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A framework to support the creation of a Business Intelligence tool- application in an industrial context

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Master Thesis

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To my family

Abstract

Over the years, the world is becoming increasingly dominated by an exponential evolution of technology and information. Organizations are progressively more dependent on IT systems that are capable of managing large quantities of data and make it available for decision making, resorting to reports and consulting tools, such as Business Intelligence software. Consequently, allowing the use of available data to create information that duly supports decision making, namely Business Intelligence, has become essential in creating a competitive advantage for any organization. However, it is important to bear in mind that not every company has fully joined this evolution, existing still a long path to cover.

This work aims to develop a replicable framework to support companies in the creation of a Business Intelligence tool to provide superior value insights on the company's results and better support the decision-making process, considering the Data Collection, Data Storage and Analysis concepts. The framework developed considers not only the design and construction of the final tool to visualize the results, but also the understanding of the initial situation of the process, a deep critical analysis to identify weaknesses, the proposal of solutions to address the identified weaknesses and the development and implementation of those proposed solutions.

Moreover, the developed framework is validated through a pilot project developed in a real context, in a process of an industrial Portuguese company. Here, the framework was precisely followed, considering the end-users' requirements, resulting in multiple improvements proposals and developments regarding the Data Collection (including the Extract, Transformed and Load processes), Data Storage and finally Analysis (e.g., the Business Intelligence tool). The developed Business Intelligent tool enables not only the results visualization, but also its customization according to the requirements of the organization.

Conclusively, the developed framework is recognised as a valuable global solution, adaptable to multiple companies' contexts, since it considers the analysis and improvements from the roots of the processes, up until the Business Intelligence tool; finally, future improvements are proposed.

Acknowledgements

I have been given the pleasure of getting across multiple people during my academic life, but I could not end this cycle without mentioning the crucial elements that made this process unforgettable.

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List of Abbreviations

ERP- Enterprise Resources Planning

UN- *Unidade de Negócio* (Business Units)

O&M- Operations and Maintenance

ASE- Efacec's Automation Business Unit

AMT- Efacec's Switchgear Business Unit

AMB- Efacec's Environment and Industry Business Unit

SRV- Efacec's Service Business Unit

TRF- Efacec's Transformers Business Unit

TRP- Efacec's Transportation Business Unit

EEM- Efacec's Electric Mobility Business Unit

ENE- Efacec's Energy Business Unit

CFO- Chief Financial Officer

COO- Chief Operating Officer

BPM- Business Process Management

RePro- Rethinking Process

BPR- Business Process Reengineering

MIS- Management Information System

PDSS- Personal Decision Support Systems

EIS- Executive Information System

DW- Data Warehouse

BI- Business Intelligence

BA- Business Analytics

BI&A- Business Intelligence and Analytics

ETL- Extract, Transform and Load

DM- Data Marts

DBMS- Database Management Systems

RDBM- Relational Database Management System

SQL- Structures Query Language

OLAP- Online Analytical Processing

MDM- Mobile Device Management

OP- Operational Performance

LI- Location Intelligence

PGP- Planning and Performance Management Department

P&L- Profit and Losses

E2C- Empower To Collect

BL- *Balanço* (Financial Statement)

MD- Direct Method

MI- Indirect Method

CAPEX- Capital Expenditures

FSE- External Supply and Services

1 Introduction

This report was developed under the scope of a double degree program between the Master's Degree in Services Engineering and Management at the Faculty of Engineering of the University of Porto (FEUP), and the Master of Business Engineering (focused on Operations Management) at the Faculty of Economics and Business Administration from the Ghent University.

Developed at Efacec Power Solutions SA, in the Operation Control Department for Products, the project concerns the development of a business intelligence tool to support the top managers' decision-making process. The development of the dissertation includes not only an initial analysis of the state of the art, but also a characterization of the project, developed at Efacec Power Solutions SA., and the development of the adopted methodology. Finally, the presentation and discussion of achieved results are presented, as well as conclusions and future developments.

In the subsequent introductory chapter, the company and the department where the project was settled will be described, together with the context and the motivation of this project. Lastly, the report outline is presented.

1.1 Efacec Power Solutions SA.

Efacec was founded in 1905 by a mechanical sawing company, "A Moderna". As a Portuguese company with more than 100 years of history, Efacec has a vigorous exporting profile with a presence in more than 65 countries. Despite its years, Efacec has always been capable of putting itself at the head of technological development and innovation in multiple areas, as mirrored in their current signature "Empowering the future".

Currently, Efacec represents one of the largest industrial companies and a prestigious brand focused on designing a smarter future, offering a comprehensive portfolio and delivering custom-made solutions according to the specificities of each client and market. To achieve this, Efacec develops and delivers integrated solutions in the fields of Energy, Mobility and Environment.

Hence, Efacec is organized into three main segments: Energy, Environment and Mobility; and two transversal areas regarding the solution offered: Products and Systems (see Figure 1). The Energy field covers the "development of solutions for T&D, integrating conventional and renewable power systems to provide the best innovative solutions regarding efficiency, resilience, and reliability" (Efacec Power Solutions SA., 2020). The solutions provided by Efacec in the energy field are power transformers, high and medium voltage switchgear, energy management systems, services regarding industrial facilities Operation and Maintenance (O&M), and others. In the Environment field, Efacec aims to "manage water and solid waste cycles, reducing carbon footprint and developing green solutions that improve our quality of life" (Efacec Power Solutions SA., 2020), such as pumping stations, industrial dust removal, landfill energy recovery, between others. Finally, regarding the Mobility segment, the company offers solutions concerning electric mobility and transportation, such as charging solutions for electric vehicles, design, supply, installation, and commissioning of turn-key transportation systems, among others. Within these three segments, there are eight business units (in

Portuguese *"Unidades de Negócio"* -UN): Switchgear, Automation, Transformers, Service, Electric Mobility, Service, Energy, Environment and Industry, Transportation.

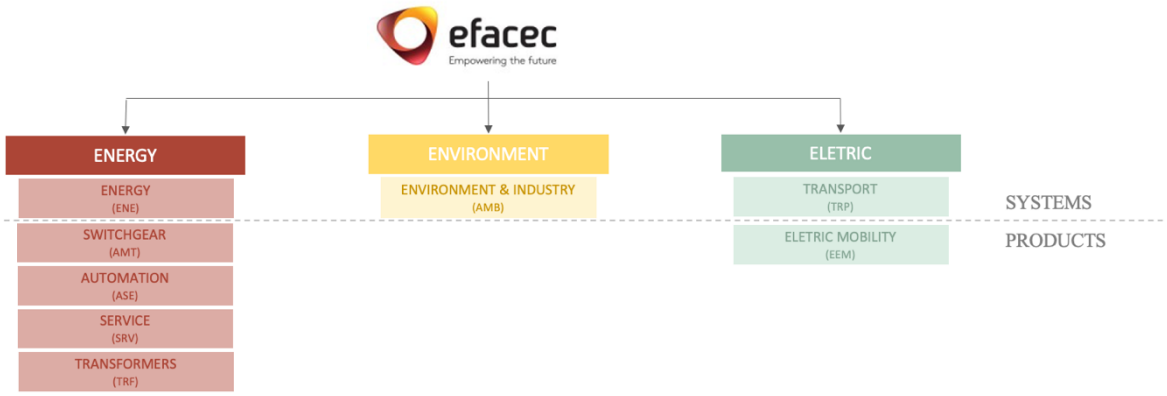

Figure 1 Efacec Business Units Scheme

Despite the global pandemic that the world started living in 2020, Efacec was able to achieve, with 2.304 employees (79% in Portugal and 21% worldwide), € 240.6M in orders and € 216.9M in revenue. Moreover, Efacec maintains its vigorous exporting profile, with only 36% of the revenue in Portugal (Efacec Power Solutions, 2020).

In 2020, due to the new Corporative Organization, Efacec suffered some structural changes and received new strategic orientations with the main objectives of "promoting a new relationship between Employees and Executive Committee, giving more responsibility and autonomy to the directors of the business areas" (Efacec Power Solutions SA., 2020). This new organizational structure and management model, among other transformations, resulted in different structures for some functional areas, such as Commercial, Technology, Operations and Finance. These areas work transversally to the Business Units, to international network and Corporative Center (see Figure 2)

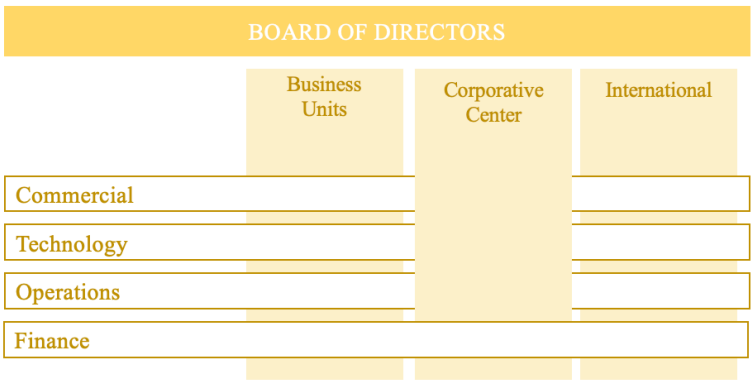

Figure 2. Efacec Organizational Chart (based on Efacec Power Solutions, 2020)

Efacec has a vast and complex international network composed of twelve affiliate companies across the world. Figure 3 presents Efacec's affiliate companies as well as their business units.

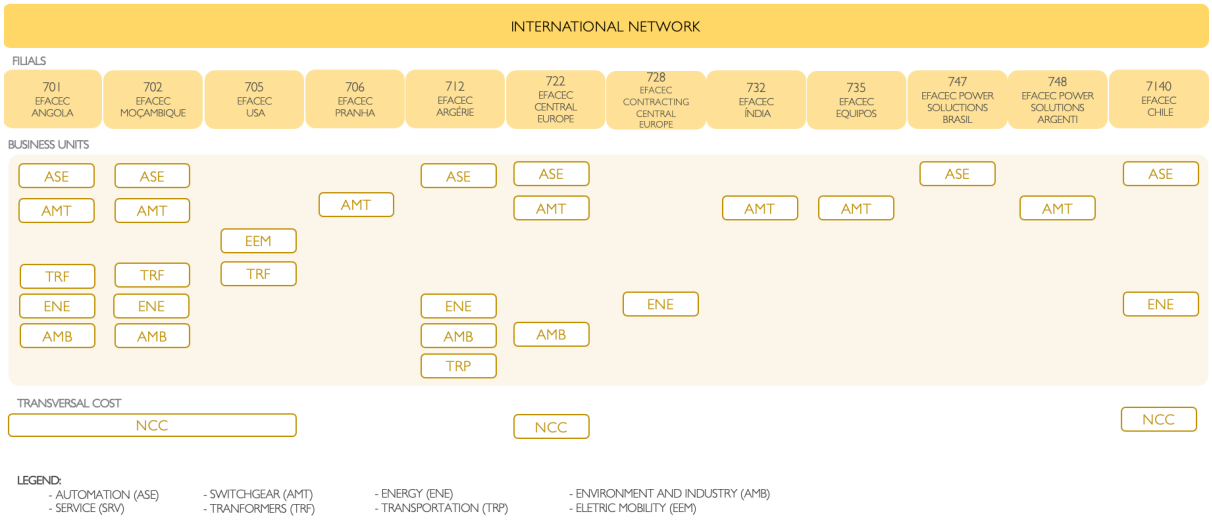

Figure 3. Efacec international Network structure

In the development of the Operations New Functional Area, the Operational Control Department for Products and the Operational Control Department for Systems were two of the departments formed. With very similar responsibilities each one of these departments coordinates activities regarding the business units in their correspondent group, either product or systems.

1.1.1. Operation Control Department for Products at Efacec

The Operational Control Department for Products coordinates the activities, control and tracking of the multiple product's business units (Switchgear, Automation, Transformers, Service, Electric Mobility), promoting an analytical perspective and production of functional information transversally to all business units, supporting the operations management and focusing on the following objectives:

- challenge and support the business units on the execution of the planning process in the short, medium and long term;
- orient the businesses to balance the physical dimension of operations execution and generation of a positive cash-flow, foreseeing the decision-making and the continuous definition of resources, ensuring stability and efficiency improvement;
- support the businesses concerning the respective transversal support and corporative functions;
- instigate the process automation to gather information indicators and metrics, ensuring the visibility of the levels of activities performance and the pursuit of the defined objectives;
- promote the upgrade of the project state and the line of integration of products and systems, incorporating the information to support the internal policy of management of the respective businesses.

1.2 Project context and motivation

Market's globalization has created new challenges to companies, increasing competition and higher speed changes in market conditions and customer needs. To keep adapting and flexibly respond to the market, while keeping the company under control, the exact knowledge of the current corporate and market situation is indispensable. (Otmane Azeroual, 2018).

Not being an exception, Efacec also deals with this new challenge in the market and the huge impacts of the global pandemic, COVID-19. In addition, Efacec is also in the process of transitioning between two different Enterprise Resources Planning (ERPs): one older (with more than fifteen years old) and the newer one that is at the beginning of its implementation since 2018, going live in 2019 for part of the organization. All these challenges make it particularly difficult for Efacec to define and obtain the business information needed to support the decision-making process of managers.

Nonetheless, as mentioned before, Efacec is also going through a delicate process of transitioning the Corporative Organizations, leading to organizational changes and new strategic orientations. Between other changes, it can also be underlined the creation of the Operational Control Department for Products which, between other responsibilities, provides global financial information of the different business units to the target managers (CFO, COO, Operation Directors, Financial Directors and Executive Commission). The creation of this new department consequently leads to the creation of new processes, such as the Operational Planning Process and the Rolling Forecast. Aware of the impacts and importance of Business Intelligence systems, Efacec has already developed some tools, however, they did not cover the entirety of the Operational Control Department for Products processes.

According to Otmane Azeroual (2018), frequently an enormous amount of data is available at companies, however, without the structure and organization that a BI system provides, it can spread confusion and ultimately complicate business. Operational Control Department for Products has available a large volume of data regarding its different businesses, but that alone is not enough. To leverage the data, it's crucial to organize, structure and develop a visual and easy to understand information system that presents the data according to the target managers requirements.

Therefore, this project represents an opportunity to explore the necessity of data and how a Business Intelligence Tool can significantly support the decision-making process. Then, there can be identified two main deliverables of the project: a replicable methodology and the application and validation of this methodology in a pilot project at Efacec's Operational Control Department for Products.

1.3 Report outline

Alongside this first Introduction chapter, containing the company and the department description and the project context and motivation, there can be distinguished five more chapters:

- *Literature Review:* comprises the state of the art in the relevant areas addressed in the project, starting with the definition of analysis of the Business Process Management Lifecycle, the evolution and characterization of Business intelligence & Analytics, and finally the Influence of BPM and BI on the Organizational Performance.

- *Project Characterization:* provides a detailed description of the project, identifies the goals and requirements of the target managers in the decision-making process and presents and specifies the methodology developed.
- *The Initial Situation of the Process:* represents the start of the pilot project at the company, contextualizing and describing the initial stage of the process, identifying the process pain points and proposal of solutions to overcome them.
- *Development and Implementation of the Business Intelligence Tool:* this chapter comprised the description of which developments were performed and implemented at the company and the overview of the results achieved in the process, more specifically, the BI tool.
- *Conclusions and Future Developments*: as the final chapter, the difficulties found during the journey are mentioned, conclusions are drawn and suggestions for future work are provided

2 Literature review

This chapter explores the literature on Business Process Management and Business Intelligence and Analytics. These reviewed topics were addressed based on the benefits explored regarding the aligning of the development of a BI asset and the business process improvement, enabling the understanding of the existent elements and selecting the best fitting methodologies for the success of the project. Starting with the Business Process Management topic, it reflects on the implication and advantages of this asset and its life cycle, focusing on one of the most important phases, the Business Process Reengineering. Afterwards, the evolution of Decision Support Systems throughout the years is explored, converging on the last stage, Business Intelligence and Analytics. In this topic, the architecture of the process (Data Collection and Integration, Data Storage, and Analysis) is explored step by step and exhaustively described. In each of these phases, the various appliable techniques and views are characterized and explored.

2.1 Business process management

Business Process Management (BPM) has its roots in the business process orientation trend in the 1990s, where the power of the process-centred approach into leading to substantial improvements in both performance and compliance of a system has been recognized. The business process represents a set of activities performed in coordination within an organizational and technical environment to accomplish a business goal. Business Process Management "includes concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes." (Weske, 2019). Besides innovating, continuously transforming businesses and entire cross-organizational value chains, BPM has also the power to increase productivity gains (Rosemann & Brocke, 2015). The BPM lifecycle conceptualized by (Dumas et al., 2018), comprises six phases (see Figure 4).

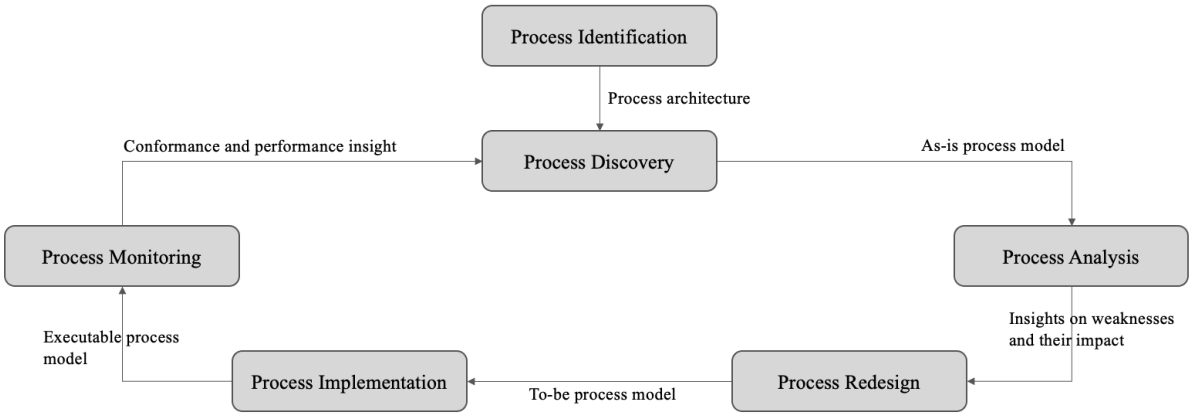

Figure 4. BPM Life Cycle (based on Dumas et al., 2018)

In the first phase, Process Identification, the problem is proposed, and relevant processes are identified, delimited, and interrelated. Succeeding is the Process Discovery phase, also designated as "AS-IS process modelling", where the current state of the pertinent processes is documented. Based on the AS-IS process model constructed on the second phase, in the third phase (Process Analysis) the issues are identified, documented and, if possible, quantified accordingly with performance measures. Based on the potential impact and the estimated effort

required to resolve the identified issues, they are prioritized. Afterwards, comes the Process Redesign phase, or "process improvement" phase, for which the main goal is the identification of required changes to the process, so the issues previously identified can be resolved. Typically, the output of this phase is a TO-BE process model. In the next phase, the Process implementation, the modifications required to achieve the TO-BE model are prepared and performed, covering two aspects: organizational change management (related to the necessary activities to adapt the way of working of all elements involved) and automation (related to the development and deployment or enhancement of IT systems to support the TO-BE process). Once the redesigned processes are implemented and running, data is collected to evaluate the performance of the process (Dumas et al., 2018).

This Dumas et al. view over the Business Process Management lifecycle was adopted as a base for the development of the methodology used in this dissertation, as it will be further explored in detail in chapter 3, in the methodology section.

2.1.1. Process redesign

It is conceptual among experts that the Process Redesign is a central part of BPM (Kerpedzhiev et al., 2021), and despite the possibility of entailing large technical and human investments, it may also yield substantial returns (Huang et al., 2015), representing a critical success factor (Rosemann & Brocke, 2015). According to Dumas et al. (2018), a wide range of process re-design approaches can be identified. Hence, upon the exploration of methods and techniques discussed in reviews and articles on process redesign and service design by multiple authors, seven process re-design approaches can be raised (Gross et al., 2021):

- *Pattern-based approach:* an approach based on the reproduction of solutions that have been applied previously, in real-life examples, and seem worthwhile to reproduce in another situation or setting. Some used techniques are explorative process design patterns are customer-centric design patterns and the Rethink of Process (RePro) principles.
- *Imitation-based approach:* based on exploring the existing processes designs, considering the seeking behavior, with the purpose of copying totally or just parts of existent process's design (e.g., positive deviance and benchmarking).
- *Problem-based approach:* represents the most noteworthy approach and its focus on exploring the problems on processes with the aim of improving issues or bottlenecks. Approaches such as Lean and Six Sigma represent problem-based approaches in the sense that they "… continuously tweaking existing processes through the identification and elimination of process problems.".
- *Outcome-based approach* (end-to start logic): based on a predefined outcome, the perfect process is designed (through reverse engineering) to achieve that outcome. Product-based design and the process model canvas are two outcome-based approaches.
- *Customer-based approach:* this approach aims to "…identify and analyze a process from the customer point of view." (e.g., service blueprinting and job centric approach).
- *Interaction-based approach:* a continuous guide on the interaction between the process redesign participants and artefacts. 7FE and NESTT are two commonly used approaches, while NESTT defends the use of the walls of the working room to

visualize, organize and discover different viewpoints on a process; 7FE enables the specification of a redesign facilitator.

- *Alternative-based approach:* an opportunity-driven approach that intends to study an extensive collection of possible process design alternatives, based on underlying assumptions made, since the process problems have not been explored yet (e.g., process grammar, handbook of organizational processes and the BPR framework).

The Problem-based approach, more concretely appealing to the Lean principle (i.e., elimination of non-value-added activities to easily enable the process objective achievement), was the one adopted in this dissertation's methodology, to analyze and identify improvements opportunities.

2.2 Business Intelligence & Analytics

Throughout times, organizations lean to collect data at a finer granularity, leading to a much larger volume of data. Factors such as an ever-increasing number of very diverse internal and external data sources, the sheer volume of data generated and used in everyday business, the complexity of business processes, as well as various compliance, privacy, and other data-related issues, have made cross-organizational data integration and analysis more complex than ever before. This resulted in businesses leveraging their data assets aggressively by positioning and investing in more sophisticated data analysis techniques to drive better decisions and discover new opportunities (Chaudhuri et al., 2011). It was in 1960 that this evolution has begun, and the first Management Information Systems (MISs) emerged from the idea of using the newly available data to support decision making. Throughout the following decades, as represented in Figure 5, these systems progressed through multiple phases.

