsoleDate and ProcessedDate is greater than 10 minutes, and the delay has the value of 11,53%. From the left to the right, the second and third chart, have the same meaning as the first chart but for “GeneratedDate and ProcessedDate” and “GeneratedDate and ConsoleDate”.

The fourth chart named “Total Wrong Kilometers” represents the total number of rows in the table which a kilometer of a certain vehicle with more recent GeneratedDate has a lower value than a kilometer of this same vehicle with older GeneratedDate. As can be seen it has a value of 349.486.

Data is considered being with poor quality when the GPSRealQuality in the SupportEvents table is less than 3. The fifth chart named “Poor Quality Data (%)” represents the percentage of all data which have poor quality. As can be seen 50,62% of the data have poor quality.

The sixth element is a filter, which allows you to select and filter all graphics by vehicle identifier.

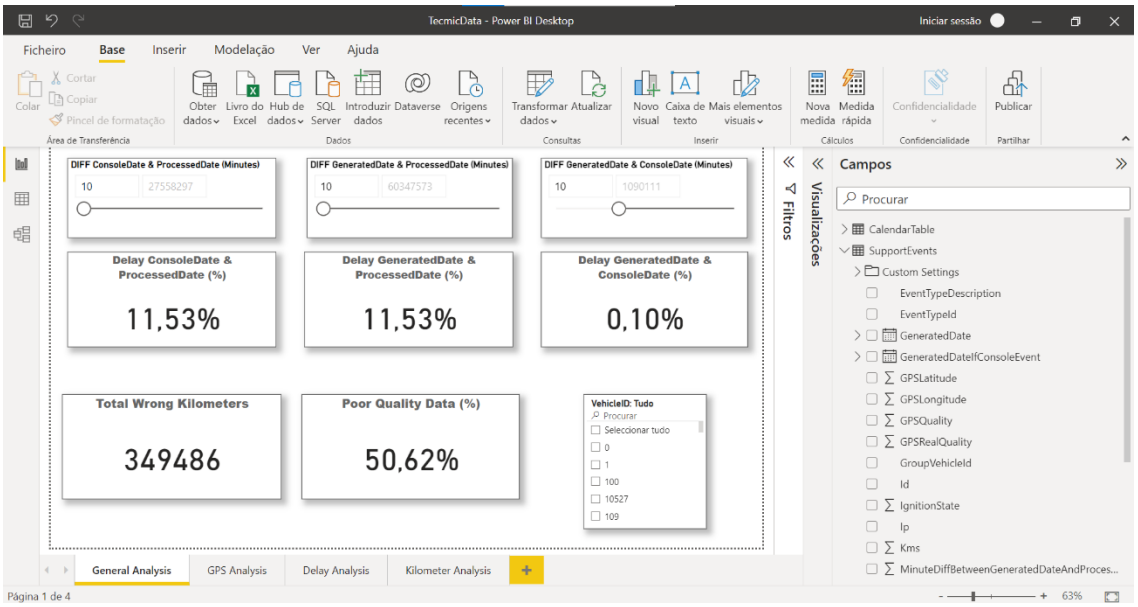

Figure 5.3: General Analysis

5.3. GPS Analysis

From Figure 5.4 can be seen the first chart named GPS Analysis represents the real GPS quality for each vehicle over time. On the Y axis we have GPSRealQuality values ranging from 0 to 4, with 4 being high quality. On the X axis we have a hierarchy, with GeneratedDate, VehicleID and GeneratedDateTime, the last one representing the exact time of event occurrence. Here it can be used the drill-down and drill-up features to expand or retract the data, in order to obtain different points of view of the information.

There is a map in the Figure 5.4 named “Vehicle Location”, each bubble on the map represents the location of a vehicle, as can be seen through the map some bubbles located in Portugal.

The other elements in figure are filters. We can filter the data of GPS Analysis chart and Vehicle Location map by the VehicleID, EventTypeName, GroupClientName, GroupVehicleName and by a date range.