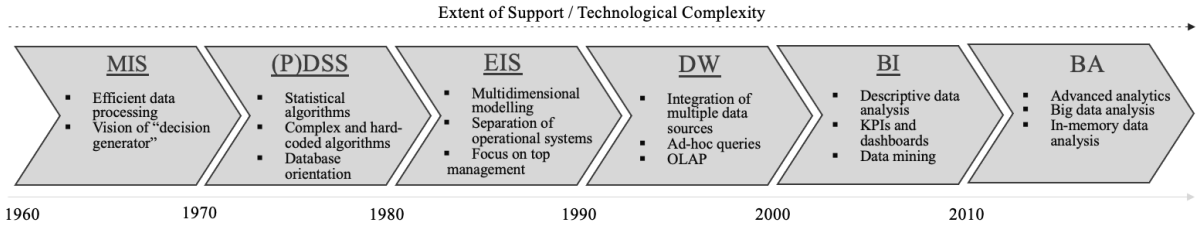

Figure 5. Evolution of Decision support systems (based on Kowalczyk (2017))

Starting from Personal Decisions support systems (PDSSs), to Executive Information System (EISs) and Data Warehouses (DWs), until the latest evolution of technology, the Business Intelligence (BI) and Business Analytics (BA). Along with this transformation, capabilities such as data processing and data availability are enriched, enabling the provision of more advanced data analysis capacities to organizations (Kowalczyk, 2017). Accordingly to Wixom & Watson (2010), BI can be defined as a "broad category of technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help its users make better decisions". Usually, the hub of a BI solution is the data warehouse (DW) (Harris & Davenport, 2017a), as data from internal and external sources are extracted and loaded into the data warehouse at certain intervals or at specific times (Gudfinnsson et al., 2015). These two latest stages of technological evolution (BI and BA) caused some distinctive opinions and definitions from industry experts. Harris & Davenport (2017a), clearly differentiated both concepts of BI and BA, defining Business Analysis as "... the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and

actions.". Although agreeing with the differentiation of both concepts, (Chae et al., 2014), defined BA as "the application of a broad range of analytical techniques and methods and data-driven analytic methodologies to different business domains.". Diverging from those opinions, (Mortenson et al., 2015) consider BI as an amalgamation of Business Analytics and Information Technology, as well as Gudfinnsson et al. (2015) that also supported the argument of considering Business analytics (BA) as an integral part of BI. Upon discordance, with the argument of large similarity between both concepts, contrasting with the opinion of other practitioners that argued that BI is a division of analytics, Chen et al. (2012) proposed the Business Intelligence and Analytics (BI&A) concept. Defining BI&A as a unified concept that "… relies heavily on various data collection, extraction, and analysis technologies".

Nowadays, Business Intelligence & Analytics is recognized as a practice to facilitate the delivery of information and knowledge in the processes and systems of organizations. Because of the analytical techniques implemented in data mining[1], along with visualizations and scorecards/dashboards, allowing data modelling, investigation, and monitoring of the subject areas, as well as advanced reporting. Also, cloud computing and Big Data analytics added to BI&A deliver effective results and significant benefits for businesses (Balachandran & Prasad, 2017; Raut et al., 2019).

In the typical BI&A architecture (see Figure 6) can be highlighted three main ideas: Data Collection and Integration, Data Storage, and Analysis (Chaudhuri et al., 2011, Kowalczyk, 2017).

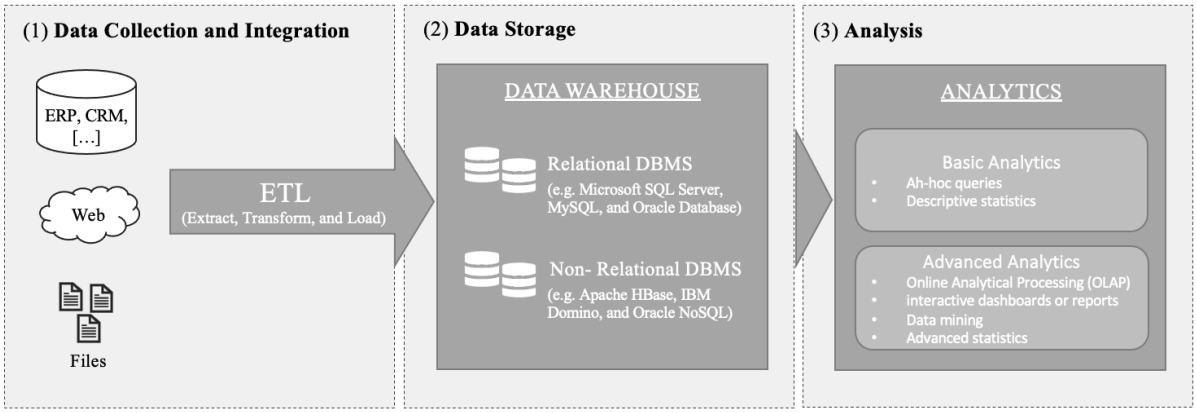

Figure 6. BI&A architecture

Data Collection and Integration

"The effective use of data for decision support depends on the ability to efficiently collect and integrate data of high quality from different kinds of internal and external data sources" (Kowalczyk, 2017). Extract, Transform, Load (ETL) refers to a process used in the data collection and integration, normally associated with a data warehouse. Data can have multiple roots sources (such as ERP applications, Excel spreadsheets, CRM tool, and others), subsequently, bringing all the data together in a standard, homogenous environment (in other words, reshaping the relevant data into useful information to be stored in the data warehouse) is essential. So, Extract, Transform, Load are three database functions that are combined into one tool that automates the process to pull data out of its source and place it into a database.

[1] Data mining: a technical process, automatic or semi-automatic, that analyzes large amounts of scattered information so that they have meaning and are converted into knowledge.

- Extract is the first phase and involves the reading of data and extracting the relevant subset of data, it is important to build it such as it does not negatively affect the source system in terms of performance, response time or any type of locking (Gour et al., 2010).
- Transform represent the process of converting the data previously extracted to a specific format, so it can be placed in the database. It involves data correction, cleansing of data, removing incorrect and duplicate data, incomplete data formation, and fixing data errors, data integrity and formatting incompatible data before loading it into a Data Warehouse system. However, not always this transformation process is necessary, for some data there is no need to perform any transformation (Vyas & Vaishnav, 2017).
- Finally, Load refers to the transitioning of the data in the targeted data source. It also includes refreshing the data warehouse, meaning expand updates from the data sources to the data warehouse at a specified frequency to provide up-to-date data for the subsequent process (Vaisman & Zimányi, 2014).

The ETL process is fundamental since it plays a significant role in the quality of the data loaded to the data warehouse, allowing the data warehouse to serve as a source of data for business intelligence or other analytical activities (Hendayun et al., 2021).

Data Storage

Data Storage denotes a centralized database, typically called “Data Warehouse” (DW). For several years, two approaches have been competing in data modelling for data warehouses: the subject-modelling approach of Immon and the dimensional modelling approach of Kimball. While Kimball, also known as the ‘father of the BI’, defines the data warehouse as "A copy of transactional data specifically structured for query and analysis" with the goal of “provide information to support decision-making in a company" (Kimball & Ross, 2013). On the other hand, Immon, also known as the ‘father of DW’ supports that a warehouse is “a subject-oriented, integrated, time-variant and non-volatile collection of data in support of management's decision-making process”(Darma et al., 2019). Figure 7 sums up both perspectives.

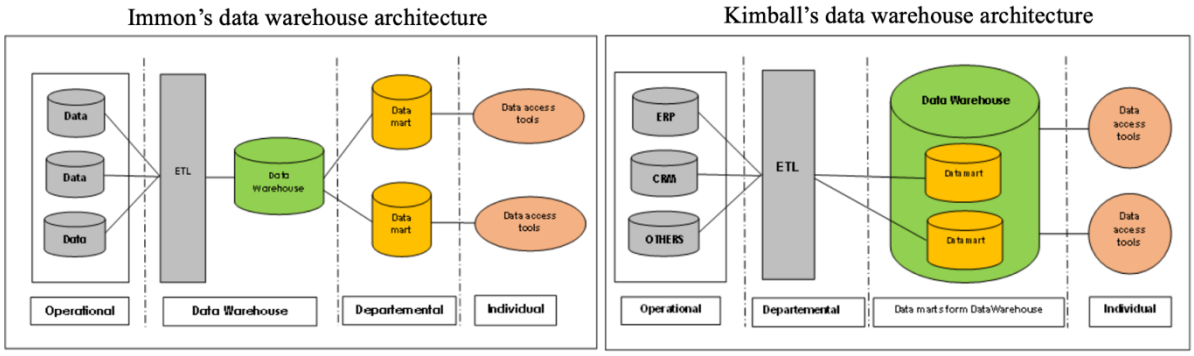

Figure 7. Kimball and Immon data warehouse architecture (Yessad & Labiod, 2017)

After comparing both approaches, Yessad & Labiod (2017) noted that the Immon approach is optimal when requirements are not defined or the DM is the source for several BI systems, also if the sources system structure is relatively stable. Kimbal’s approach is “highly recommended for data marts since the dimensional model offers high query performance and it is understandable by end-users. In addition, it is also appropriate to develop the data warehouse if the requirements are known and well defined.” (Kimball & Ross, 2013).

Accordingly to Kowalczyk (2017), exists two types of distinctive database management Systems (DBMS): Relational Database Management Systems and Non-Relational Database Management Systems. A Relational Database can be described as a set of tables (containing a collection of items), referred to as a relation with data category presented in columns, comparable to a spreadsheet. A few assumptions on how the data will be extracted is required, and as an outcome, multiple views can be created upon the same table. The access and modification of the data stored in the database are typically done using Structured Query Language[2] (SQL). Microsoft SQL Server, MySQL, and Oracle Database are some examples of Relational DBMS, widely used by companies to manage the database. In contrast, the Non-Relational Database Management Systems do not use tables (relations), nor SQL as it´s a query language, and it follows a schema-less approach to data management. In other words, it does not require schema definition before inserting data nor changing the schema when data collection and management need to evolve. In its place, it uses identification keys, enabling data to be found based on the assigned key. However, it may represent a solution for the increasing amount of data storage (Jatana et al., 2012). Apache HBase, IBM Domino, and Oracle NoSQL are some examples of Non-Relational Database Management Systems.

In recent years, companies need of processing higher volumes of data with complex structures (i.e., heterogeneous data) in real-time has increased exponentially, resulting in large advances in the field of Big Data. Big data is defined as "high volume, high velocity, and/or high variety information assets that require new forms of processing to enable enhanced decision making, insight discovery and process optimization" (Cavanillas et al., 2016). However, the main challenge is not in data processing capacity, but rather in the quality of the insights extracted from the information and its value. Hence, the field of Big Data is often connected with BI&A (Kowalczyk, 2017).

Kimball's perspective is the perspective that this dissertation assumes since it considers the user requirements and uses dimensional DM virtually integrated. Also, this project invokes a Relational Database Management Systems, using Microsoft SQL Server.

Analysis

Today, in the age of technology, large volumes of data exist (i.e., it has become relatively easy to collect data) but, as many companies are realizing, the biggest challenge is to make sense out of all data that has been collected (Winston, 2014). Analytics can be defined as "the extensive use of data, statistical and quantitative analysis, explanatory and predictive models, and fact-based management to drive decisions and actions." (Harris & Davenport, 2017). Analytics capabilities associated with BI&A include not only basic techniques for accessing and analyzing data (e.g., descriptive statistics and ad-hoc queries[3]), but also more advanced techniques for working with data in a structured way, including Online Analytical Processing (OLAP)[4] and interactive dashboards or reports (Kowalczyk & Buxmann, 2014).

[2] Structured Query Language (SQL): a programming language that is highly used in relational database, due to its easiness of use and the highly effective manner in which it queries, manipulates, aggregates data and performs a wide range of other functions to turn massive collections of structured data into usable information.

[3] Ad-hoc Query: the word "ad hoc" suggests that the query is designed for a "particular purpose", having different output value on every execution, while a predefined query has the same output in every execution.

[4] OLAP: is a powerful technology for data discovery, including capabilities for limitless report viewing, complex analytical calculations, and predictive "what if" scenario planning (*OLAP Definition*, n.d.).

Software such as Microsoft Power BI, MicroStrategy 2020, Alteryx Analytics, and IBM Watson Analytics gain relevance when exploring the market (Kerpedzhiev et al., 2021).

- *Microsoft Power BI:* a Bi platform[5] (Prakash Ukhalkar, 2020) unique software since it "enables users to do data preparation, data discovery, and dashboards with the same design tool. The platform integrates with Excel and Office 365 and has a very active user community that extends the tool's capabilities."
- *MicroStrategy 2020:* an Embedded BI Software[6] (Prakash Ukhalkar, 2020) that "merges self-service data preparation and visual data discovery in an enterprise BI and analytics platform. It provides out-of-the-box gateways and native drivers that connect to any enterprise resource, including databases, mobile device management (MDM) systems, enterprise directories, cloud applications and physical access control systems".
- *Alteryx Analytics:* a Location Intelligence software[7] (Prakash Ukhalkar, 2020) that "allows users to organize, clean, and analyse data in a repeatable workflow. The platform features tools to run a variety of analytic jobs (predictive, statistical, spatial) inside a single interface."
- *IBM Watson Analytics:* is an Embedded BI Software (Prakash Ukhalkar, 2020) that "offers a machine learning-enabled user experience that includes automated pattern detection, support for natural language query and generation, and embedded advanced analytics capabilities."

This dissertation adopts the Chen et al. unified concept of BI&A as well as the Chaudhuri et al. and Kowalczyk understanding of BI&A architecture. Consequently, the three phases of Data Collection and Integration, Data Storage, and Analysis symbolize key concepts used in this project's methodology.

2.3 Influence of BPM and BI on the organizational performance

As explored previously, BPM is a five phases holistic and multidimensional concept, organizations most frequently rely on to achieve continuous process improvement (e.g., better organizational performance) (Malinova et al., 2014). Additionally, Williams & Williams (2004) stated that "the business value of BI lies…", not only in supporting decisions through internal and external data collection, analysis, and reporting but also "…in its ability to improve the effectiveness of the core business processes that drive business performance". Also, both Richards et al. (2019), throughout an extensive study, and Bronzo et al. (2013) identify a positive relationship between the use of data analysis tools in the management practices, on account of the higher detail of the information used, and consequently, a positive impact in the organizations' performance. Therefore, it can be assumed that both concepts BPM and BI present a common goal, the improvement of Operational Performance (OP), and the alignment of both initiatives (i.e., BI-BPM alignment) seem natural.

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[5] BI platforms: "enable enterprises to build BI applications by providing capabilities in three categories: analysis; information delivery, such as reports and dashboards; and platform integration.". (Glossary, n.d.)

[6] Embedded BI Software: includes the "integration of reports, dashboards, and data visualizations inside an application. The information is typically displayed and managed by a BI platform and is placed directly within the application's user interface to improve data usability and decision-making.". (TIBCO, n.d.)

[7] Location Intelligence software (LI): allows the deriving of "insights from location data to answer spatial questions. LI goes beyond simple data visualization on maps, to analyzing location data as an integral part of a business or societal problem.". (Carto, n.d.)

Throughout an explorative study, (Suša Vugec et al., 2020) stated that “the primary goal of BI is to provide high-quality information that supports smart decision making”. Accordingly with multiple researchers from the area, in a BI context de dimension and information quality generated in the BI conversion-and-use processes, is decisive for its acceptance and use. This emphasizes the relevance of the BI data conversion and use processes. Typically, the low structure of processes based on which a BI tool is constructed (i.e., management processes) challenges the identification of relevant information accordingly with the user’s needs. BPM enables not only the identification of the relevant information for the business process, but it has also been recognized as an important success factor in the implementation and use of BI systems. Consequently, this BI-BPM alignment will not only contribute to further positive impacts on the OP but also add value to the quality of the BI, guaranteeing its superior contribution.

The potential for the alignment of both assets BPM and BI were highly recognized during this project, so it not only considered the development of a BI but also the previous business process improvement, as will be furthered explored in the third chapter.

Immon defends a ‘data-driven approach’ where the data is loaded to the DW without knowing the user requirements. He defends that both DW and Data Marts[8] (DM) have their own physical existence, consequently, after loaded to the central DW there is the creation of DM to cover the individual department needs. With this subject orientation and consistency of departmental data can be guarantee since the data origin is always the central warehouse. This approach “is recommended if the analysis requirements are not defined or the purpose of the marts is to provide information on several BI systems It is also preferred if the structures of the source system are relatively stable.” (Yessad & Labiod, 2017). On the opposite hand, Kimbal defends a "user requirements-driven" approach, based on Dimensional Modeling[9], with the involvement of end-users in the early stages of the project. Here DW can be recognized as an arranged of reliable data marts, based on shared conformed dimensions, that can be created in different time seats because there is no necessity of creating central storage (Kimball & Ross, 2013). In other words, each data mart provides a dimensional view of a single business process and an integrated data warehouse. (Breslin, 2004).

[8] Data Marts: a small data warehouse that contains a subset of the data warehouse that contains most of the information used routinely for business intelligence. In other words, it consists of a slice of the entirely organizations data (Burstein & W. Holsapple, 2008).

[9] Dimensional Modeling: a data modeling approach that capitalizes on the unique requirements of the data warehouse. Every dimensional model is composed of one central table with a composite key, called the fact table, which uses foreign keys to link to a set of dimension tables (Tseng & Chou, 2006).

3 Project characterization

This chapter begins with the characterization of the project, starting with a detailed description of the project and its objective, followed by the identification of goals and requirements for the decision-making process. Finally, a detailed explanation of the methodology used is presented.

3.1 The project

Efacec is a worldwide company working within an extensive range of products in very diverse areas of knowledge, which makes business analysis and management extremely complex. With a responsibility to provide target managers with operational elements from Product's business units, the Operational Control Department for Products is confronted with hurdles regarding the extensive dimension and frequency of the information demanded, the multiple sources of the information, and the effort required from the department to gather it. In addition to the already identified difficulty in gathering all business information and the stringent requirements of the target managers, it is evident the burning necessity for the company to work towards this drawback.

Efacec has already implemented and re-structured multiple processes to automate, using the most recent technologies, and with that achieve increased efficiency. However, because of its big dimension and the low number of resources working on these processes, the Operational Control Department for Products had only experienced small investment in their processes. Due to its crucial role in providing information to the decision-making processes of the top-level managers, it is urgent the implementation of a BI tool to facilitate the process and allow the dynamically updated visualization of data by these elements, anytime requested.

The first deliverable of this project is the design of a replicable methodology, that supports the process of re-structuration, the data collection and organization and the development of data analysis instruments, to assist companies in surpassing the difficulties in accurately supporting the decision-making process. The second deliverable is the application of this methodology, through a pilot project, on the Operational Planning Process, in one of the most critical processes of the Operational Control Department for Products. This pilot project will, not only allow the assistance of the department in supporting the decision-making process but will also, validate the developed methodology in a practical context.

The methodology will cover these topics of the process:

- the characterization of the Operational planning Process, underlying data sources and models, in the initial stage of the project;
- the characterization of decision-making process requirements;
- critical analysis of the process and suggestions of improvements;
- definition of the procedure for data processing and obtaining the necessary information for the Business Intelligence (BI);
- development and implementation of suggested improvements to the whole process, in an agnostic tool to the data sources used.

3.2 Identification of Goals and requirements for the decision-making process

As previously enlightened, the Operational Control Department for Products has the responsibility to complete multiple processes to support the target managers' decision-making process. Being the target managers of the Operational Control Department for Products processes the CFO, COO, Operation Directors, Financial Directors and Board Directors of Efacec Power Solutions Sa.. Generally, each one of these processes outcomes are diverse company results reports vital for the target managers' decision-making process.

Consequently, the Operational Control Department for Products must have reliable information reports, to enable the target managers to take effective decisions, based on precise and authentic company data. Subsequently, the results and reports created by the multiple Operational Control Department for Products' processes must enable the target managers to analyze and get to know the company's results accurately. In other words, target managers must be assured that the information presented is *trustworthy* and *reflects the actual situation* of the company at that moment. Additionally, managers must be able to access and consult reports *quickly* and *effortlessly*, and whenever necessary.

Finally, all the processes performed to support the decision-making have pre-established deadlines (e.g., weekly, every 15 days, monthly) to report the outcome to the target managers. It is fundamental to *assure the meeting of the deadlines* regardless of the changes implemented in the processes. The Operational Control Department for Products has the responsibility to supports top board element decisions, and the decisions of these elements cannot be delayed, so reports must be delivered to these elements on time.

3.3 Methodology

This chapter presents the methodology followed in this dissertation, based on the topics explored in chapter 2 and some additional techniques and concepts enlightened ahead. This project's methodology (represented in Figure 8) has four main phases: Process Discovery, Process Analysis, Process Redesign, Process Implementation.

All the four major phases are based on Dumas et al. (2018), BPM life Cycle (see Figure 4 in chapter 2). At the beginning of the project, the scope, as well as the process to act on were clear and, due to the short-time work (4 months) there was no time to gather and analyze the project results. Therefore, the first and last phase of the author's BPM Life Cycle (Process Identification and Process Monitoring) were not considered for this Project's methodology construction.

Figure 8. Methodology

It is important to emphasize the importance of the validation of all the outputs (such as the AS-IS model, list of issues, the improvements proposals, and the TO-BE model) at each phase with

the members involved in the process. This will guaranty the authenticity of the outputs, and safeguarding their accuracy, so the following phases are not compromised.

Despite being a methodology developed to solve and fulfil the requirements found at EFACEC's Operation Control Department for Products, it is central to take into consideration that the amount of data available in companies and its usage is growing exponentially. So, this methodology has a huge potential of being the solution to analyze, and aid in solving similar problems in other departments, and even in other companies, since it is easily replicable and adjustable to other existing needs, allowing the company to comprehensively analyze their processes and re-design them, guarantying the data gathering and safety of the records. This way, the implementation of a Business Intelligence tool can be better supported, and the data can be attractively displayed and easily customized.

3.4.1. Phase 1: Business Process Discovery (AS-IS model)

At the start of the project, it became important to understand the functioning of the process, the data flow, and the underlying data models. This comprehension of "how the process is done at the moment" (AS-IS), was achieved through meetings and other interactions with the members who were most involved in the process. In these meetings, members were asked to explain not only their role in the process but also the sources and flow of the information. The merge between the information gathered in these meetings and the information generated from a deep individual analysis of all the process elements enabled the design of a data scheme at the moment (i.e., AS-IS data scheme). Regarding the objective of the project being the development of a BI tool to support a decision-making process, it was considered that this model should be a visual representation summing up the components present in the process, their relationships, and the information flow. This way, the necessary information to support the following phases could be assured and the process could be analyzed accordingly to the main objective, focusing on the data flow throughout the process.

3.4.2. Phase 2: Business Process Analysis (list of issues)

The Business Process Analysis step is based on a deep critical analysis of the process, with the main goal of identifying weaknesses of the process. In the meetings previously performed, in Phase 1, already some issues were identified by the company involved members. However, these meetings did not allow the identification of all the issues present in the process. So, in this phase, the observation of the involved members performing the process and questioning was key to the identification of additional issues and raise an all-inclusive list of issues.

3.4.3. Phase 3: Business Process Re-design

Once the process is known (and the AS-IS scheme designed) and a deep analysis of the scheme has been done (identifying the weaknesses of the process), it is indispensable the reflection on these issues, so proposed changes can be made, and the identified issues can be resolved. As explored in the Literature Review chapter, multiple process redesign approaches can be applied in the re-design process. However, the best fit for this project is the problem-based approach. Here, the existing processes are tweaked through the identification and elimination of process issues, and a proposal of changes are developed to automate and standardize the process. More

specifically, using the Lean Management approach, eliminating activities that do not add value and/or adjusting activities that cause waste (Gross et al., 2021).

Additionally, it is essential to ensure that the three ideas of Data Collection and Integration, Data Storage and Analysis, defended by Chaudhuri et al. (2011) and Kowalczyk (2017), are reviewed also in chapter 2, are considered. As well as Kimball's perspective, that considers the user requirements and uses dimensional DM virtually integrated, in the Data Storage element. This will ensure the reliability of the sources of data and their proper functioning and consequently assuring the noble quality of the data presented in the BI Tool.

The dimension and complexity of the improvements will mostly depend on each process and their automation and standardization state. Nevertheless, these changes will enable the design of the TO-BE data scheme, that empowers the visualization of the improvements and their impact on the data flow and relationship, as well as the implications regarding the elements of the process (such as the creation of new elements or even elimination of unnecessary ones). To allow the comparison between the process before and after improvements it is important to maintain the structure used initially in the design of the AS-IS data scheme.

3.4.4. Phase 4: Process Implementation

In this phase, the improvements previously identified are prepared and performed, to achieve an executable process model. This phase can be divided into two sub-phases: Processes Improvements Developments and Business Intelligence Tool Development.

Processes Improvements Developments

In this sub-phase, the improvements regarding the automation of the process to support the BI Tool (such as Data Collection and Integration and Data Storage) are performed and implemented at the company. Here the ETL process must be ensured, and the data must be loaded to the database.

In this project, the major sources of data were Microsoft Excel files, so the Extract, Transformed and Load process was developed through Excel macros using Microsoft Visual Studio, recurring to Visual Basic programing language. This element allowed not only the extraction of the data from the excel files, but also its modulation accordingly with the database structure and the posterior load of the transformed data to the respective Data Marts. Microsoft SQL Server, a Relational Database Management System, was the DBMS already used at Efacec, so it was also the chosen software for this project. This software enabled the creation of different Database Views[10], allowing the selection of subsets accordingly with the requirements for the development of the BI Tool.

Additionally, in this sub-phase, it is important not only to implement the developed changes to the process and guarantee that it is working as planned but also to explain and ensure that the involved elements understand the changes in the process. People, by nature, tend to express some resistance to change, so it is extremely important to involve them in the re-design process and carefully explain the changes being made and their advantages afterwards. This way, by ensuring that every element involved in the process understands the advantages and reasons for

[10] Database Views: A database view is a subset of a database and is based on a query that runs on one or more database tables. Database views are saved in the database as named queries and can be used to save frequently used, complex queries.

changes, the right administering of an improved process can be easily guaranteed. This implementation of changes should be performed through short-time meetings with the process involved members.

Business Intelligence Tool Development

Finally, the visual representation is built based on the previously Extracted, Transformed, and Loaded (to the DW) data and respective Data Views. In the past, Efacec used the MicroStrategy software, however with the appearance of Power BI the company has started using it since it better adapt to their requirements. Efacec has already developed some data visualization elements in other processes using Microsoft Power BI, so this was the software used in this project

In this sub-phase, understanding the requirements and needs of the end-users (i.e., the target managers in this project), in terms of data visualization (regarding the BI tool) is indispensable. Thereby, by knowing and understanding their needs and requirements, the tool was designed and developed more objectively according to the requirements. In this phase, it is also important to guarantee the dynamic update of the Tool's data, so the visual elements showed always portray the most recent validated values. To start the practical development of the Tool, it is crucial to structure and prepare the data to better serve and facilitate its configuration and design (already performed in previous phases). Ultimately, once the data is structured, it is fundamental to carefully design and arrange the front-end elements to display the information appealingly and intuitively. This way, the main goal of facilitating the visualization and analysis of the company's results can be easily met.

The validation and approval of the BI tool by the end-users is an essential step of this phase. Even when the user requirements have been considered since the beginning of this phase, by observing the result (i.e., the BI tool), more inputs can arise and some changes to the tool may be required. This way, the exact correspondence between the user's requirements and tool development can be ensured. So, presentation meetings with the end-used should be scheduled, to better guarantee the meeting of users' requirements, considering their opinion over the BI tool developed.

4 The initial situation of the process

In this chapter, the pilot project developed at Efacec will be presented. This project covers Phase 1 (Process Discovery), Phase 2 (Process Analysis) and Phase 3 (Process Redesign) of the previously described methodology. It first explores the Operational Planning Process at Efacec and the subsequent interactions, followed by a deep analysis of the process state at the beginning of this dissertation, originating the AS-IS data scheme. The deep and critical analysis of this scheme allows the detection of the process pain points, which are later addressed in the next section with proposed solutions for each of them. Finally, the last step of this chapter is the development and representation of the TO-BE data scheme, which includes the description of the proposed solutions.

4.1 The Operational Planning Process at Efacec

As previously mentioned, Efacec suffered changes regarding the organization's structure, the management model and the adoption of a more transversal role of the risk management area. This led to the review of some risk management processes, involving multiple areas of the organization (such as legal, risk management processes, operational, management control, administrative and finance), "in order to evolve in terms of risk identification, measurement and mitigation, while enhancing, given the new circumstances and challenges of management, economic rationality and conservation criteria in the presentation of financial information" (Efacec Power Solutions, 2020). Additionally, a dynamic business planning approach was adopted to overcome changes and uncertainty settings: define a target, monitor analyses, and forecast trends for better decision-making and resources allocation. Figure 9 depicts a resume of the Dynamic Management Model adopted, as well and the new integrated management routines.

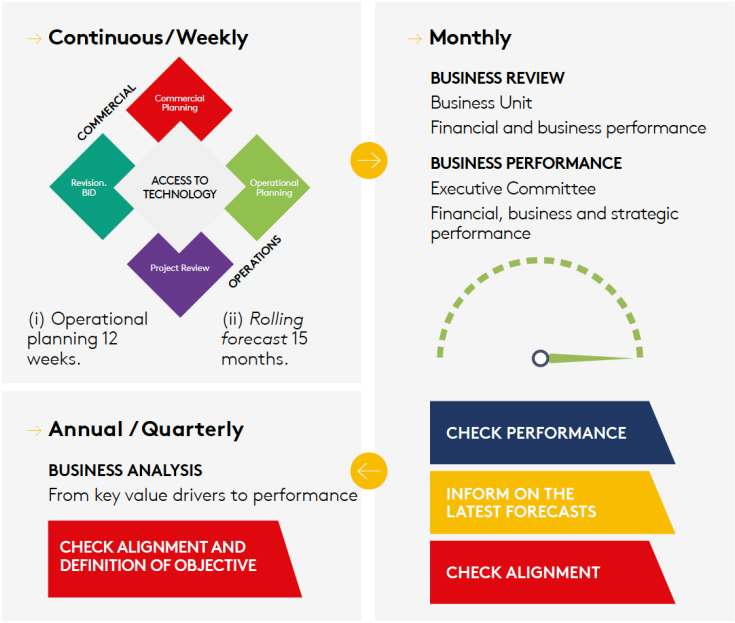


Figure 9. Efacec's dynamic management model (Efacec Power Solutions, 2020)

Despite the replicability of the methodology developed, this dissertation's pilot project will be focused on the Operational Planning Process, which is a relatively recent process, only implemented at Efacec at the end of the year 2020. It is a complex process of forecasting the

cash-flows and the weekly economical-financial results of the company, for a time frame of 12 weeks, involving eight of the Efacec's departments (Planning and Performance Management, Treasury, Business Units Directors, Project Management, Commercial, Financial International and the Operational Control), performed individually for each one of the eight Business Units. In Figure 10 the macro-organization of the process elements is represented.

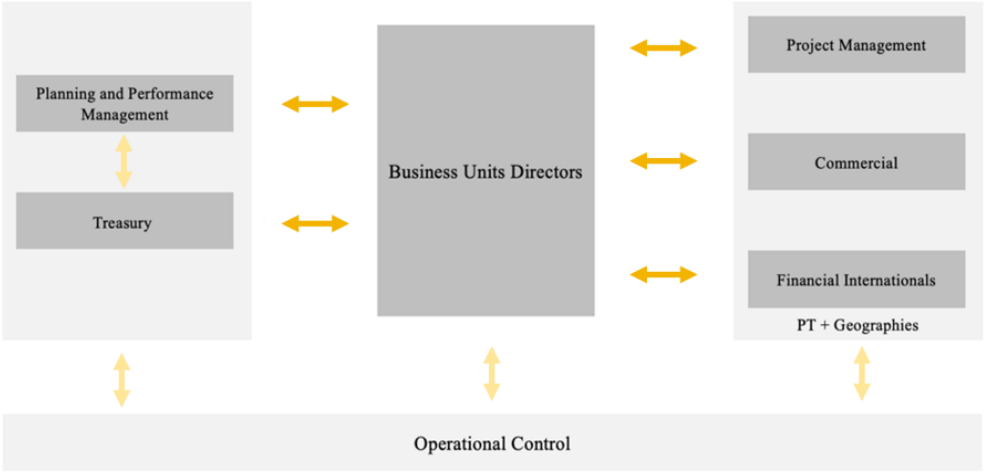


Figure 10. Operational Planning Process macro organization (based on (Efacec Power Solutions, 2020)

Moreover, the output of this process is 12 weeks forecast report regarding the cashflow, the operational cashflow, the orders, the invoicing, the cash in, the consumptions, the Profit & Loss (P&L) and the financial statement of each Business Unit. This processes' results represent a vital point for the decision-making process of the target managers, regarding the allocation of financial resources.

4.2 Initial situation of the process & underlying data models

The assessment of the initial situation of the process, or process discovery phase, was made through meetings with the involved members in the process and with an individual analysis of its artefacts. This enabled the understanding of the workflow of the process as well as the interaction between the different assets on the process, and the design of the AS-IS data scheme (see Figure 11).

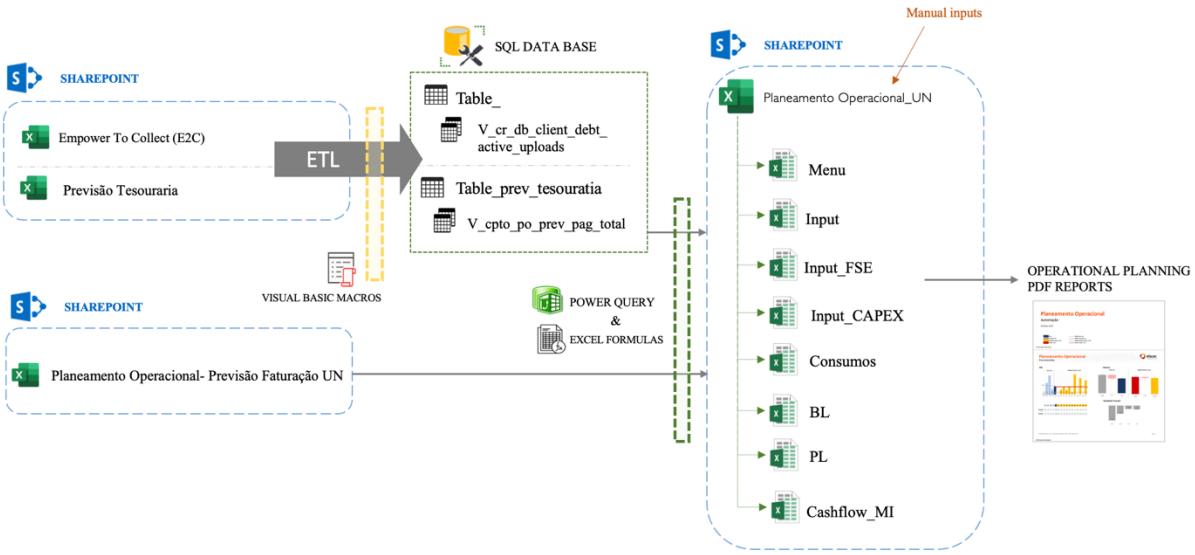


Figure 11. AS-IS Data Scheme of the Operational Planning Process

The departments work together to accomplish this process every week. Besides the inputs manually insert in the *"Planeamento Operacional_UN"* file (excel file used to gather and generate the necessary information, for the Operational Planning Process, and to produce the final processes reports) there were already identified some automation mechanisms to update some of the information in the file. There could be identified four main sources of information:

- "*Previsão Tesouraria"*: an excel file containing information regarding the operational cashflow, from where information such as intra-group payments and receivables, financial charges, and others are extracted and loaded to the respective *"Planeamento Operacional_UN". This file* is managed by the Treasury Department, and the information has already been saved in a database. Through Power Query, the information is extracted from the database, transformed, and placed in the respective spaces at the *"Planeamento Operacional_UN"* worksheets using excel formulas (e.g., conditional formulas such as *'sumif'*); the update of the queries, is weakly done using Visual Basic macros.
- *"Planeamento Operacional- Previsão faturação UN":* an individual UN excel file, maintained by the Operational Control department, where the future invoices are registered, and the prevision date of reception are forecasted accordingly with inputs from the Project Managers. On the contrary to the "*Previsão Tesouraria"* information, this information was not yet saved in a database, it was obtained through excel formulas that automatically access this file and extract the necessary information.
- *Empower To Collect* (E2C): a debt tracking tool, with an Excel interface, that provides information on the cash in (e.g., Open items); it is managed by the Operational Control of each UN.
- *Manual Inputs*: the forecast inputs (i.e., prevision values for the following weeks) are manually inserted directly in the *"Planeamento Operacional_UN"* file by the respective Operational Control department of each UN. The actual values (i.e., values achieved in the present week) of each week are manually introduced by the Planning and Performance Management Department (PGP) weekly.

At the initial moment of process analysis, only the information from the "*Previsão Tesouraria"* file and E2C were saved in a database, using Visual Basic macros. Once in the database, this data was selected accordingly with the date of its introduction in the database, being only

present the most recent results in the views, one for the invoices and one for the E2C information. This guarantees that the data posteriorly loaded to the *"Planeamento Operacional_UN",* using Power Query (a Microsoft excel tool to transform and prepare data) and Excel formulas, was always the most recent. On the contrary, the information from the *"Planeamento Operacional- Previsão faturação UN"* was directly loaded to the *"Planeamento Operacional_UN"* file using excel formulas.

As it was previously mentioned, the Operational Planning Process is constructed based on one central excel file, **"***Planeamento Operacional_UN",* where the information is collected and processed. This file is composed of fourteen worksheets (see Appendix A):

- *'Menu'*: where general process information details regarding the UN, the date of update, the present week, and others are recorded; additionally, it also details the target for the correspondent week, regarding for example orders, invoices, cash in, consumptions, between others.
- *'Cover'*: the cover of the Operational Planning Report generated at the end of the process; it specifies the UN, the date and some important captions.
- *'Orders'*, *'Invoicing'*, *'Cash In'* and *'Consumptions'*: four different worksheets that automatically generate graphical elements of the achieved results, the forecast quality and the deviations between the previsions and the actual results.
- '*Profits & Losses* (P&L)': summarizes the revenues, costs, and expenses incurred and the forecast previsions.
- *'Financial Statement* (in Portuguese *"Balanço"*- BL)': represents the business activities and the financial performance of a company (i.e., provides an overview of assets, liabilities, and stockholders' equity).
- '*Cashflow using Indirect Method* (Cashflow MI)': offers information on cash generated from various activities and shows the effects of changes in asset and liability accounts on a company's cash position.
- '*Operational Cashflow using the Direct Method* (Operational Cashflow MD)': uses actual cash inflows (only the cash that's been received) and outflows from the company's operations.
- *'Input'*, *'Input CAPEX*[11]*'*, *'Input FSE*[12]*'*: as the name suggests are worksheets specially designed for manually insert data to feed the other worksheets.
- *'Historical Projection'*: is a records worksheet, it is manually filled with the previous forecasted information regarding orders, invoicing, and cash in, serving as a source of information for the worksheets that compare the obtained results (e.g., 'Orders', 'Invoicing', 'Cash In' and 'Consumptions')

Not all these worksheets represent output worksheets (i.e., the user doesn't need to insert any elements, it automatically presents results based on other worksheets' inputs), on the contrary, most of them are input worksheets. The menu, input, CAPEX input, FSE input, historical projection, consumptions, and P&L worksheets were considered input worksheets, while the

[11] Capital expenditures (CAPEX): funds used by a company to acquire, upgrade, and maintain physical assets such as property, plants, buildings, technology, or equipment. CapEx is often used to undertake new projects or investments by a company

[12] External Supplies and Services (in portuguese *"Fornecimento de Serviços Externos"* – FSE): all costs per acquisition of current consumer goods, other than stocks and services provided by entities outside the statistical unit of observation.

cover, cashflow using the indirect method, the operational cashflow (using direct method), orders, invoicing, cash in and BL worksheets represent outputs worksheets.

The central excel file, *"Planeamento Operacional_UN",* was already designed and prepared to collect and format the information to produce the Operational Planning PDF Report at the end of the process (as can be perceived by the similarities between both files, available in Appendix A and B). So, when the weekly inputs are finalized and the values are approved, the Operational Planning PDF Report is produced. This report is the weekly report delivered to the target managers to support their decision-making process (an example of a report can be consulted in Appendix B).

It is important to refer that all these files are shared inside the company through the SharePoint of Microsoft. Consequently, this implies that every week, new *"Planeamento Operacional_UN"* and Operational Planning PDF Report are created, for each Business Unit, resulting in a huge number of stored files.

4.3 Critical analysis and improvements opportunities identification

The second phase of the applied methodology (Process Analysis) involves the weaknesses identification upon a deep analysis of the process and the meetings performed to understand the process.

The Operational Planning Process is weekly repeated by every involved member for each UN. Despite already presenting some automation level (such as the automatic insertion of results from the "*Previsão Tesouraria"* and E2C*)* it was identified as insufficient due to the high frequency of process execution it implies. In a process with such a high frequency of performance, automation represents a huge advantage, since it minimizes the effort done by the multiple departments involved and can even increase the accuracy of the process results, minimizing mistakes. Therefore, the lack of automation represents the first identified weakness of the process.

Additionally, as mentioned in the previous section, at least eight Operational Planning excel files are created every week, one for each business unit, which produces a huge number of files to manage (imagine for example in a timeframe of one year, there are produced, at least, 416 Operational Planning excel files and 416 reports). This characteristic of the process represents a process weakness not only because of the difficulties it brings to the file's management procedure, but also the lack of records it promotes. With the creation of new files every week the connection between the different files does not exist (except for the *'Historical Projection"* worksheet, exclusively created for this purpose, where a minor part of the week results are registered), therefore the registration of company result's records is also not feasible.

The individuality of the reports submitted to the target managers (i.e., reports only present the results for one UN), as well as the limited timeframe, previously defined for each report, and the fact that it is a static file (PDF file), doesn´t allow the users to customize the reports accordingly with requirements at the exact moment of accessing (e.g., see the results of two units in one report). These identified characteristics, represent additional limitations to the process.

Finally, Efacec is a multinational company and when analyzing the company's results, it is essential to consider both the national results and the international results. Yet, at the beginning of this dissertation, it was noticed that the international network information was presented

accordingly with medium values weekly obtained, and that does not reflect the reality of the company's results. The reason for using these medium values instead of the actual results is the lack of information on the results of the international network, which mainly affects the Cashflow MD matter. However, this way of contemplation of the international network results also negatively affects the accuracy of the reports produced in this process.

4.4 Suggestions for improvements

This section presents Phase 3 (Process redesign) of the applied methodology, which encourages the solutions proposed to solve the weaknesses previously identified.

To address the weakness found in the data use on the international network and fight the absence of available information regarding this network, enabling the collection of the operational information of each element in the international network (called 'UN-filial' from here on- to recall the international network structure see Figure 3, in chapter 1) is crucial. Figure 12 portray the proposed solution for the international network weakness.

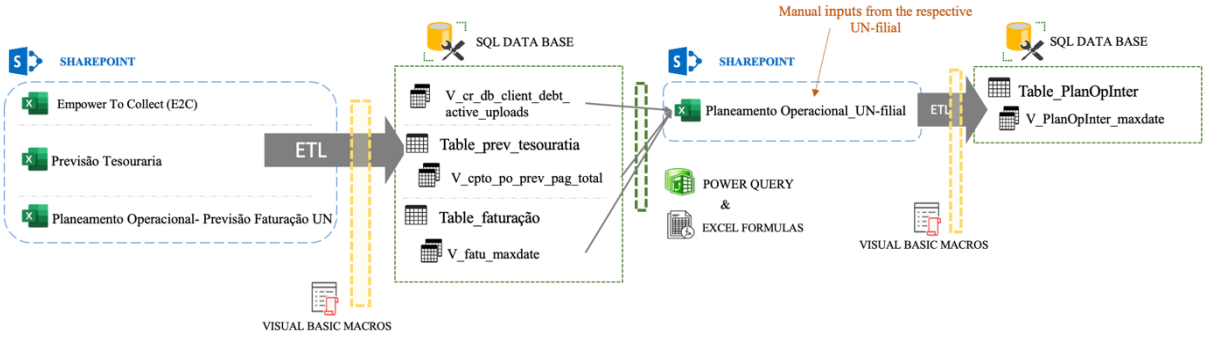


Figure 12. Scheme of the solution proposed for the international network

The solution proposed implied the creation of an individual excel file for each element of the international network, with a similar structure to the *"Planeamento Operacional UN"* and with the same sources of information (i.e., "*Previsão Tesouraria"*, *"Planeamento Operacional-Previsão faturação UN"* and Empower To Collect), adapting the formulas to filter the information accordingly with the respective UN-filial. This will enable each UN-filial information to be weekly updated by the selected member of each UN-filial and shared with the whole company.

However, initially safeguarding in a database the information gathered from the three main sources of data: *"Previsão de Tesouraria"*, *"Planeamento Operacional-Previsão Faturação_UN"* was essential. As identified at the beginning of the process, more concretely in the AS-IS data scheme, two of the identified sources of information were already being saved in the database, so there was only the necessity to execute this procedure to the other one source missing in the database, the *"Planeamento Operacional- Previsão de Faturação_UN. The* implementation of this procedure should be done accordingly with the approach already taken for the other sources. Hence, using Visual Basic Macros, a process of data extraction, transformation (accordingly with the structure design for the database), and the load to the respective database table represents the first solution proposal. However, these database tables will not represent the direct sources of information for the *"Planeamento Operacional _UN-filial"*, but rather their respective Views, once they merely select the most recent data, simplifying the process. Therefore, these views should feed the *"Planeamento Operacional*

_UN-filial" through Power Query and Excel formulas, which access the view's information and load it to the excel file.

These files can easily be aggregated by UN or Filial accordingly with the requirements, enabling a better perspective on each UN or Filial overall results, since they all present the same structure. Afterwards, to safeguard and create records, this information must be saved in the database ("Table_PlanOpInter"). This will represent a novel source of the *"Planeamento Operacional_UN"*, which using Excel conditional functions will add the international results in the respective spaces. This way, Efacec can consider the international network results more accurately, uncompromising the process and better supporting the decision-making process.

The lack of automation and the lack of records were also two additional weaknesses identified in the process. Altering the workflow of the process, encouraging the Data Collection and Integration, Data Storage and Analysis, defended by Chaudhuri et al. (2011) and Kowalczyk (2017) (to recall see Figure 6), as well as considering the user requirements and using dimensional DM virtually integrated, as defended by Kimball's, were two indispensable perspectives taken in account. Figure 13 depicts the TO-BE data scheme proposed for this process.