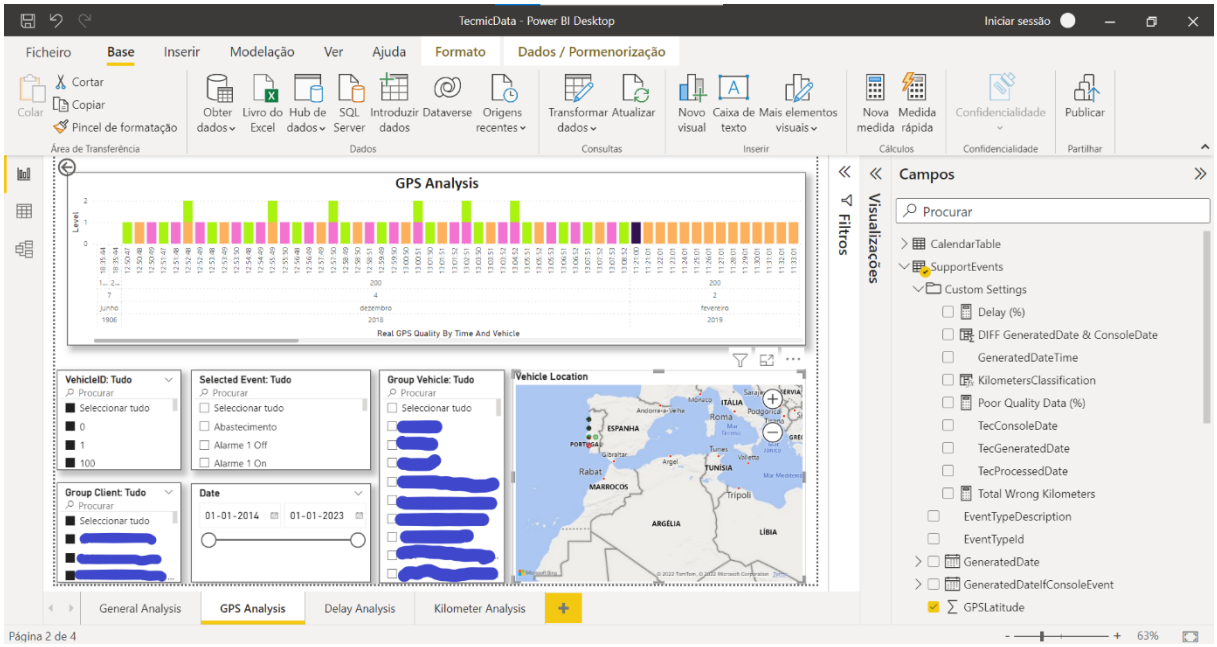

Figure 5.4: GPS Analysis

5.4. Delay Analysis

From Figure 5.5 can be seen the first chart named “Delay Analysis” represents the delay between GeneratedDate and ProcessedDate for each vehicle over time. On Y axis it is the difference in minutes between GeneratedDate and ProcessedDate. On the X axis we have a hierarchy, with GeneratedDate, VehicleID and GeneratedDateTime, the last one representing the exact time of event occurrence. Here it can be used the drill-down and drill-up features to expand or retract the data, in order to obtain different points of view of the information.

There is a map in the Figure 5.5 named “Vehicle Location”, each bubble on the map represents the location of a vehicle, as can be seen through the map some bubbles located in Portugal.

The other elements in figure are filters. We can filter the data of Delay Analysis chart and Vehicle Location map by the VehicleID, EventTypeName, GroupClientName, GroupVehicleName and by a date range.

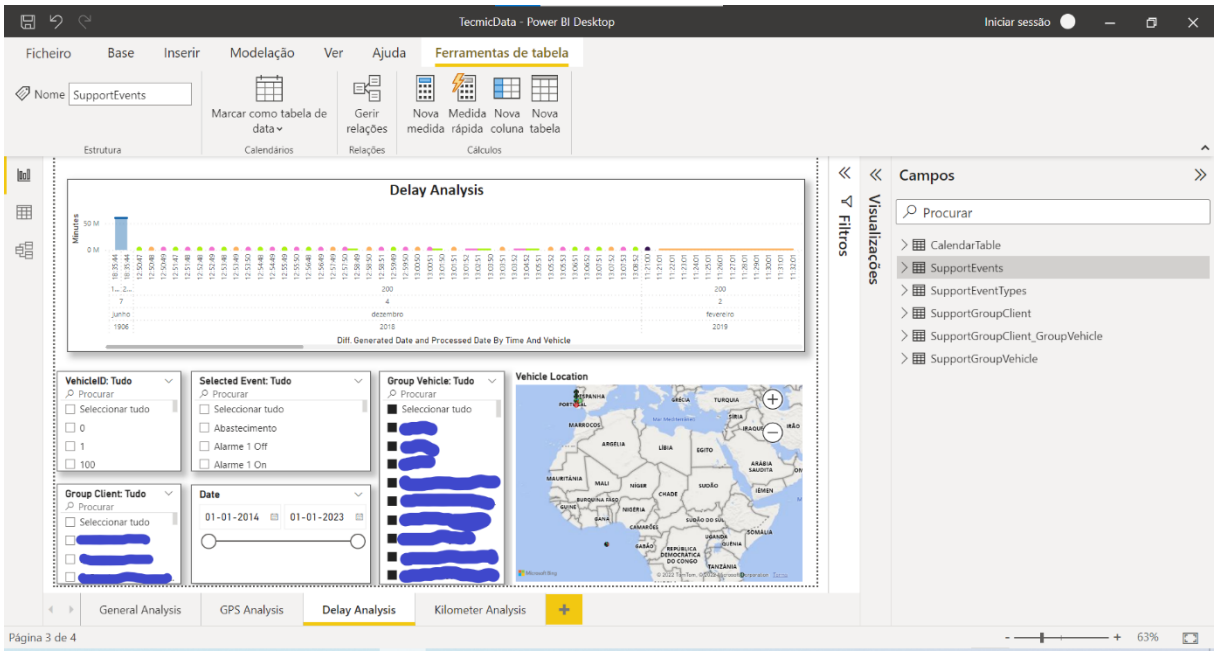

Figure 5.5: Delay Analysis

5.5. Kilometer Analysis

The first chart in the Figure 5.6 named “Total Wrong Kilometers rows per Vehicle” presents for each vehicle the total number of wrong kilometers. Through this chart is possible to see which vehicle has the highest number of wrong kilometers. The other elements in the figure are filters, we can filter the data of Total Wrong Kilometers rows per Vehicle chart by the VehicleID, EventTypeName, GroupClientName, GroupVehicleName and by a date range.