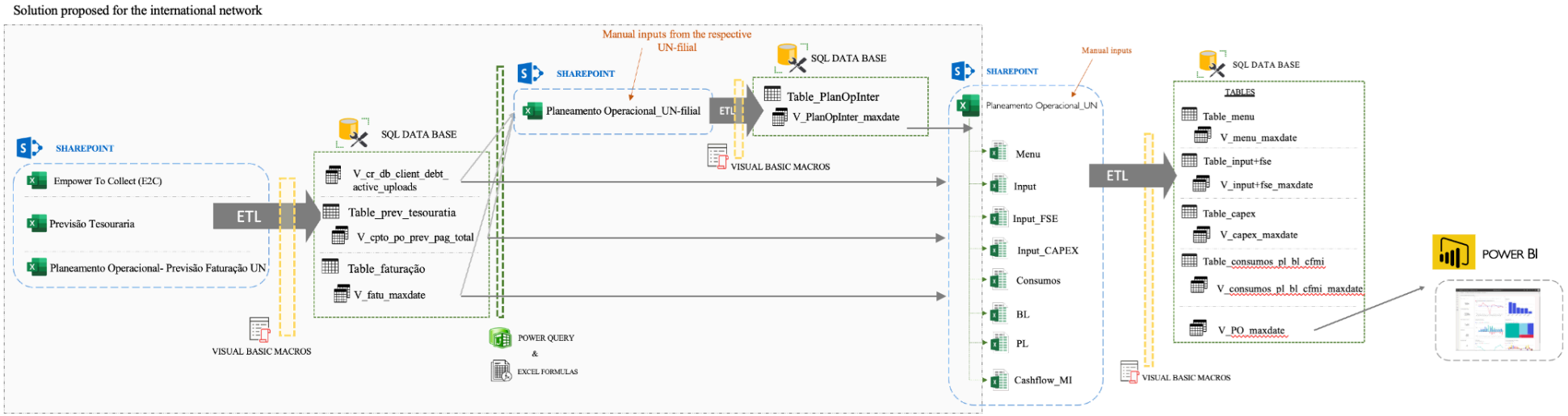


Figure 13. TO-BE data Scheme of Operational Planning Process

The solution proposed for the international network represents the initial stage of the TO-BE data scheme, as the *"Planeamento Operacional_UN-filial"* (excel files generated during the proposed improvements in the international network) represent one new source of information for the Operational Planning Process at Efacec. Therefore, in the TO-BE data scheme there can be identified four sources of information for the *"Planeamento Operacional_UN": "Planeamento Operacional_UN-filial"*, *"Previsão de Tesouraria"*, *"Planeamento Operacional-Previsão Faturação_UN"* and E2C. At this point, all these sources' information are should be saved in the database, being the respective views the connection point between the files and *"Planeamento Operacional_UN"*. Accordingly, using Power Query and Excel formulas the information at the database is accessed and loaded to the excel file.

To create records of the information present in the *"Planeamento Operacional _UN"*, it is essential, upon manual inputs of the Operational Control of each UN and the PGP, to promote the safeguarding of all these file details in a database. So, using Visual Basic Macros, the information should be automatically loaded to the file as well as the manual inputs, which should be ultimately Extracted, Transformed, and Loaded to the database. The multiple worksheets existing in the *"Planeamento Operacional _UN*" present very district structures, which implies the creation of distinctive tables accordingly with different data requests. Once again, to facilitate the construction of the BI tool and guarantee the dynamic update of the information it was essential to generate views that select the most recent updates of each worksheet ("V_menu_maxdate", "V_input+fse_maxdate", V_capex_maxdate and "V_consumos_pl_bl_cfmi_maxdate"). Still, due to the high complexity created by the multiple tables and respective views, gathered all the most recent information for each week in a single View is fundamental. Therefore, the "V_PO_maxdate" represent the view created to aggregate all the distinct database Views, representing the key source of information of the BI tool (see Figure 14).

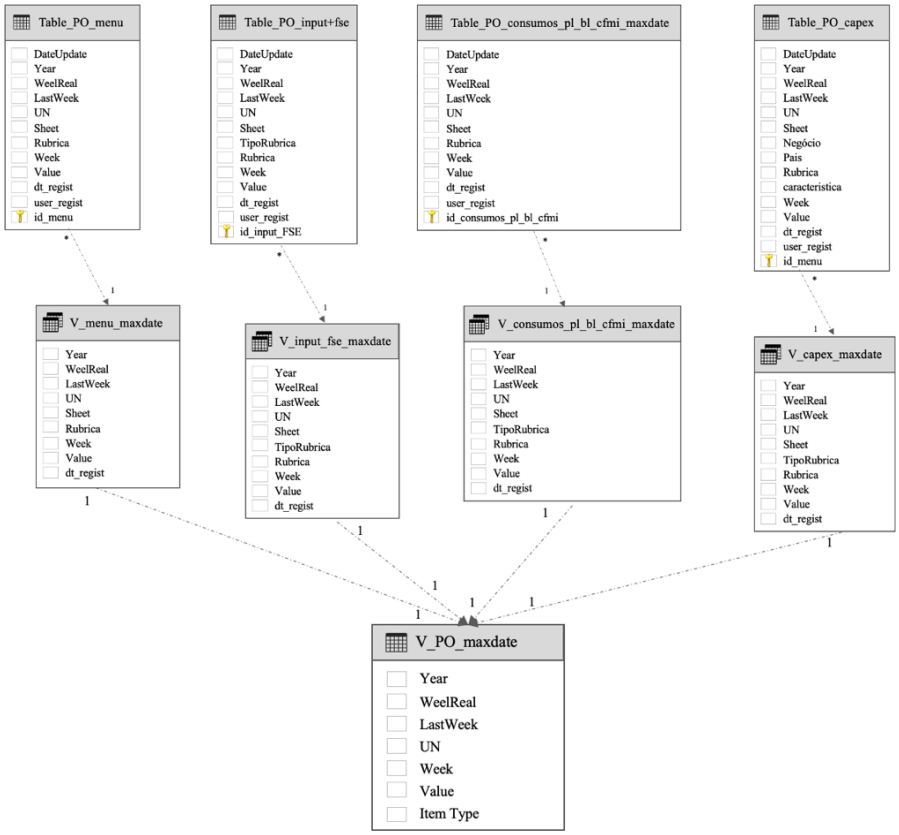


Figure 14. Relationship between "Planeamento Operacional _UN" database tables and Views

The Business Intelligence tool to represent the operational results of the company is the last stage of the TO-BE data scheme. Besides enabling a visual representation of the process results, it also addresses other weaknesses previously identified, such as the inability of the users to customize the reports, the non-dynamic update of the reports and the huge number of files created. A Business Intelligence tool developed accordingly with the goals of the end-users, on the contrary to the reports weekly presented at the moment, will allow the customization of the information accordingly with the requirements at each moment (e.g., understand the total results of two of the business units or consult the results of the global company depending in the needs). Moreover, with a Business Intelligence tool, the reports created in the process become useful since the information is all easily accessible in the tool (reducing the files created at least by 50%); and the information is dynamically updated, ensuring that the information presented is always the most recent.

5 Development and implementation of the business intelligence tool

Chapter 5 presents the sequence of the pilot project developed at Efacec. It comprises the execution of phase 4 (process implementation) of the developed methodology. It starts exploring the objectives and requests for the dashboards of the Business Intelligence Tool, to enable the development of a BI accordingly. Then it is described the improvements made in the process to achieve the TO-BE data scheme previously design. However, as will be explained more ahead, some limitations did not allow the implementation of the process improvements, yet. So, the improvements were developed and are ready to be implemented whenever possible. Nonetheless, in the last section, the results achieved (i.e., the BI tool) are detailed described.

5.1 Goal & requirements for the business intelligence tool

The Operational Planning Process is a monthly process that encompassed multiple actual and forecasted financial elements of the company, concerning all eight Business Units (including their national and international network). This process was initially built together with all involved members and the end-users, being the results presented in the operational reports already structured accordingly with their requirements. This way, the business intelligence tool must guarantee that it presents at least all the elements already presented by the operational reports, with the possibility of adding more visual elements when needed.

Regarding the vast dimension of Efacec's businesses, the strategic organization of the information, as well as the opportunity of customization of the reports according to requirements are critical. Target managers find it essential to have an easily understandable tool, enabling the customization of the information, which is not conceivable at the moment with the operational reports produced. There are two imperative topics to consider in this filtering necessity:

- *The time frame:* decisions are made based on data, and the more available data, the best support there is for the decision-making process; the opportunity of selecting a wide time frame to see the company results or even the deviation between the forecasted and the achieved results, instead of having a fixed time frame of 13 weeks (actual week + forecasted weeks), represents one of the requirements for the BI. As well as the ability to go back in time and consult the forecasted results for the company in the past weeks.
- *The business units:* at the moment the reports presented show results regarding one business unit; it was considered essential to, for example, join two business units results or even the global company (all business units) results when necessary.

Additionally, once again, it is essential to guarantee the accuracy of the information presented as well as its dynamic update. The previous analysis and improvements proposal represent an enormous step to guaranty these characteristics of the BI tool. Nevertheless, it is also important to assure that the involved members in the data processing practice understand the changes, their advantages, and can perform them perfectly.

5.2 Development of improvements

5.2.1. International network improvements development

As previously explained, the improvement proposed to solve the lack of accuracy of the international network results can be divided into three steps: (1) Insert the invoicing information

of each UN (i.e., the *"Planeamento Operacional- Previsão faturação UN"* results) in the database; (2) create the new proposed file (*"Planeamento Operacional_UN-filial)*, which automatically gets information from the database and the missing values will be filled in by the respective; and finally (3) Save the *"Planeamento Operacional_UN-filial"* results in the database. All these phases are detailed described below.

(1) Insert the invoicing information of each UN in the database

The procedure to safeguarding information in the database was already applied to other company files, so, the procedure followed to insert the invoice information of each UN in the database was based on these previously applied procedures. Accordingly, Visual Basic macros were developed and implemented in each one of the eight invoice files (one of each UN), to Extract, Transform and Load the data to the database. It is important to notice that the structure defined for the data in the database must be defined accordingly with the type and complexity of data. Thus, the main variance of this procedure from the previous ones applied was the structure defined for the data in the database. The structure of the *"Planeamento Operacional- Previsão faturação UN"* is complex, presenting multiple columns (see Appendix C), so also the database structure for this data (represented in Table 1) presents a complex structure. Besides the columns of information of the respective file, it is a good practice to always add three extra control columns: one to register the date of data insertion in the database ('dt_regist'), another to register the user identification ('user_id') and finally a primary key column ('id_faturação') to uniquely identify each record in a table. This practice was restrictedly followed in all the processes of database tables creation.

Table 1. Invoice information database structure

Column Name	Data Type	Allow Nulls
'Data_criação'	Date[13]	x
'Data_faturação'	Date	x
'id_company'	Int[14]	x
'Nome_Empresa'	Varchar(100)[15]	x
'id_UN'	Varchar(100)	x
'Divisão_Origem'	Varchar(100)	x
'Divisão_destino'	Varchar(100)	√
'Codigo_cliente'	Varchar(100)	x
'Nome_cliente'	Varchar(100)	x
'Codigo_projeto'	Varchar(100)	x
'Nome_projeto'	Varchar(100)	√
'Data_Previsão_manual'	Date	√
'Valor_s_iva'	Varchar(200)	x
'Valor_c_iva'	Varchar(200)	x
'PMR_cliente'	Int	√
'PMR_un'	Int	x
'Grupo_ngrupo'	Varchar(100)	x

[13] Date (data type): data is limited to the format of YYYY-MM-DD

[14] Int (data type): data is limited to the format of and integer number

[15] Varchar(100) (data type): varying data set with the length specified between brackets (in this case, the data is limited to 100 characters)

'Factoring'	Varchar(100)	x
'Data_Previsão'	Date	x
'Semana_Recebimento'	Int	x
'Data_Previsão_cfactoring'	Date	x
'Semana_Recebimento_cfactoring'	Int	x
'dt_factoring'	Date	x
'dt_prev'	Int	x
'dt_regist'	Datetime	x
'user_regist'	Varchar(100)	x
'id_faturação'	int	x

Once defined the table's structure, it could be created in the database (Microsoft SQL Server), using the SQL Programing Language (see Figure 15). This code creates a unique database table, that will save the information relative to the invoices for all the company's Business Units.

```
CREATE TABLE [dbo].[table_faturação](
    [Data_criação] [date] NOT NULL,
    [Data_faturação] [date] NOT NULL,
    [id_company] [int] NOT NULL,
    [Nome_Empresa] [varchar](100) NOT NULL,
    [id_UN] [varchar](100) NOT NULL,
    [Divisão_origem] [varchar](100) NOT NULL,
    [Divisão_destino] [varchar](100) NULL,
    [Codigo_cliente] [varchar](100) NOT NULL,
    [Nome_Cliente] [varchar](100) NOT NULL,
    [Codigo_projeto] [varchar](100) NOT NULL,
    [Nome_Projeto] [varchar](100) NULL,
    [Data_Previsão_manual] [date] NULL,
    [Valor_s_iva] [varchar](200) NOT NULL,
    [Valor_c_iva] [varchar](200) NOT NULL,
    [PMR_cliente] [int] NULL,
    [PMR_un] [int] NOT NULL,
    [Grupo_ngrupo] [varchar](100) NOT NULL,
    [Factoring] [varchar](100) NOT NULL,
    [Data_previsão] [date] NOT NULL,
    [Semana_recebimento] [int] NOT NULL,
    [Data_Previsão_cfactoring] [date] NOT NULL,
    [Semana_recebimento_cfactoring] [int] NOT NULL,
    [dt_factoring] [date] NOT NULL,
    [dt_prev] [int] NOT NULL,
    [dt_regist] [datetime] NOT NULL,
    [user_regist] [varchar](100) NOT NULL,
    [id_faturação] [int] IDENTITY(1,1) NOT NULL,
PRIMARY KEY CLUSTERED
```

Figure 15. SQL example code to create the Invoice table at Microsoft SQL Server

Yet even though the table is available in the database, the invoice values are still not inserted in the database table. Figure 16 and Figure 17 portray the Visual Basic macro created to extract and transform the information, so its structure fits the database table structure. The ETL process represents a crucial and complex step of the project, enabling the extraction, transformation (accordingly with the process needs) and saving of the data in the database, which will be a vital source of information for future process elements and the BI tool, and represented a key step in this project.

```
Sub ImportarValoresFaturaçaoParaSQL()
Dim Values2insert As String
Dim errCheck As Boolean
Dim dData As String
Dim cntRow As Integer
Dim Un_Name As String
Dim id_company As String
Dim rngTable As Range
Dim UN_id As String
Dim Valor_civa, Valor_siva As String
Dim Prev_dt As Integer
Dim id_ActiveWeek As Integer

errCheck = 0
'On Error GoTo err

ThisWorkbook.Sheets("base").Activate

'Define each column as a range
Set rngTable1 = Range("Table1")
Set rngData_cria = Range("Table1[Data Criação]")
Set rngData_fatu = Range("Table1[Data Faturação]")
Set rngCod_emp = Range("Table1[Código Empresa]")
Set rngNome_emp = Range("Table1[Nome Empresa]")
Set rngUN = Range("Table1[UN]")
Set rngDivisao_origem = Range("Table1[Divisão Origem]")
Set rngDivisao_destino = Range("Table1[Divisão Destino]")
Set rngCod_cliente = Range("Table1[Código Cliente]")
Set rngNome_cliente = Range("Table1[Nome Cliente]")
Set rngCod_projeto = Range("Table1[Código Projeto]")
Set rngNome_projeto = Range("Table1[Nome Projeto]")
Set rngData_Previsaomanual = Range("Table1[Data Previsão (manual)]")
Set rngvalor_siva = Range("Table1[Valor s/IVA €]")
Set rngvalor_civa = Range("Table1[Valor c/ IVA €]")
Set rngPMR_Cliente = Range("Table1[PMR Cliente]")
Set rngPMR_un = Range("Table1[PMR Un]")
Set rngGrupo_naogrupo = Range("Table1[Grupo / Não grupo]")
Set rngFactoring = Range("Table1[Factoring]")
Set rngData_Previsao = Range("Table1[Data Previsão]")
Set rngSemana_recebimento = Range("Table1[Semana recebimento ]")
Set rngData_previsaocfactoring = Range("Table1[Data Previsão (com factoring)]")
Set rngSemana_recebimento2 = Range("Table1[Semana recebimento2]")
.Set rngData_factoring = Range("Table1[Dt Factoring]")

  'Number of rows to insert on each run, used to improve performance
  stepRowsInsert = 100

  dData = Now()

  'Count SQL Lines insert
    cntRow = 0
   RowCount = rngTable1.Rows.Count
    cntRow = 0
    limitRowToInsert = 0

    For Each r In rngData_cria

      If cntRow = 0 Or limitRowToInsert = 0 Then
        Values2insert = "('"
      Else
        Values2insert = Values2insert & ",('"
      End If

      cntRow = cntRow + 1

      UN_id = Cells(3, 5)

      Values2insert = Values2insert & Format(rngData_cria(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & Format(rngData_fatu(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & Trim(rngCod_emp(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngNome_emp(cntRow)) & "',"
      Values2insert = Values2insert & "'" & UN_id & "',"
      Values2insert = Values2insert & "'" & Trim(rngDivisao_origem(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngDivisao_destino(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngCod_cliente(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngNome_cliente(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngCod_projeto(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Replace(Trim(rngNome_projeto(cntRow)), "'", "") & "',"
      Values2insert = Values2insert & "'" & Format(rngData_Previsaomanual(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & Replace(Round(rngvalor_siva(cntRow), 3), ",", ".") & "',"

      Values2insert = Values2insert & "'" & Replace(Round(rngvalor_civa(cntRow), 3), ",", ".") & "',"
      Values2insert = Values2insert & "'" & rngPMR_Cliente(cntRow) & "',"
      Values2insert = Values2insert & "'" & rngPMR_un(cntRow) & "',"
      Values2insert = Values2insert & "'" & Trim(rngGrupo_naogrupo(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Trim(rngFactoring(cntRow)) & "',"
      Values2insert = Values2insert & "'" & Format(rngData_Previsao(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & rngSemana_recebimento(cntRow) & "',"
      Values2insert = Values2insert & "'" & Format(rngData_previsaocfactoring(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & rngSemana_recebimento2(cntRow) & "',"
      Values2insert = Values2insert & "'" & Format(rngData_factoring(cntRow), "YYYY-MM-DD") & "',"
      Values2insert = Values2insert & "'" & Format(dData, "YYYY-MM-DD HH:MM:SS") & "',"
      Values2insert = Values2insert & "'" & Application.UserName & "')"


       limitRowToInsert = limitRowToInsert + 1

       Next r
```

Figure 16. Visual Basic Macro to extract and transform data (Part 1)

```
Application.StatusBar = "Completed: " & Round((cntRow / RowCount) * 100, 1) & "% | Uploaded for  " & cntRow & " rows"

    If limitRowToInsert = stepRowsInsert Then
        insertResult = insertSqlData(Values2insert)
        limitRowToInsert = 0
        Values2insert = ""
    Else

    If insertResult <> "" Then
        GoTo err
    End If

  End If

'inserting left values into sql
If limitRowToInsert > 0 Then
  insertResult = insertSqlData(Values2insert)
  'MsgBox Values2insert

End If
If insertResult <> "" Then
  GoTo err
End If

errCheck = 1
err:
  If errCheck = 0 Then
    MsgBox "Error! Record(s) not insert in the data base." & vbNewLine & "Erro: " & err.Description, vbCritical, "Erro"
  Else
    MsgBox cntRow & " Record(s) successfully insert.", vbInformation, "Success"
  End If
  Set conn = Nothing
  Set rs = Nothing

End Sub
```

Figure 17. Visual Basic Macro to extract and transform data (Part 2)

It automatically detects the location of the information and saves it in a defined variable, however, due to the high volume of data, the information is inserted in the database, through a function (see Figure 18) in ranges of 100 rows. So, through a function, for every 100 Rows, it activates the connection with the database and inserts the data. This insertion in limited ranges also optimizes the macro execution, reducing the execution time.

```
Function insertSqlData(Values2insert As String) As String

Dim conn As ADODB.Connection
Dim rs As ADODB.Recordset
Dim sConnString As String
Dim sExecuteCode As String
Dim errCheck As Boolean
Dim dData As String
Dim cntRow As String

errCheck = 0
On Error GoTo err

'Create the connection string. Integrated Security=SSPI;
sConnString = "Provider=SQLOLEDB;Data Source=172.19.129.23,1433\SQLEXPRESS;" & _
              "Initial Catalog=COMM;User Id=planop;Password=planopefacec"


' Create the Connection and Recordset objects.
Set conn = New ADODB.Connection
Set rs = New ADODB.Recordset

' Open the connection and execute.
conn.Open sConnString

'SQL code to select the table in the data base
sExecuteCode = "INSERT INTO [COMM].[dbo].[table_faturação] " & _
               "([Data_criação]" & _
               ",[Data_faturação] " & _
               ",[id_company] " & _
               ",[Nome_Empresa] " & _
               ",[id_UN] " & _
               ",[Divisão_origem] " & _
               ",[Divisão_destino] " & _
               ",[Codigo_cliente] " & _
               ",[Nome_Cliente] " & _
               ",[Codigo_projeto] " & _
               ",[Nome_Projeto] " & _
               ",[Data_Previsão_manual] " & _
               ",[Valor_s_iva] " & _
               ",[Valor_c_iva] " & _
               ",[PMR_cliente] " & _
               ",[PMR_un] " & _
               ",[Grupo_ngrupo] " & _
               ",[Factoring] " & _
               ",[Data_previsão] " & _
               ",[Semana_recebimento] " & ",[Data_Previsão_cfactoring] " & _
               ", [Semana_recebimento_cfactoring]" & ",[dt_factoring] " & _
               ",[dt_regist] " & ",[user_regist] " & _
               ") " & "Values " & _
               Values2insert & ";"


Set rs = conn.Execute(sExecuteCode)

errCheck = 1
err:
  If errCheck = 0 Then
    MsgBox "Error! Record(s) not insert in the data base." & vbNewLine & "Erro: " & err.Description, vbCritical, "Erro"
  Else
    'MsgBox cntRow & limitRowToInsert & " Record(s) successfully insert.", vbInformation, "Success"
 End If
  Set conn = Nothing
  Set rs = Nothing

End Function
```

Figure 18. Visual Basic macro to load data to database (Part 1)

This macro to extract and transform data, and respective functions to load data to the database were applied individually to each Business Unit's *"Planeamento Operacional- Previsão faturação UN",* where it was connected a button in the major worksheet file to execute the Visual Basic macro and function. This simplifies the process of weekly update database data since the user only must click on a button to ETL the file's data to the database.

(2) Create the new proposed file ("Planeamento Operacional_UN-filial") for each UN-filial element

At this stage, the *"Planeamento Operacional_UN-filial"* was created considering merely the Cashflow using the direct method topic (Figure 19 depict an example of a file for UN ASE and filial 701). In the future, this process should be implemented for the totality of the elements composing the Operational Planning process (i.e., all the worksheets of the *"Planeamento Operacional_UN")* in order more detailly obtain the international network results.

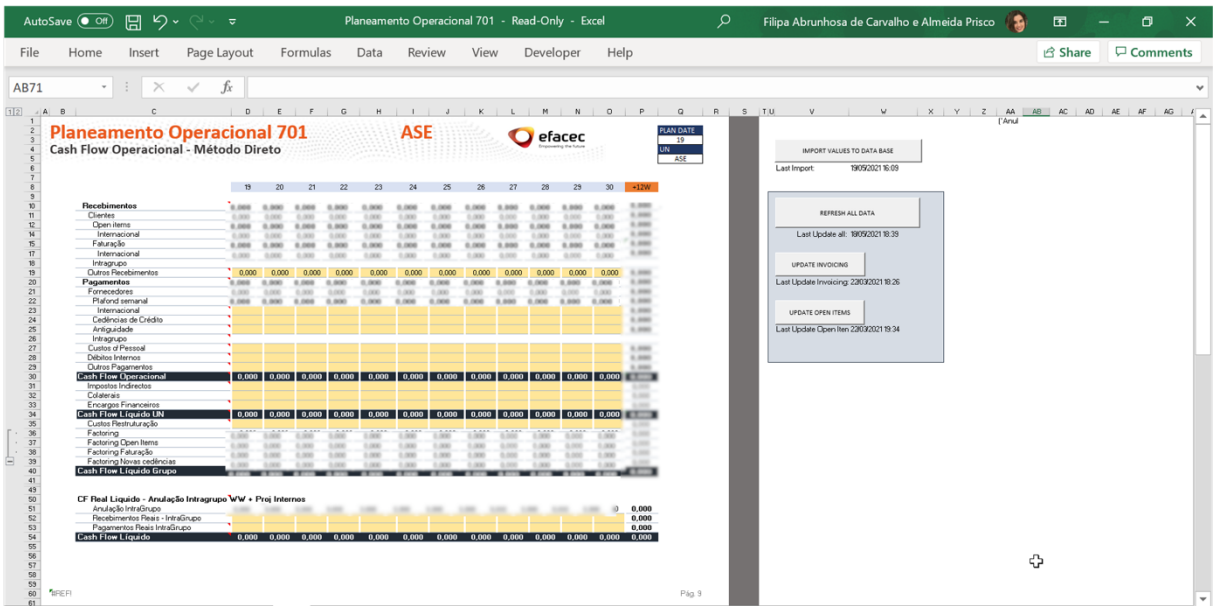
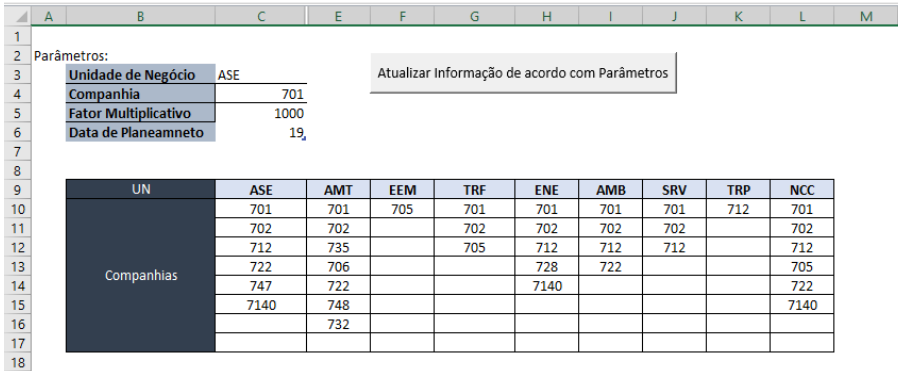


Figure 19. "Planeamento Operacional_ASE-701" file

Upon the creation of the new file, it was necessary to change the source of the invoicing query, for the new database table created for these elements, more precisely, the "V_fatu_maxdate" (database view containing the most recent data regarding the invoices of all UNs). Additionally, since it was created a different file for each UN_filial, there was the need to filter the presented information regarding these elements (i.e., UN and filial of each respective file). This way, it was created an additional excel worksheet, "Parameters" (see Figure 20), hidden at the end of the process, to detail the UN, the filial and the multiplicative factor (i.e., define the units of the showed data, normally it is expressed in millions of euros but here there was the necessity to change it to thousands of euros). These elements were characterized as parameters and programmed to automatically filter the queries information presented, accordingly with the UN and filial chosen, upon click on the button *"Atualizar informação de acordo com parâmetros"* (in English, update the information accordingly with the parameters defined). This way, the creation of the *"Planeamento Operacional_UN-filial"* files for each UN was simpler and the information can be automatically adapted to the respective UN-filial.



Parâmetros:

Unidade de Negócio	ASE
Companhia	701
Fator Multiplicativo	1000
Data de Planeamneto	19

Atualizar Informação de acordo com Parâmetros

UN	ASE	AMT	EEM	TRF	ENE	AMB	SRV	TRP	NCC
Companhias	701	701	705	701	701	701	701	712	701
	702	702		702	702	702	702		702
	712	735		705	712	712	712		712
	722	706			728	722			705
	747	722			7140				722
	7140	748							7140
		732							

Figure 20. Worksheet Parameters from the "Planeamento Operacional_UN-filial"

This is a new file, created to be fulfilled by individuals not trained to execute this work (i.e., each filial responsible chosen for this process), therefore, there was the necessity to build an instructions procedure guide (see Appendix D) to guarantee the right filling of the file. Also,

the components to be filled in by these elements were painted in yellow, to facilitate the process, and the rest of the components were automatically filled by excel formulas.

(3) Save the "Planeamento Operacional_UN-filial" results in the database

The procedure followed to save the international results of all UNs in the database was very similar to the one used when saving the *"Planeamento Operacional- Previsão faturação UN"* information in the database. Evidently, the database's table structure (see Table 2) and the Visual Basic Macro needed to be adapted to the file's structure (see Appendix E).

Table 2. International network information database structure

Column Name	Data Type	Allow Nulls
'id_rubrica'	Varchar(100)	x
'id_company'	int	x
'id_UN'	Varchar(100)	x
'week'	int	x
'value'	Float[16]	√
'dt_regist'	Datetime	x
'user_regist'	Varchar(100)	x
'plan_week'	Varchar(100)	x
'id'	int	x

However, the lack of resources available in the filial to execute this procedure was a limitation to its implementation. Therefore, the implementation was not possible at the time of this dissertation development, continuing the international network results to insert in the *"Planeamento Operacional_ UN"* accordingly with the medium value. Nevertheless, these improvements were developed and are now ready to be implemented at the company whenever possible, despite not being implemented now.

Still, the improvements regarding the *"Planeamento Operacional- Previsão faturação UN"* file (i.e., saving the data in the database) were executed anyway, representing the view "V_fatu_maxdate" (containing the most recent data regarding the invoices of all UNs) the new source of the query regarding the invoices of the *"Planeamento Operacional_UN-filial"* file.

5.2.2. Other improvements developed

Accordingly, the next step of the TO-BE Data Scheme consists in guaranteeing that the *"Planeamento Operacional_UN"* weekly updated values are safeguarded in the database, so they can be the source base for the Power Bi dashboards. The structure as well as the relationships between the 4 database tables created to save the central file information and 4 respective views, to select the most recent data, respectively, can be consulted in Figure 14. These elements consecutively convert to a single view, the "V_PO_maxdate", containing all the most recent information for every plan week, for the eight Business Units (the SQL code used to create this view can be consulted in Appendix F). However, contrary to the previously described files in the process, the *"Planeamento Operacional_UN"* were already ongoing files

[16] Float (data type): composed of a number that is not an integer, because it includes a fraction represented in decimal format.

not prepared to be connected to the database. So, it was necessary to guarantee 3 main matters in the excel files:

- the data type of the excel elements correspond to the data type defined in the database (e.g., it was necessary to change a data type of "update date" excel worksheet "Menu" file from general to date, to correspond to the data type defined in the database);
- guarantee that there were no values on the format of percentage, and when in the name field when that value should be presented in percentage, using "(%)";
- finally, guarantee that there are no repeated field names in the same worksheet for different values (e.g., in the worksheet "cashflow_MD" were detected two distinct fields with exactly the same name- *"IVA"*- it was necessary to specify them: *"IVA recebimentos"* (IVA cash in) and *"IVA pagamentos"* (IVA payments)).

Upon guaranteeing this matters the function to Extract, Transform and Load data to the database could be developed. Despite having a very similar structure to the other ETL macros, the complexity needed for this file was much higher since it presents 11 distinct worksheets of data to be inserted into the database. Briefly, the solution taken to overcome this characteristic was the creation of individual functions to extract and transform the details from each worksheet and a central sub[17] (see Appendix G) to collect every worksheet detail (already extracted and transformed previously) and load it to the database. It is important to salient that the correct insertion of data in the database (i.e., insert all the worksheets data at once) was also taken into account, otherwise, in case of error the date of insertion in the different database tables would not be exactly the same, representing a serious issue for the data joining in the "V_PO_maxdate". Hence, when an error is detected, the function rollback, deleting every sheet's details already insert in the database, this way the data correspondence can be guaranteed. This represents an important detail to guarantee the accuracy of the data saved in the database since it represents the main source of information for the Power BI (the BI tool).

During the development of this dissertation, there weren't conditions, at the company to implement these process improvements, nevertheless, these improvements are detailed and prepared to be implemented at the company whenever possible. The interest of the company in implementing them and consequently have a BI tool to support the decision-making is considerable, so it is set that the improvements will be implemented soon.

5.3 Presentation of the results achieved

Despite not being implemented at the company, the pre-described improvements were performed, using the results obtained in the past weeks (i.e., there were created records of the results achieved since the start of the process), to enable the construction of the BI tool. This will also represent an important detail for future implementation, since it increases the tool's value in supporting the decision-making, once the range of results available will be almost the totality of results obtained in the process. Consequently, more data is presented, improving the quality of the process, and so the support is given in the decision-making process. When implemented and initialized in the company, the BI tool will automatically actualize the information with the new results (considering that the proposed improvements were also implemented), without needing any additional efforts.

[17] Sub: a small program within the VBA Editor that performs a specific action in Excel. It is used to break large pieces of code into smaller parts that can be easily managed.

The BI tool presented is the final result obtained in this pilot project, after meeting with a group of end-users and consider their suggestions, mainly in the matter of the elements to represent in the additional visual representations developed. It is important to note that all the results presented in the platform do not correspond to the real company values, since they were changed due to privacy matters of the company.

The Microsoft Power Bi Desktop was the application used to develop the BI tool since it was already used at the company for other processes' results visualization. Additionally, it allows the management of data sources, the use of new data sources to be columns, calculated fields, manage the relationships between the tables as well as publish the reports on an online platform.

With the *"Planeamento Operacional_UN"* data saved in the database and the conditions reunited to the records collection, the BI tool, using Microsoft Power BI could be developed. As previously mentioned, the "V_PO_maxdate" (containing the most recent records of every week for every UN) represents the main source for the Power BI.

Since the beginning of the process, the structure needed for the final BI tool was taken into account, being the data organized accordingly. This facilitated the process of designing the BI tool and the maintenance of the tool. Yet when constructing the BI tool there was noticed that there was no fixed order for the different data elements. The financial information of a company is normally presented using data tables, where the order of the respective elements presented are important to achieve and show the actual results of a company. This way, there was the necessity of creating, directly in the software, one auxiliary table, the "Aux_Order". This auxiliary table presents an order for all the elements present in each *"Planeamento Operacional_UN"*, so, after creating this order table in the software, it was used the "Merge Queries" function to add the auxiliar table columns (including the order column defined in the auxiliar table) to the main table. Once in the main table, it was created a new column that takes into account this order column and the element designation (in the table called "Rubrica") and finally it was used the order by function (based on the order column) to guarantee the static order of the elements when in the dashboards (see Appendix H).

Based on this merged table, containing pre-established order of the elements, there were created 7 dashboards and a Menu page (see Figure 21). It represents the first tool page that allows the user to navigate towards the seven dashboards it contains by clicking on the distinct buttons.

Figure 21. Power BI Menu page

Figure 22 depicts the standardized structure defined for the seven dashboards, it selected as essential the designation of the dashboard, the navigations options into the other tool dashboards and the customization requirements pre-defined by the target managers.

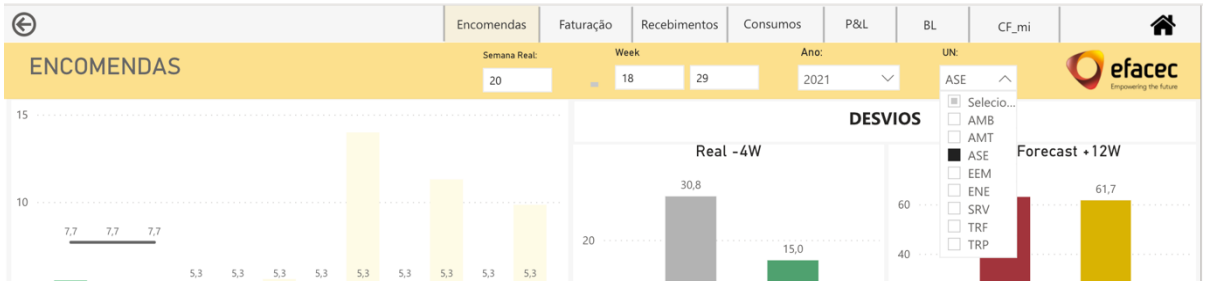


Figure 22. Standardized structure of the tool dashboards

All these elements from the different dashboards are synchronized, which means that a change of a detail in one of the dashboards is instantly reflected in all the other six dashboards. The first filtering option *'Semana Real'* (Actual Week) allows the user to filter the values shown, in other words, it allows the user to go back and observe the results in the Real Week selected (e.g., consider that the Real Week selected is the week 20, the tool will represent the results achieved and forecasted in the week 20, being the results until the week 20, inclusive, actual achieved values and the posterior weeks to the week 20 the forecasted values in the week 20).

The second filter, 'Week', reflects the week's frame the user needs to see represented in the dashboards (e.g., by choosing from week 18 until week 29, the results presented in the dashboards will mainly reflect the results only between week 18 and 29), except the *'Desvios'* (deviations) graphs in three of the dashboards, as it will be explained more ahead. The third filter, *'Ano'* (Year), gives the opportunity for the user to select the year of the results presented. Finally, the filter 'UN' allows the user to filter the results accordingly with the chosen Business Unit. Here it can be selected only one UN or multiple UNs or even all the UNs, which represents all company results.

Additionally, the complexity of these graphs and other graphs showed more ahead forced the creation of multiple calculation Measures[18], to obtain the pretended results. Figure 23 depicts an example of a measure developed.

[18] Power BI Measures: the way of defining calculations in a DAX model, which helps the calculation of values based on each row, but rather, it gives us aggregate values from multiple rows from a table

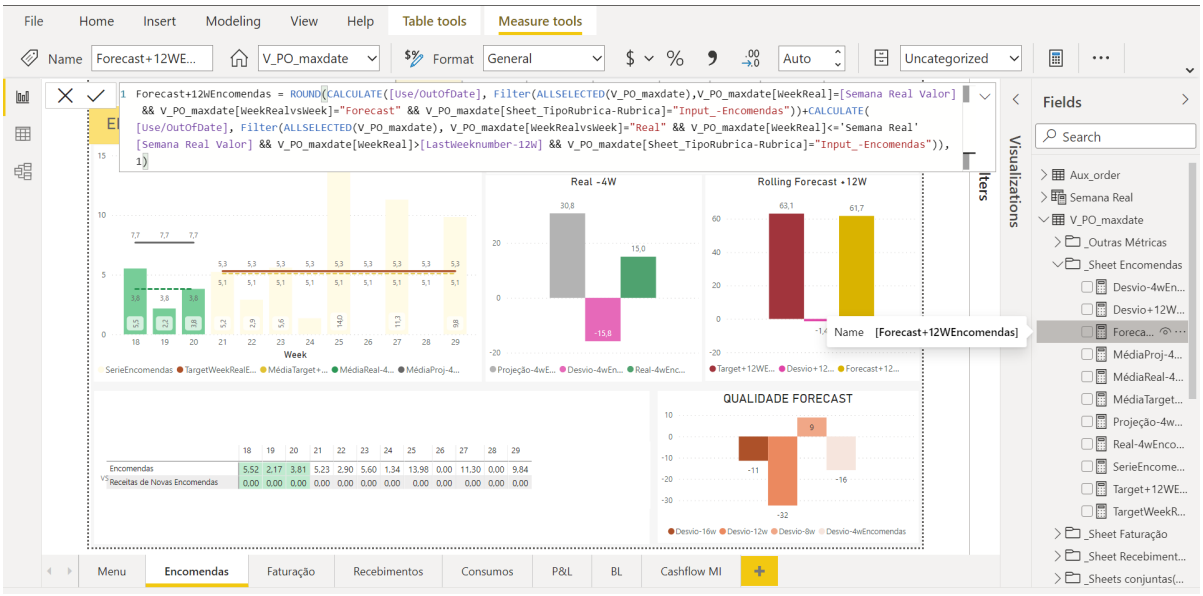


Figure 23. Power BI Measure example

Three of the seven dashboards, *'Encomendas'* (Orders), *'Faturação'* (Invoice) and *'Recebimentos'* (in English 'Cash In'), present a very similar dashboard structure, varying only type of results presented. These dashboards present a set of analysis that enable to draw conclusions on the orders, invoices, and cash in evolution in the defined range.

Figure 24 presents the 'Encomendas' dashboard, the other two ('Faturação' and *'Recebimentos'*) can be consulted in Appendix I.

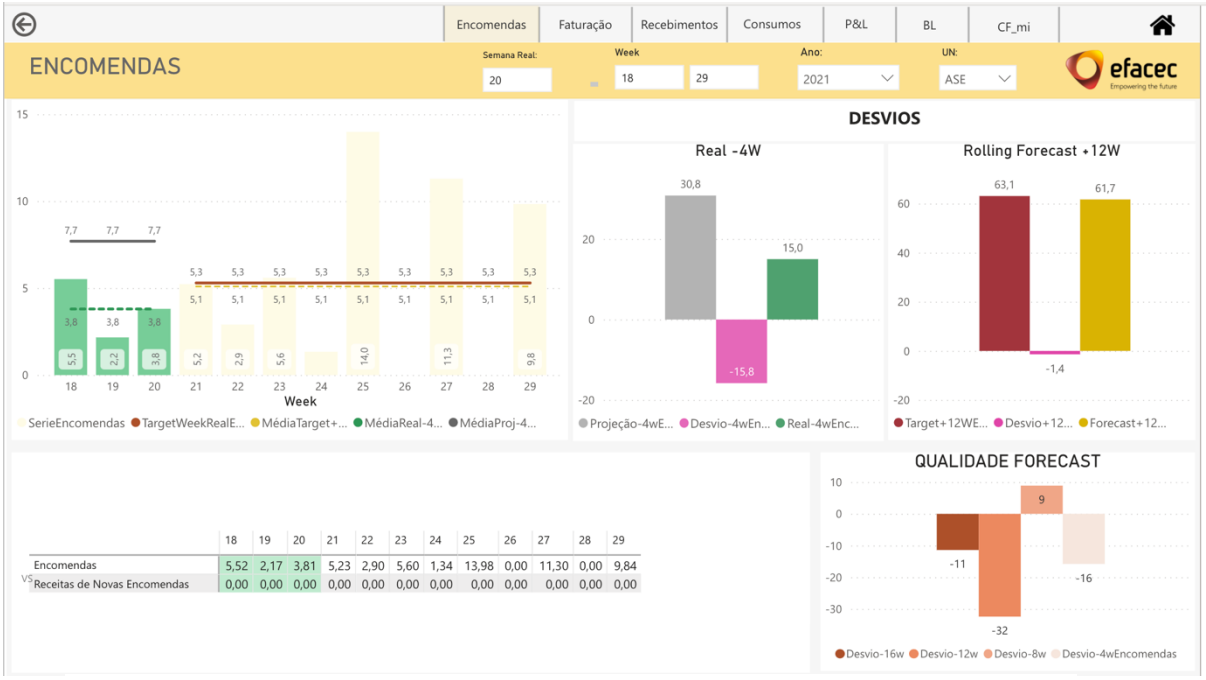


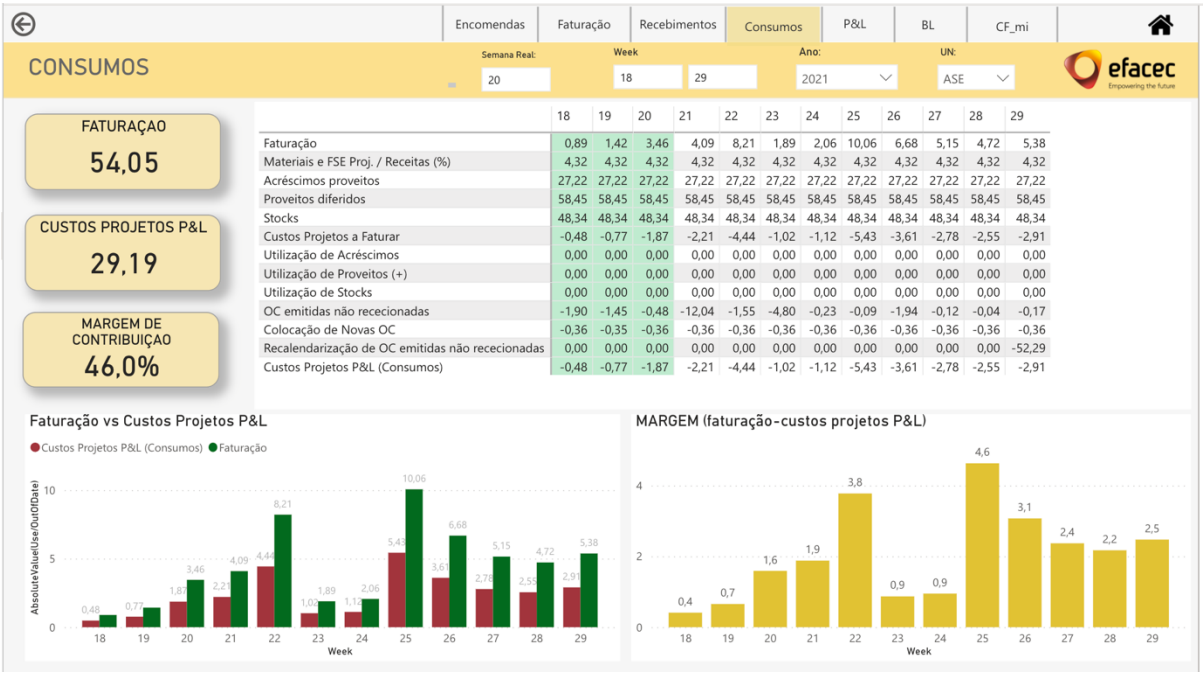
Figure 24. Bi tool 'Encomendas' dashboard

It presents the results achieved in a table and bar chart form, where are also represented the medium achieved values. Additionally, it informs on the forecast quality (on the dashboard called *'Qualidade do forecast'*), comparing the results achieved to the forecasting firsts forecasting values existing for each week. Finally, it presents a variance analysis between the real values achieved in the past four weeks and the first forecasted values exiting for those four

weeks (graph *'Real -4W'*), and between the target values defined and the forecasted values regarding the following 12 weeks (graph 'Rolling Forecast +12W'). These three final graphs described are not affected by the week's frame (i.e., 'Week' filter) since they present results accordingly with a specific number of weeks, being only affected by the *'Semana Real'*, *'Ano'* and 'UN' filters. For this analysis having records of the results process in the source, and consequently available for the Bi tool is crucial since they use results achieved in the past weeks and compare them with the pretended Actual Week.

In the remaining dashboards, there is presented table features where the respective results are shown, exactly as the ones presented in the *"Planeamento Operacional_UN"* excel file. Moreover, there are presented other charts to better illustrate the evolution of the company's results and better support the decision-making process of the target managers.

Figure 25 portrays the 'Consumos' (Consumptions) dashboard which, on the contrary to the excel file, enables the users to easily draw conclusions on the differences between the invoicing and the P&L projects costs in each week of the selected time frame, and finally on the total results obtained regarding the invoicing, P&L project costs and contribution margin.