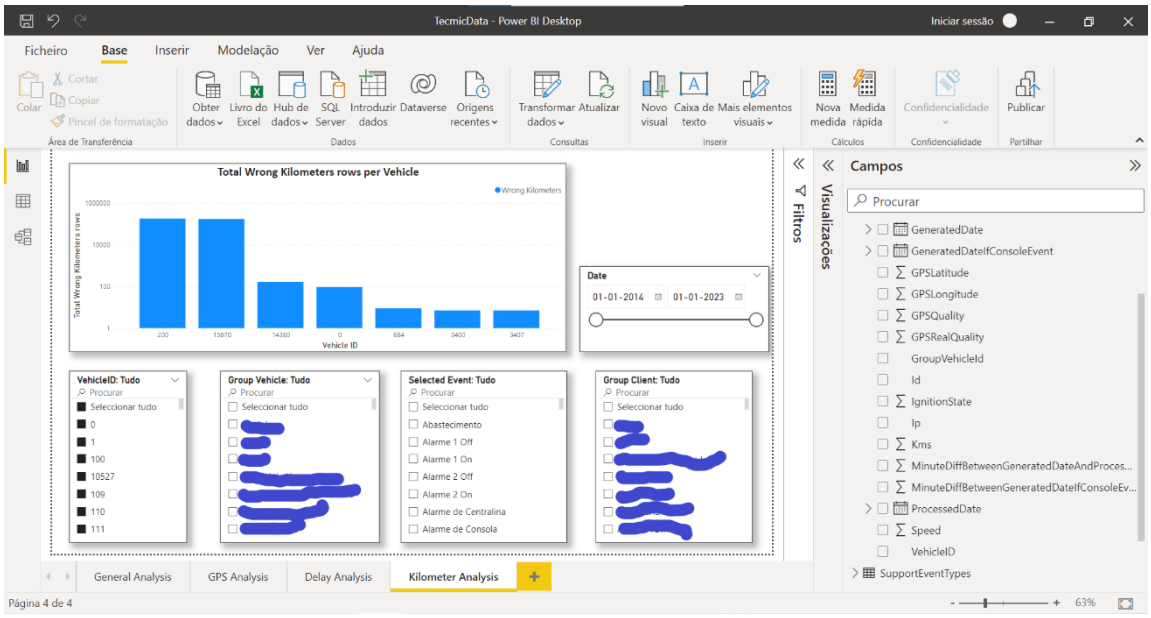

Figure 5.6: Total Wrong Kilometers

6

Conclusion

Contents

6.1. Conclusions

The Business Intelligence (BI) industry has grown fast and has helped business leaders to make the right decisions for their business. It has become indispensable for companies that care about their growth and the quality of services provided. There are many BI tools available on the market, the right tool is the one that meets the company's requirements, with the best balance between the cost and the benefits obtained. There are already many companies in the Portuguese market in the transport sector that have used BI tools to help manage their business. Power BI has been quite prominent within the Portuguese market, as it has been one of the preferred BI tools by companies.

The complete application of BI technologies includes the creation of a data warehouse, data marts, ETL process, multidimensional analysis, and implementation of a BI tool for data visualization. It boosts the business in such a way that when creating a report with just a few clicks the user has all the necessary information for his analysis, which with traditional reporting methods could take months to obtain.

Tecmic, a fleet management company, wanted to implement BI in its XtraN platform, in order to reduce the response time to the failures in the vehicles of the managed fleets, obtain information from the database faster, and discover bottlenecks in fleet management, through reports and dashboards. A study was carried out of the leading BI tools in the market and the conclusion reached is that Power BI is the one that best fits the Tecmic requirements.

From the analyzes made, through the reports and dashboards built, it was possible to observe:

- The number of anomalies that occurred in the system per year, per quarter, per week, per month and per day, for each different type of anomaly.
- The number of anomalies by equipment and by vehicle route code.
- The total number of anomalies occurred.
- GPS quality analysis.
- Messages delay analysis.
- The number of wrong kilometers recorded by each vehicle.

It is then possible to conclude that the analyzes made through the reports and dashboards, were able to reach all their expectations and brought benefits to the company in terms of improvement in the quality of the service provided.

6.2. Future Work

For future work, it could be:

- A complete data warehouse implementation using SQL Server for the database creation, SQL Server Integration Services (SSIS) a tool for ETL process, and SQL Server Analysis Services (SSAS) to perform OLAP.
- Embed dashboards from Power BI into XTraN application, so that Tecmic's customers can have access to the reports and dashboard of their respective data.

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