	18	19	20	21	22	23	24	25	26	27	28	29
Faturação	0,89	1,42	3,46	4,09	8,21	1,89	2,06	10,06	6,68	5,15	4,72	5,38
Materiais e FSE Proj. / Receitas (%)	4,32	4,32	4,32	4,32	4,32	4,32	4,32	4,32	4,32	4,32	4,32	4,32
Acréscimos proveitos	27,22	27,22	27,22	27,22	27,22	27,22	27,22	27,22	27,22	27,22	27,22	27,22
Proveitos diferidos	58,45	58,45	58,45	58,45	58,45	58,45	58,45	58,45	58,45	58,45	58,45	58,45
Stocks	48,34	48,34	48,34	48,34	48,34	48,34	48,34	48,34	48,34	48,34	48,34	48,34
Custos Projetos a Faturar	-0,48	-0,77	-1,87	-2,21	-4,44	-1,02	-1,12	-5,43	-3,61	-2,78	-2,55	-2,91
Utilização de Acréscimos	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Utilização de Proveitos (+)	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Utilização de Stocks	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
OC emitidas não rececionadas	-1,90	-1,45	-0,48	-12,04	-1,55	-4,80	-0,23	-0,09	-1,94	-0,12	-0,04	-0,17
Colocação de Novas OC	-0,36	-0,35	-0,36	-0,36	-0,36	-0,36	-0,36	-0,36	-0,36	-0,36	-0,36	-0,36
Recalendarização de OC emitidas não rececionadas	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	-52,29
Custos Projetos P&L (Consumos)	-0,48	-0,77	-1,87	-2,21	-4,44	-1,02	-1,12	-5,43	-3,61	-2,78	-2,55	-2,91

Figure 25. BI tool 'consumos' dashboard

Figure 26 presents the 'Profits & Losses' (P&L) dashboard, presenting the relation between the Fixed Expenses and Coverage Rates and EBITDA and Gross Margin. Finally, are also presented the global values obtained for five of the most important elements of this set. The combination of these diverse representations grants the target managers a more accurate perspective on the company's Profits and Losses.

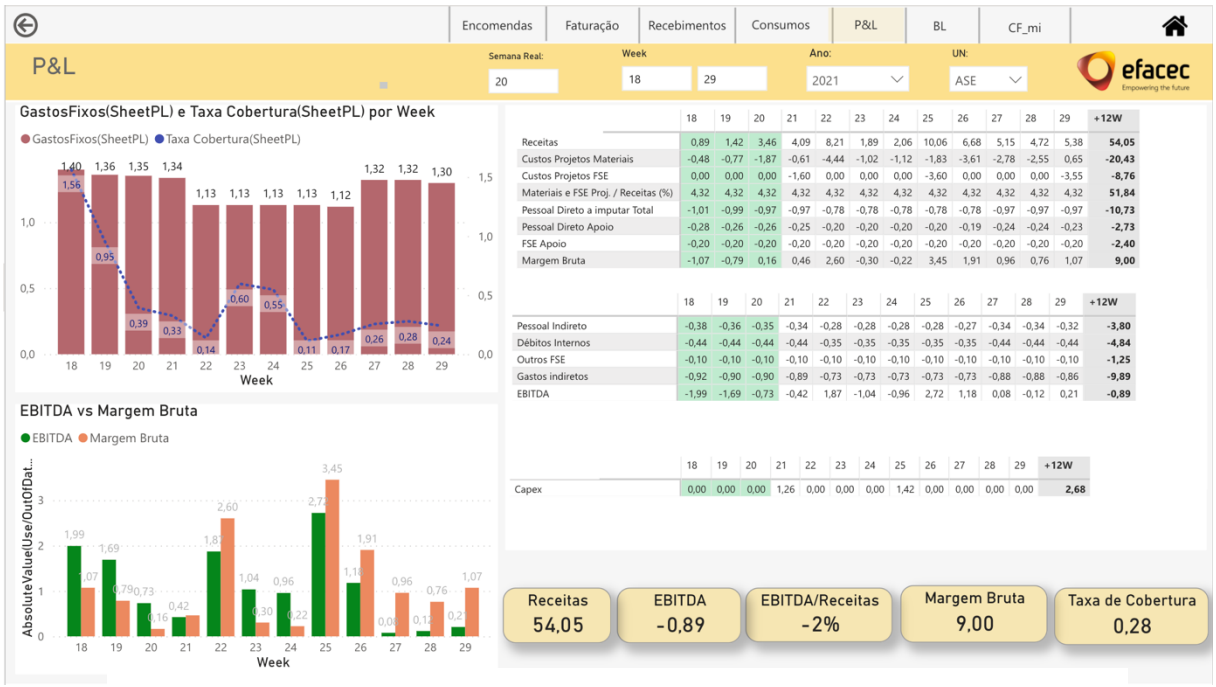


Figure 26. BI tool 'P&L' dashboard

Figure 27 portrays the 'Financial Statement' (BL) worksheet, where the results of three different operating funds are represented, enabling an easier and quicker perception of these results over the past and the forecasted weeks.

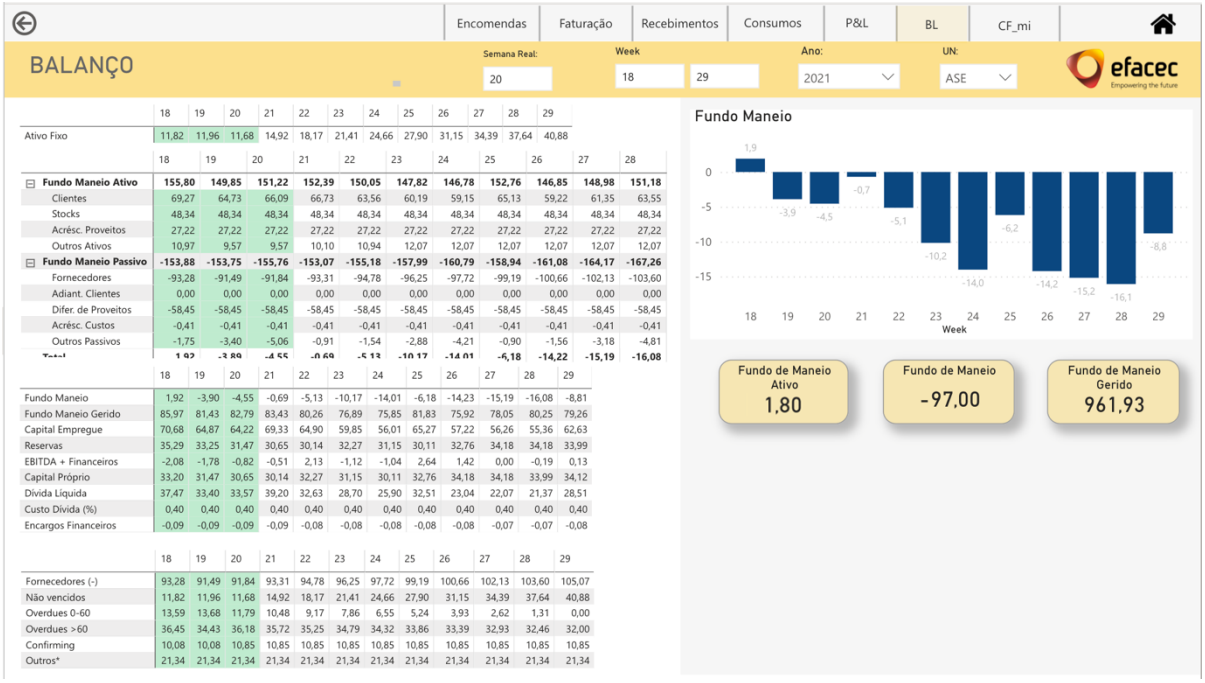


Figure 27. BI tool 'BL' dashboard

Finally, the last dashboard is the 'Cashflow' using the indirect method is revealed in Figure 28. It provides information on the relation between the payments and cash in of the company, as well as the relation between the net cashflow and the target net cashflow over the week's frame filtered. Additionally, it informs on the global net cashflow and target net cashflow, also in the defined week's frame.

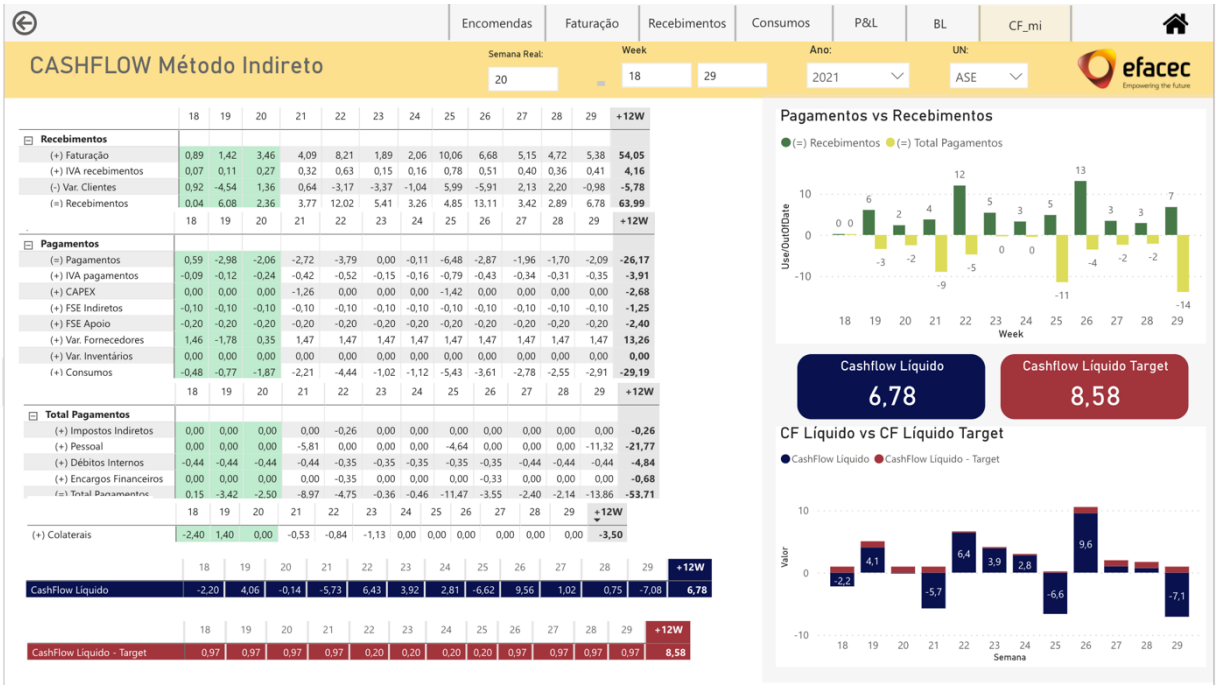


Figure 28. BI tool 'Cashflow MI' dashboard

It can be noticed that the 'Cashflow' using the direct method is not an element of this tool. Due to previous needs, this component was already managed and represented in an individual set of Power BI dashboards, with a high degree of detail. This way, the construction of a new dashboard representing this element in this BI tool was considered unnecessary. Nevertheless, as this component also represents a part of the analyzed process, a new suggestion to address this issue will be considered in the Future Developments section.

6 Conclusion and future developments

In this chapter, the results of the project are summarized, and an overview of the connection between the achieved results and the projects' objectives is presented. Additionally, the biggest challenges of the project are mentioned, as well as some possible future developments.

6.1 Conclusions

The main objectives of the present dissertation were the development of a replicable methodology to create a BI tool and its posterior application and validation with a pilot project at Efacec's Operational Control Department for Products.

At the start of the project, it became crucial to frame Efacec and the department where the pilot project would be developed. In the Literature Review context, there were clearly pointed out the views and practices used in the work area, as well as the importance that the redesign process can have in BI instruments and their positive influence on the companies' performance. This search enabled the design of a replicable methodology, facilitating the evolution of the companies' processes. Posteriorly, this methodology was validated through the pilot project, where, taking into account the requirements of the involved members and the end-users of the process, the process was redesigned, its performance improved, and the BI reports were constructed.

As mentioned previously, it was not possible to implement the proposed improvements given to company timings limitations. Nevertheless, this project is highly valued by the company, being its significance recognized by all the involved members, and so, it is now the company responsibility to proceed with this project and implement it as soon as possible.

Reproducing this framework to the other company's processes, taking into attention the end-users' requirements and structuring the data to facilitate the BI tool construction (i.e., construct a data scheme to be the base of the project), since the start of the processes, enables Efacec to increase the company's performance, simplifying its processes and painlessly update them, constantly guaranteeing the data accuracy and the representation of more authentic company results. Therefore, it can be affirmed that the proposed goals were accomplished as the developed methodology was successfully applied and validated through a pilot project, being the BI tool developed for one of the companies' department processes. Based on a theoretical basis framework, the results achieved evidently represent a valuable add in to improve the company's performance and, if extended to the other company processes, the results achieved can be even greater. Hence this work shows the potential of the use of a generic framework, in the development and implementation of a Business Intelligence tool in a real context, impacting positively the company's business.

The biggest challenges felt in this project, were mainly related to the nature of the project (i.e., Business Intelligence systems) and the different elements' timings (between the project and the company), as it was not possible to implement the developments performed in the pilot project. The development of a BI tool is a complex and long process, with multiple challenges. This way, this project was drawn up to be the starting point of continuous processes and reports evolution at Efacec and the start of a potential exponential growth of BI in the company. So, the framework designed and validated in the pilot project should be followed, and posteriorly replicated for multiple other processes by the company, to achieve a high-level feature potential.

6.2 Future developments

The benefits of the BI to companies are clear, and this project represented a start of the inclusion of Business Intelligence in the support processes for the decision making, hence, the reproduction of the developed methodology to the other decision-making support processes (and even in other company contexts) must be continuously explored, to efficiently achieve better results. The establishment of a team, of qualified individuals, to actively guaranty these developments and implementations on the multiple company processes may represent a necessary step to achieve the maximum benefits that the use of BI can have in a company.

Additionally, and regarding the pilot project developed on the Operational Planning Process, there can be raised three fundamental future developments regarding:

(1) Implementation of the pilot project's improvements proposals

The existing constraints at the Company did not allow the implementation of the improvements proposed in the Operational Planning Process, however, as it was previously mentioned, all the proposed developments were performed (i.e., are ready to be implemented) and guide files were prepared, so the company is able to implement them as soon as possible. The implementation will allow the creation of result records, a better data flow, and constantly updated dashboards report, enabling its customization to the end-users needs. Then, the implementation represents an important step for the company, since upon implementation the value of using Business Intelligence could be indeed better understood by the company individuals, motivating future transformations in other company processes. Clearly, also the support of the target managers decision-making process could be better carried and adapted to their requirements. Ultimately, upon implementation the measurement of results and assessment of the tool should be guaranteed, over time, to encourage changes that may occur in the users' requirements.

(2) Merge of the Pilot Project's BI tool with the Cashflow using Direct Method BI tool

At the end of section 5.3., it was mentioned that in the solution proposed and developed, the results regarding the Cashflow using the direct method, were not considered. This decision was taken since this element already has a BI tool (i.e., dashboards representing the results) to report them to the target managers. This was a feature developed recently, just before the start of this project, which has high granularity reports, with a high number of details that are not required for the Operational Planning Process. However, to facilitate the analysis of the Operational Planning Process results and posterior decision-making both tools should be merged in one element, or at least the necessary information regarding the Cashflow using direct method results, for the Operational Planning Process, should join the created Pilot Project's BI tool. Also, it was verified that both features follow the same procedure of data collection, structuring and representation which truly facilitates the merge process. This way, the total Operational Planning results would be represented in only one BI tool, facilitating its discussion and analysis and if necessary, more detailed about the Cashflow using direct method results (one of the most important process elements) could be found in the respective dashboards already exiting.

(3) Extension of the results to the international network

The approach taken to consider the results of the international network was identified as a weakness of the process, affecting its accuracy negatively, since using medium values does not represent the real results achieved by the company. Hence, it was proposed and developed a solution to gather the results of each UN-filial individually. However, the lack of resources available to periodically report this result represented a serious limitation to its implementation. None standing, the proposed improvements were performed and are ready to be applied whenever the necessary conditions allow it. This implementation is key to increase the process's accuracy and consequently to better support the decision-making process. Additionally, upon the implementation of these proposed improvements, it is also proposed the development of BI dashboards to represent and straightforwardly inform (i.e., automatically informed) the international network responsible for the status of these elements' results.

Finally, in the future, and upon reproduction of this project in multiple Efacec's processes, the integration of each process individual report in a single unique BI system should also be considered. Thereby, the companies' results and achievements would be gathered in one unique feature, providing a unique global company assessment, synchronizing all elements for the main companies' business goals.

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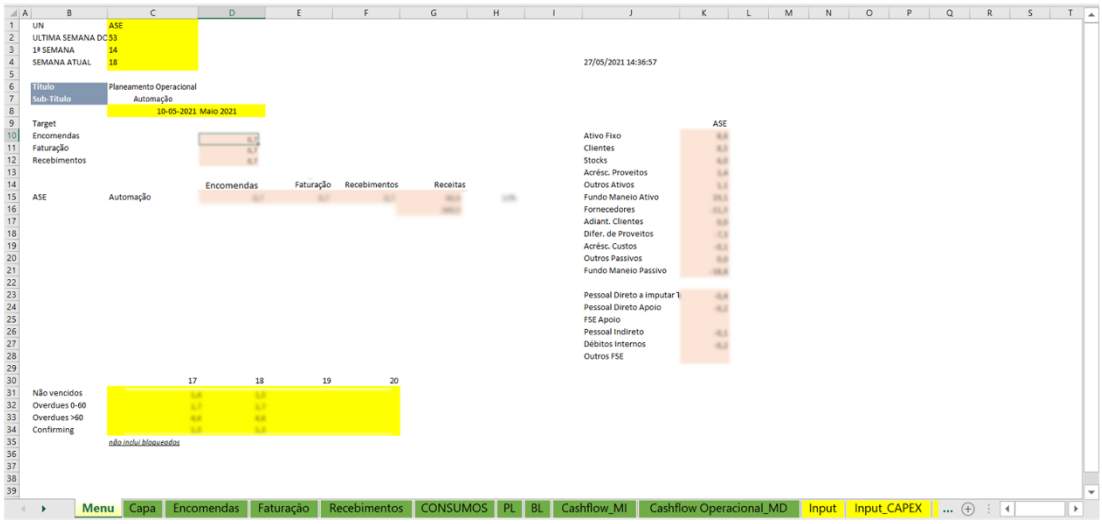
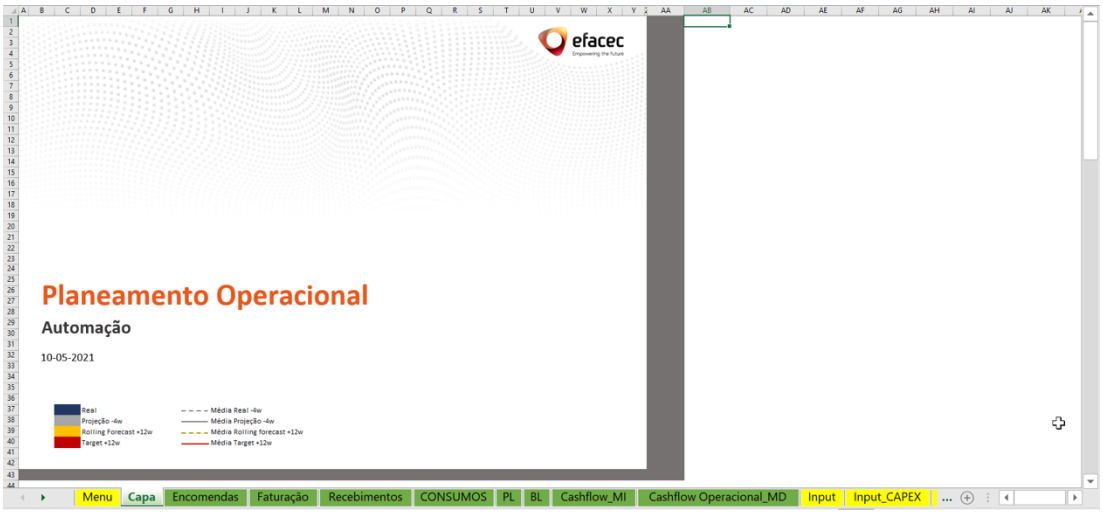
APPENDIX A: *"Planeamento Operacional_UN"* excel file worksheets

'Menu' Worksheet

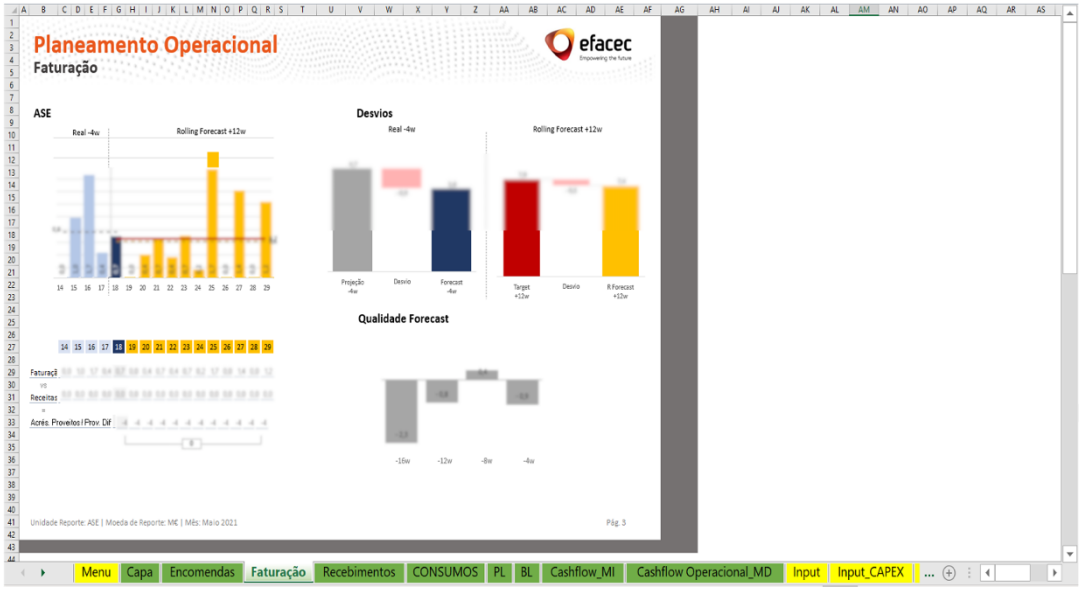


'Cover' Worksheet

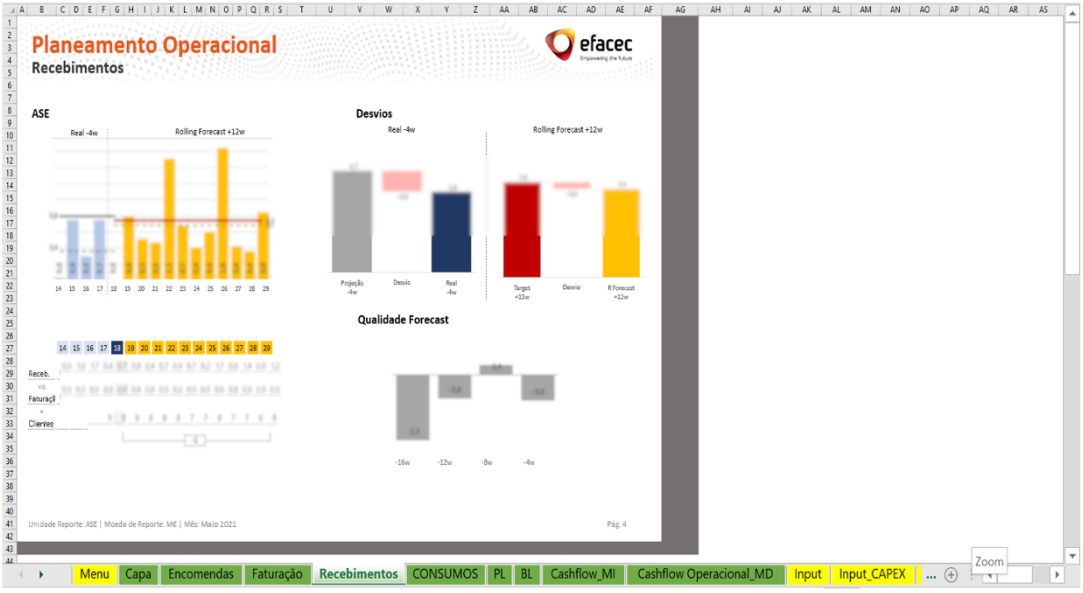


'Orders' Worksheet

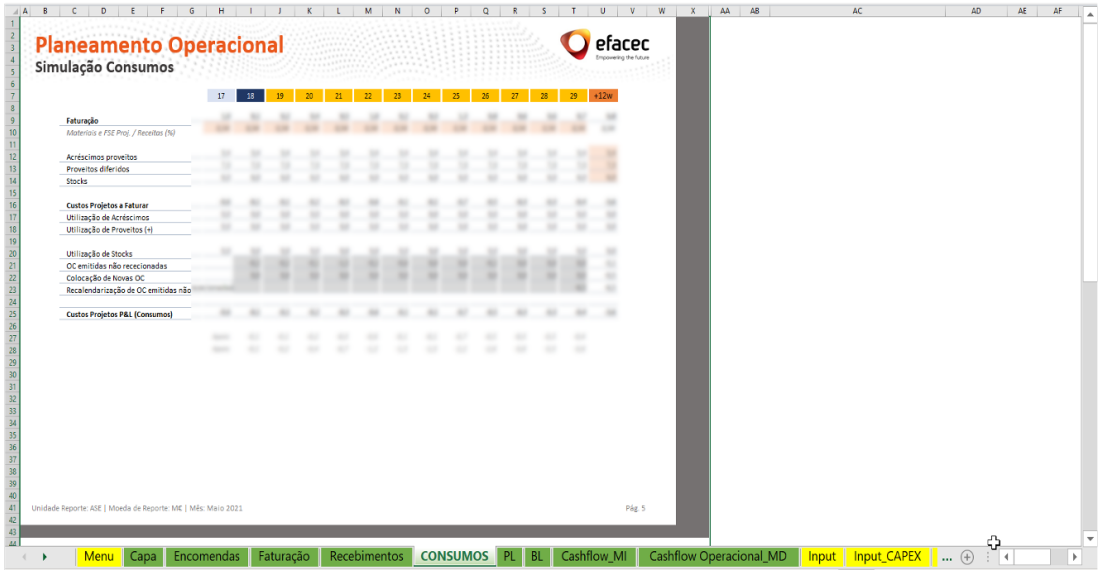
'Invoicing' Worksheet



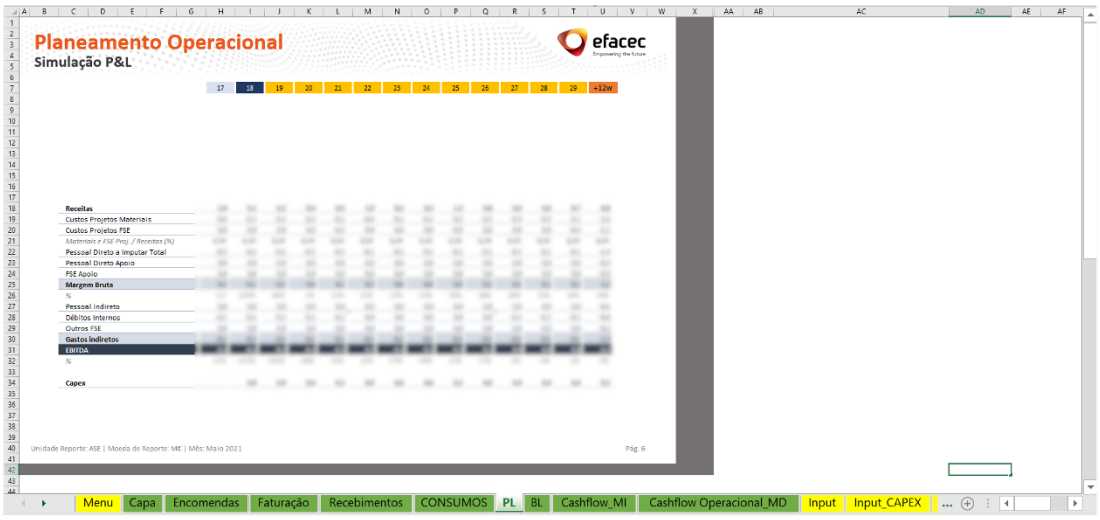
'Cash In' Worksheet



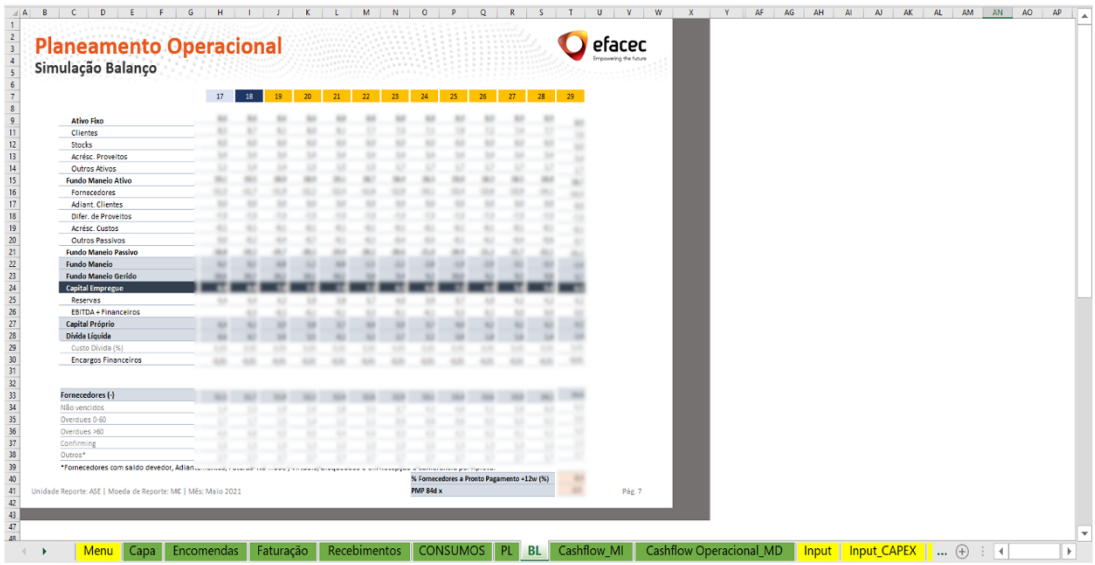
'Consumptions' Worksheet



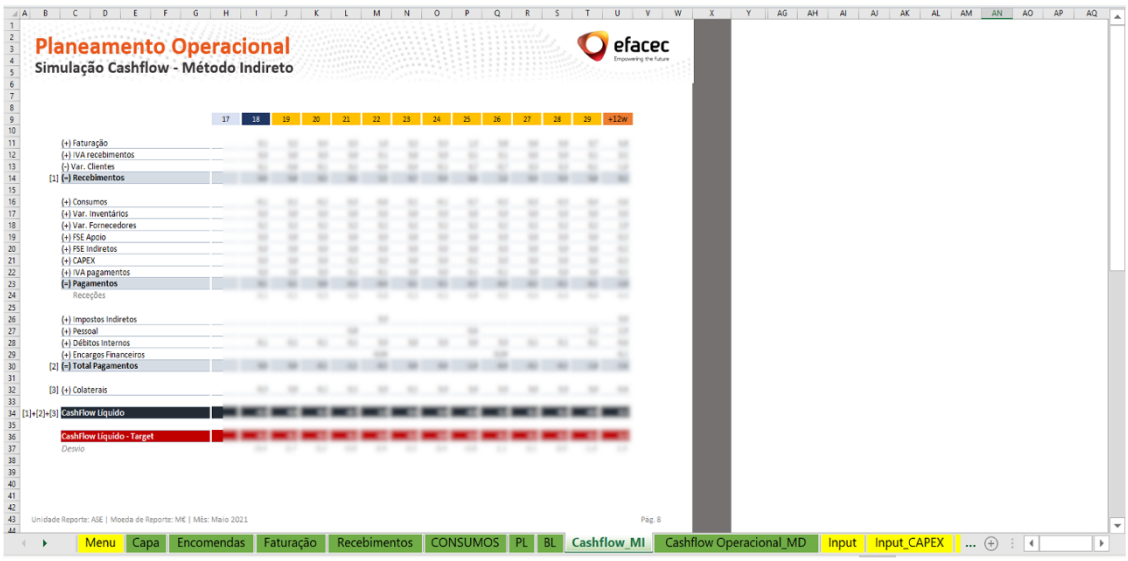
'Profits & Losses (P&L)' Worksheet



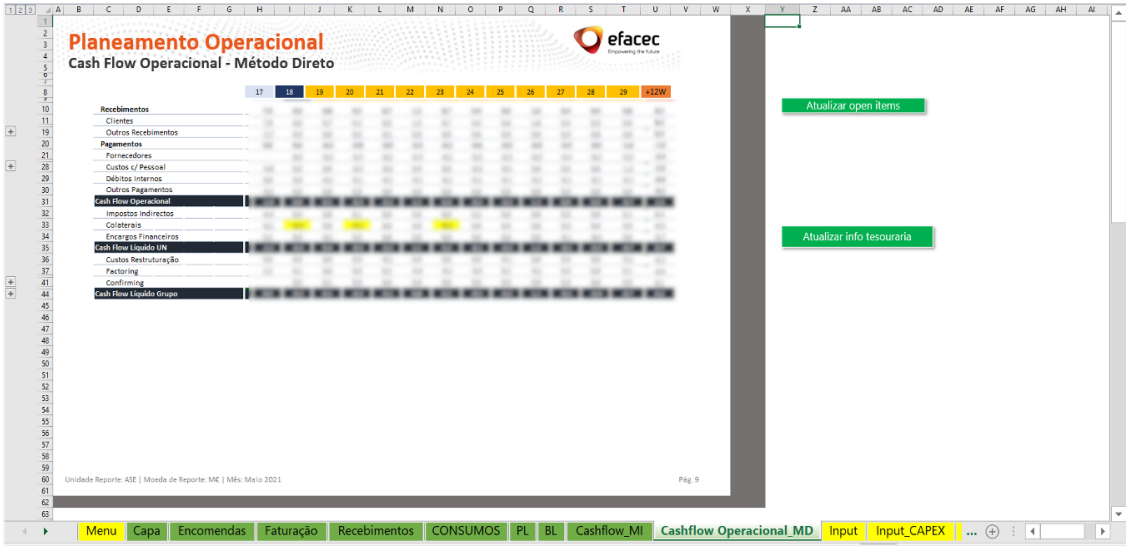
'Financial Statement (BL)' Worksheet



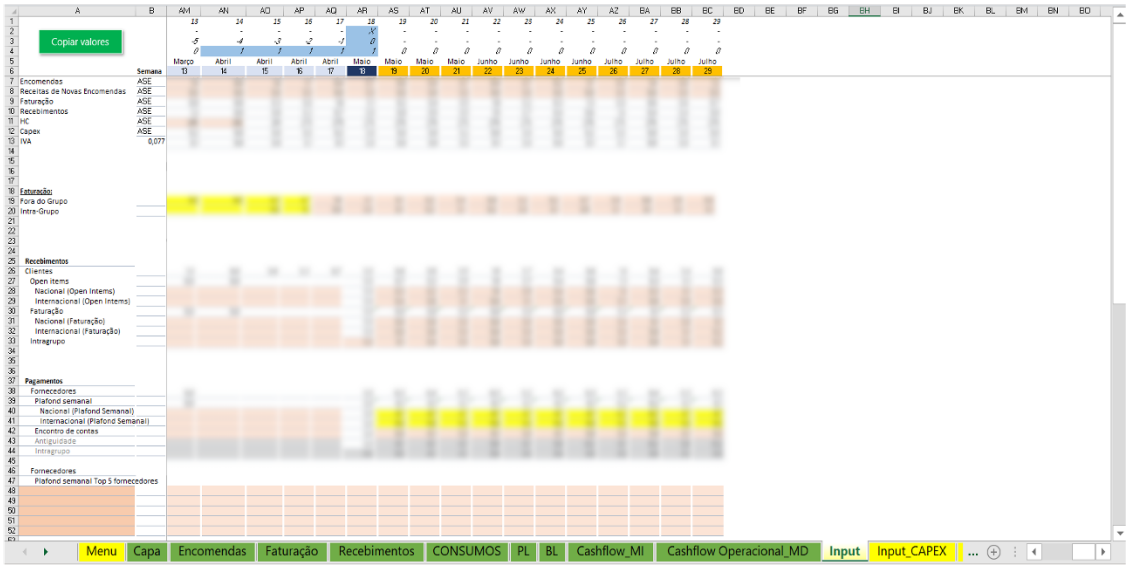
'CashFlow using indirect method (MI)' Worksheet



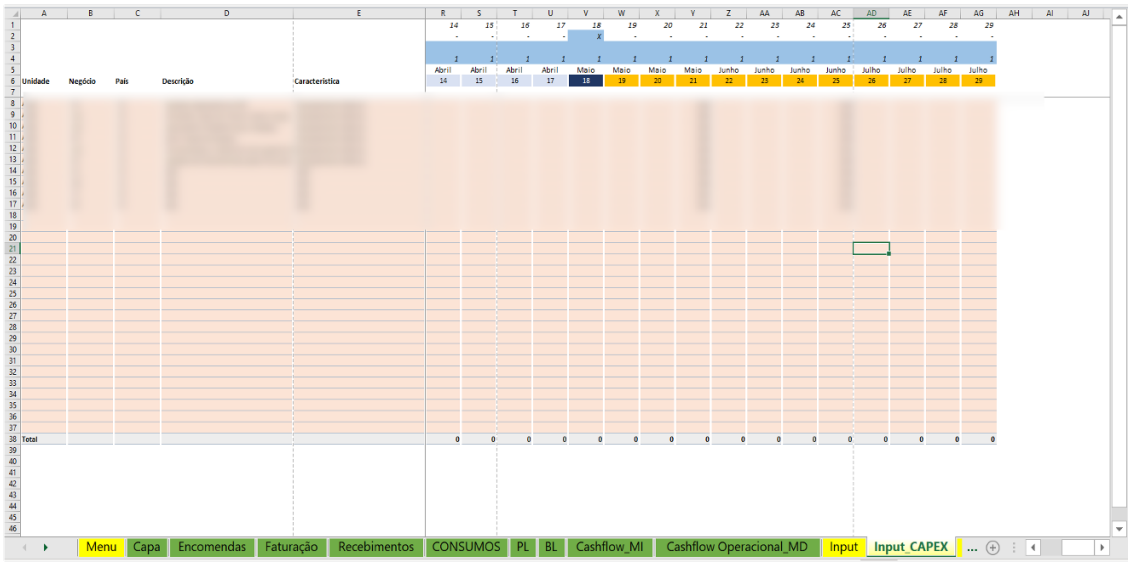
'Operational CashFlow using the direct method (MD)' Worksheet



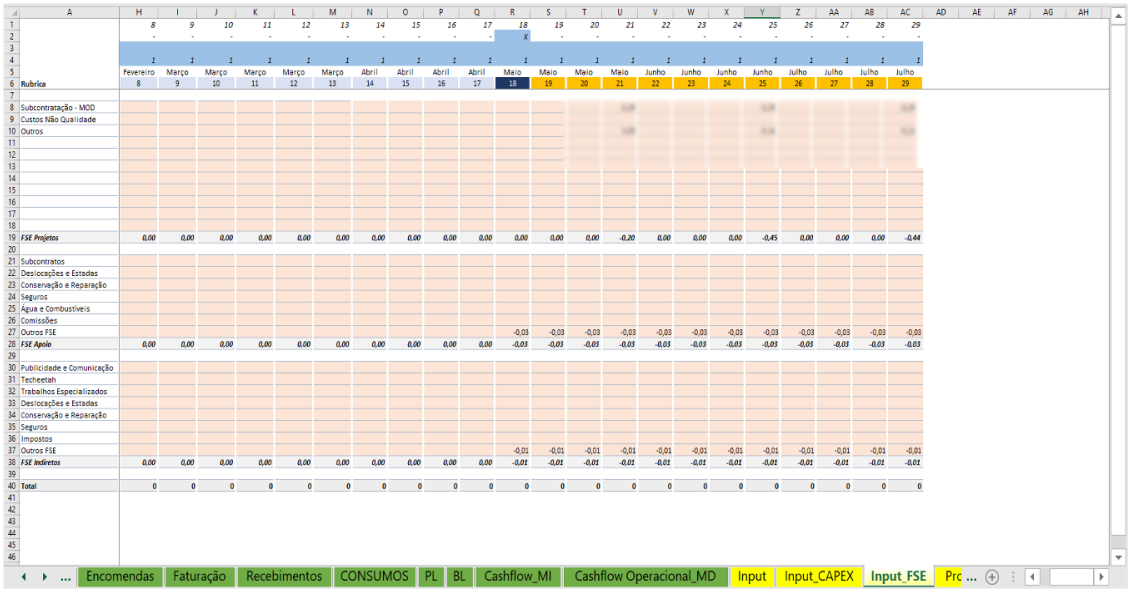
'Input' Worksheet



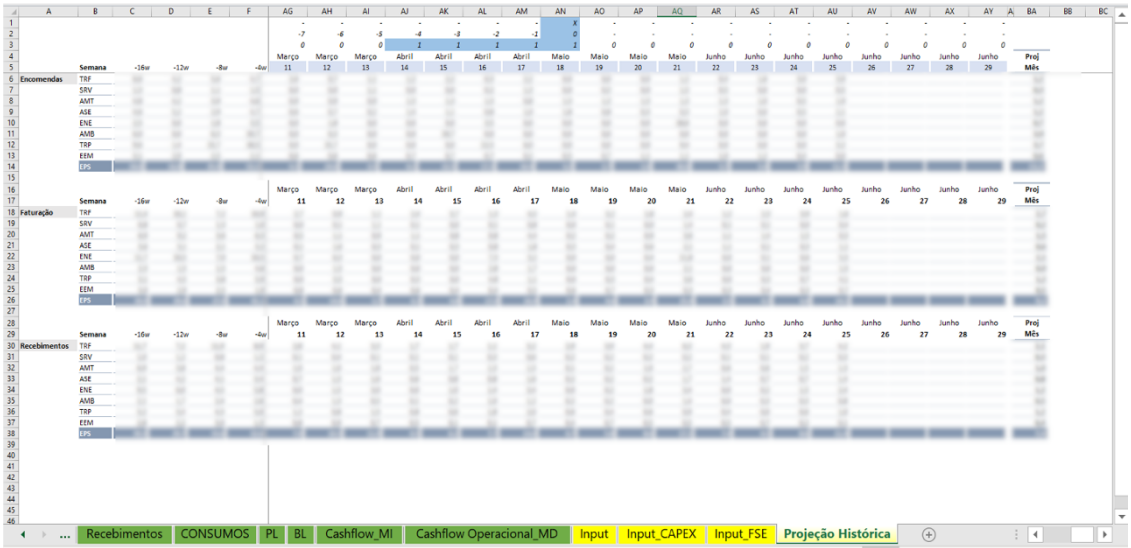
‘Input CAPEX’ Worksheet



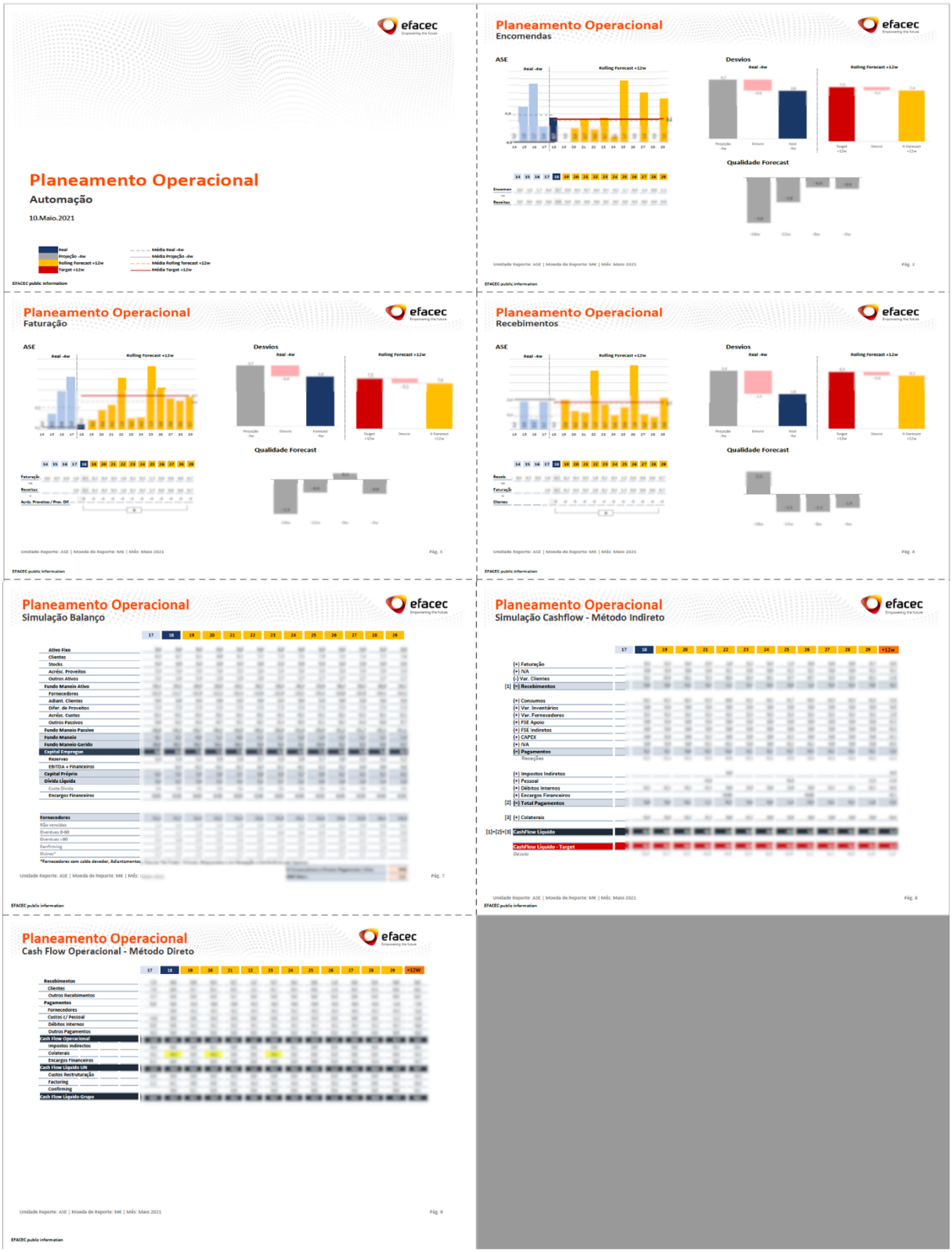
‘Input FSE’ Worksheet



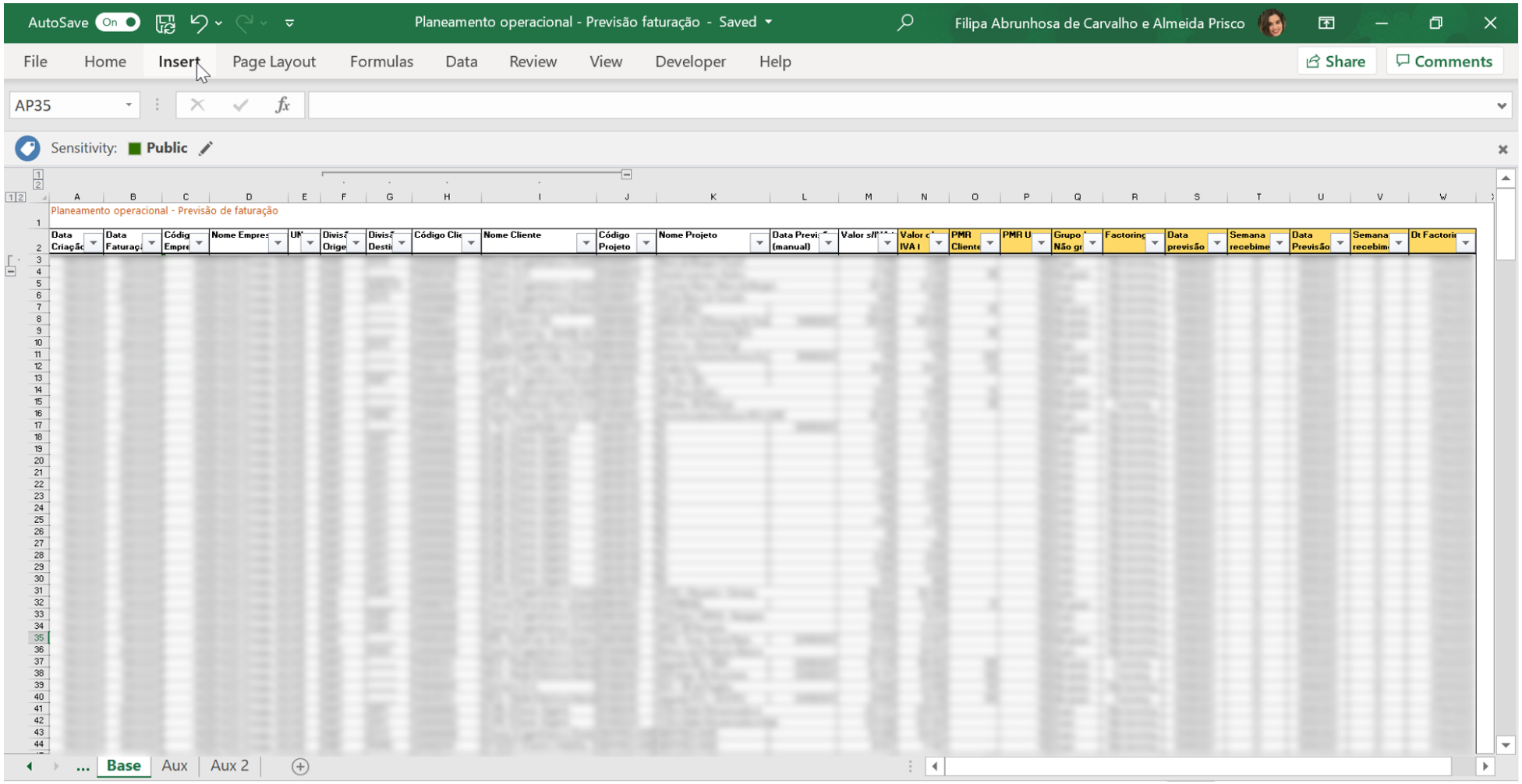
‘Historical Projection’ Worksheet



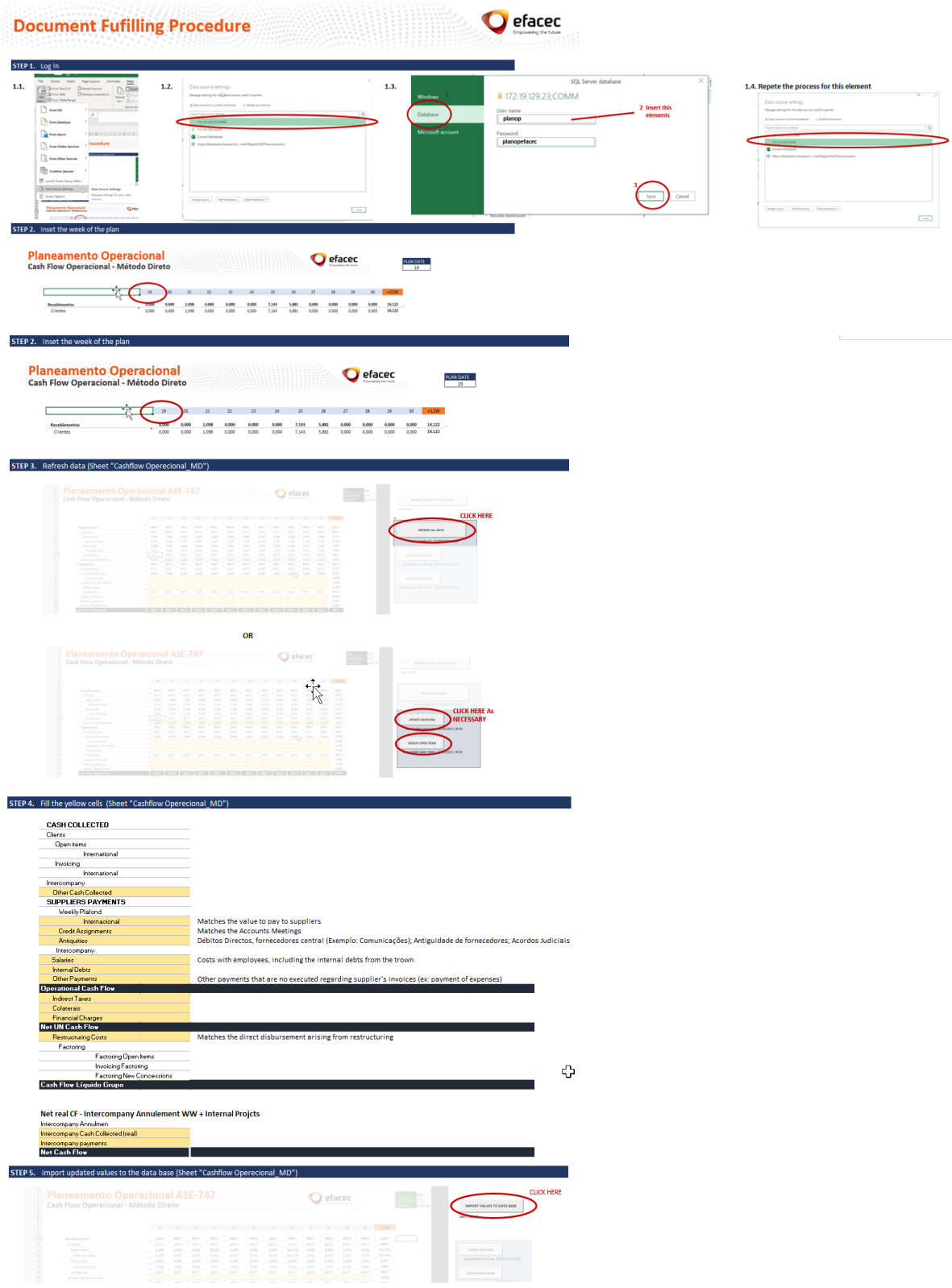
APPENDIX B: *"Planeamento Operacional_UN"* reports



APPENDIX C: *"Planeamento Operacional- Previsão faturação UN" fi*



APPENDIX D: *"Planeamento Operacional_UN-filial"* Document Fulfilling Procedure



APPENDIX E: *Visual Basic macro to Extract, Transform and load data from the "Planeamento Operacional_UN-filial" to the database*

```
Sub ImportarValoresParaSQL()

Dim conn As ADODB.Connection
Dim rs As ADODB.Recordset
Dim sConnString As String
Dim sExecuteCode As String
Dim Values2Insert As String
Dim errCheck As Boolean
Dim dData As String
Dim cntRow, cntColum As Integer
Dim Un_Name As String
Dim id_company As String
Dim Fat_mult As Integer
Dim FirstWeek As String
Dim rngTable As Range
Dim rngRubrica1 As Range
Dim Rubrica As String
Dim UN_id As String

id_company = Worksheets("Parâmetros").Range("Comp").Value
Fat_mult = Worksheets("Parâmetros").Range("Fat_mult").Value
Un_Name = Cells(5, 17).Value

Worksheets(Un_Name).Activate

Plan_Week = InputBox("Please intsert the current week.")

Set rngTable = Range("PlanOp")
Set rngRubrica = Range("Rubricas")
Set rngWeek = Range("Week_num")
Set rngRubrica1 = Range(Cells(51, 3), Cells(54, 3))

errCheck = 0
On Error GoTo err

  dData = Now()

'Count SQL Lines insert
  cntRow = 0

  For Each r In rngRubrica
      Rubrica = Trim(Cells(r.Row, 3))
      For Each c In rngWeek
        If cntRow = 0 Then
            Values2Insert = "('"
        Else
            Values2Insert = Values2Insert & ",('"
        End If

        PlanWeek = c.Value
        Value = CDbl(Cells(r.Row, c.Column).Value) / CInt(Fat_mult)
        'Insert all values in a string
        Values2Insert = Values2Insert & Rubrica & "',"
        Values2Insert = Values2Insert & "'" & id_company & "',"
        Values2Insert = Values2Insert & "'" & Un_Name & "',"
        Values2Insert = Values2Insert & "'" & PlanWeek & "',"
        Values2Insert = Values2Insert & "'" & Replace(Round(Value, 5), ",", ".") & "',"
        'Regist the date a user Name that does this update
        Values2Insert = Values2Insert & "'" & Format(dData, "YYYY-MM-DD HH:MM:SS") & "',"
        Values2Insert = Values2Insert & "'" & Application.UserName & "',"
        Values2Insert = Values2Insert & "'" & Plan_Week & "')"

        cntRow = cntRow + 1
      Next c
    Next r

    For Each r2 In rngRubrica1
         Rubrica = Trim(Cells(r2.Row, 3))
        For Each c2 In rngWeek
          Values2Insert = Values2Insert & ",('"
          PlanWeek = c2.Value
          Value = CDbl(Cells(r2.Row, c2.Column).Value) / CInt(Fat_mult)
          'Insert all values in a string
          Values2Insert = Values2Insert & Rubrica & "',"
          Values2Insert = Values2Insert & "'" & id_company & "',"
          Values2Insert = Values2Insert & "'" & Un_Name & "',"
          Values2Insert = Values2Insert & "'" & PlanWeek & "',"
          Values2Insert = Values2Insert & "'" & Replace(Round(Value, 5), ",", ".") & "',"
          'Regist the date a user Name that does this update
          Values2Insert = Values2Insert & "'" & Format(dData, "YYYY-MM-DD HH:MM:SS") & "',"
          Values2Insert = Values2Insert & "'" & Application.UserName & "',"
          Values2Insert = Values2Insert & "'" & Plan_Week & "')"

          cntRow = cntRow + 1
        Next c2
    Next r2

    sConnString = "Provider=SQLOLEDB;Data Source=172.19.129.23,1433\SQLEXPRESS;" & _
                  "Initial Catalog=COMM;User Id=planop;Password=planopefacec"
```

```
' Create the Connection and Recordset objects.
Set conn = New ADODB.Connection
Set rs = New ADODB.Recordset

' Open the connection and execute.
conn.Open sConnString

'SQL code to select the table in the data base
sExecuteCode = "INSERT INTO [COMM].[dbo].[table_CFmd_internacionais] " & _
               "([id_rubrica] " & _
               ",[id_company] " & _
               ",[id_UN] " & _
               ",[week] " & _
               ",[value] " & _
               ",[dt_regist] " & _
               ",[user_regist] " & _
               ",[plan_week] " & _
               ") " & "Values " & _
               Values2Insert & ";"

 Set rs = conn.Execute(sExecuteCode)

 Range("dt_insert_db2").Value = Now()

errCheck = 1
err:
  If errCheck = 0 Then
    MsgBox "Error! Record(s) not insert in the data base." & vbNewLine & "Erro: " & err.Description, vbCritical, "Erro"
  Else
    MsgBox cntRow & " Record(s) successfully insert.", vbInformation, "Success"
  End If
  Set conn = Nothing
  Set rs = Nothing

End Sub
```

APPENDIX F: SQL code to create final view *("V_PO_maxdate")* of the *"Planeamento Operacional_UN"*

```
CREATE VIEW [dbo].[V_PO_maxdate]
AS

SELECT [Year]
    ,[WeekReal]
    ,[LastWeek]
    ,[UN]
    --,[Sheet]
    --,[TipoRubrica]
    --,[Rubrica]
    ,[Week]
    ,[Value]
    --,[dt_regist]
      ,[Sheet]+ '_'+ [TipoRubrica] +'-'+[Rubrica]  'Item Type'
 FROM [COMM].[dbo].[V_PO_Input_fse_maxdate]


UNION all

 SELECT [Year]
    ,[WeekReal]
    ,[LastWeek]
    ,[UN]
    --,[Sheet]
    --,[Rubrica]
    ,[week]
    ,[Value]
    --,[dt_regist]
      ,[Sheet]+ '_' + '-'+[Rubrica]  'Item Type'
 FROM [dbo].[V_PO_Consumos_pl_bl_cfmi_maxdate]

 UNION all

 SELECT [Year]
    ,[WeekReal]
    ,[LastWeek]
    ,[UN]
    --,[Sheet]
    --,[Negocio]
    --,[pais]
    --,[Rubrica]
    --,[caracteristica]
    ,[week]
    ,[Value]
    --,[dt_regist]
      ,[Sheet]+ '_' + '-'+[Rubrica] + ':' + [caracteristica]  'Item Type'
 FROM [dbo].[V_PO_Capex_maxdate]

 UNION all

 SELECT [Year]
    ,[WeekReal]
    ,[LastWeek]
    ,[UN]
    --,[Sheet]
    --,[Rubrica]
      ,[Week]
    ,[Value]
    --,[dt_regist]
      ,[Sheet]+ '_'+ '-'+[Rubrica]  'Item Type'
 FROM [dbo].[V_PO_menu_maxdate]


GO
```

APPENDIX G: *Visual Basic macro to load data from the "Planeamento Operacional_UN" to the database*

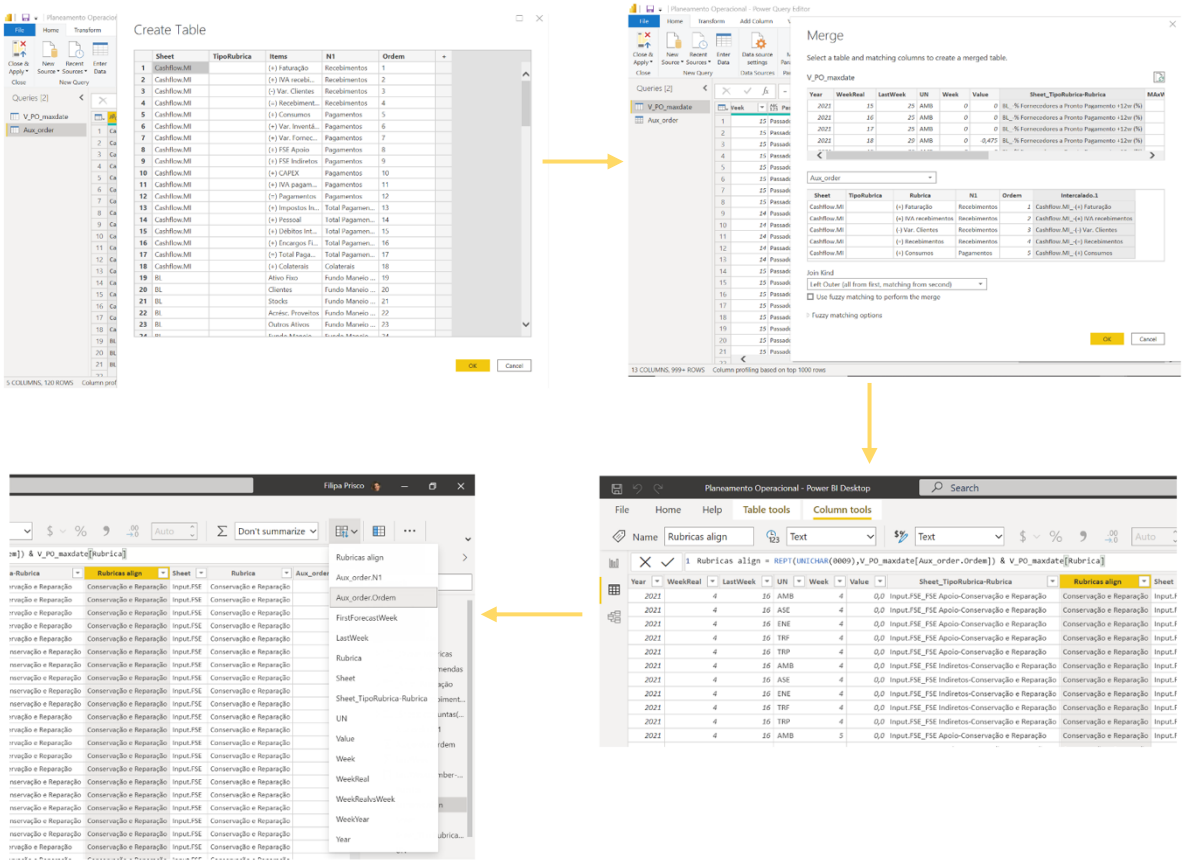
```
Sub SaveInDataBase()

Dim conn As ADODB.Connection
Dim rs As ADODB.Recordset
Dim sConnString As String
Dim sExecuteCode1, sExecuteCode2, sExecuteCode3 As String
Dim Values2InsertMenu, Values2InsertInput, Values2InsertCapex, Values2InsertConsumos As String
Dim errCheck As Boolean
Dim dData As String
Dim cntRow, cntColum As Integer
Dim I As String

errCheck = 0
On Error GoTo err
dData = Now()

'Insert values in SQL
      'Create the connection string. Integrated Security=SSPI;Trusted_connection=yes
      sConnString = "Provider=SQLOLEDB;Data Source=172.19.129.23,1433\SQLEXPRESS;" & _
            "Initial Catalog=COMM;User Id=planop;Password=planopefacec"

      ' Create the Connection and Recordset objects.
      Set conn = New ADODB.Connection
      Set rs = New ADODB.Recordset

      'Open the connection and execute.
      conn.Open sConnString
      conn.BeginTrans

      cnt = 1
      Do While cnt < 5
        If cnt = 1 Then      'Imputar valores da Sheet Menu
          Returncode1 = GetMenu(dData)
          If Returncode1 = 0 Then
               errCheck = 0
               Exit Sub
           Else
              'SQL code to select the table in the data base
              sExecuteCode1 = "INSERT INTO [COMM].[dbo].[PO_menu] " & _
                          "([DateUpdate] " & _
                          ",[Year] " & _
                          ",[WeekReal] " & _
                          ",[LastWeek] " & _
                          ",[UN] " & _
                          ",[Sheet] " & _
                          ",[Rubrica] " & _
                          ",[Week] " & _
                          ",[Value] " & _
                          ",[dt_regist] " & _
                         ",[user_regist] " & _
                          ") " & "Values " & _
                          Returncode1 & ";"
           End If
        Else

          If cnt = 2 Then 'Imputar valores da Sheet Input e input_FSE
              Returncode2 = GetInput(dData)
              If Returncode2 = 0 Then
                   errCheck = 0
                   Exit Sub
               Else
                   'SQL code to select the table in the data base
                   sExecuteCode2 = "INSERT INTO [COMM].[dbo].[PO_Input_fse] " & _
                          "([DateUpdate] " & _
                          ",[Year] " & _
                          ",[WeekReal] " & _
                          ",[LastWeek] " & _
                          ",[UN] " & _
                          ",[Sheet] " & _
                          ",[TipoRubrica] " & _
                            ",[Rubrica] " & _
                          ",[Week] " & _
                          ",[Value] " & _
                          ",[dt_regist] " & _
                         ",[user_regist] " & _
                          ") " & "Values " & _
                          Returncode2 & ";"
               End If

               Returncode13 = GetInput3(dData)
               If Returncode13 = 0 Then
                    errCheck = 0
                    Exit Sub
               Else
                   'SQL code to select the table in the data base
                   sExecuteCode13 = "INSERT INTO [COMM].[dbo].[PO_Input_fse] " & _
                          "([DateUpdate] " & _
                          ",[Year] " & _
                          ",[WeekReal] " & _
                          ",[LastWeek] " & _
                          ",[UN] " & _
                          ",[Sheet] " & _
                          ",[TipoRubrica] " & _
                            ",[Rubrica] " & _
                          ",[Week] " & _
                          ",[Value] " & _
                          ",[dt_regist] " & _
                         ",[user_regist] " & _
                          ") " & "Values " & _
_                         Returncode13 & ";"
               End If
               Returncode14 = GetInput4(dData)
               If Returncode14 = 0 Then
                    errCheck = 0
                    Exit Sub
               Else
                    'SQL code to select the table in the data base
                    sExecuteCode14 = "INSERT INTO [COMM].[dbo].[PO_Input_fse] " & _
                          "([DateUpdate] " & _
                          ",[Year] " & _
                          ",[WeekReal] " & _
                          ",[LastWeek] " & _
                          ",[UN] " & _
                          ",[Sheet] " & _
                          ",[TipoRubrica] " & _
                            ",[Rubrica] " & _
                          ",[Week] " & _
                          ",[Value] " & _
                          ",[dt_regist] " & _
                         ",[user_regist] " & _
                          ") " & "Values " & _
                          Returncode14 & ";"
               End If
```

```
Returncode3 = GetInputFSE(dData)
If Returncode3 = 0 Then
   errCheck = 0
   Exit Sub
Else
    'SQL code to select the table in the data base
    sExecuteCode3 = "INSERT INTO [COMM].[dbo].[PO_Input_fse] " & _
             "([DateUpdate] " & _
             ",[Year] " & _
             ",[WeekReal] " & _
             ",[LastWeek] " & _
             ",[UN] " & _
             ",[Sheet] " & _
             ",[TipoRubrica] " & _
             ",[Rubrica] " & _
             ",[Week] " & _
             ",[Value] " & _
             ",[dt_regist] " & _
            ",[user_regist] " & _
             ") " & "Values " & _
             Returncode3 & ";"
End If


Else

If cnt = 3 Then         'Imputar valores da Sheet Capex
Returncode4 = GetCapex(dData)
If Returncode4 = 0 Then
   errCheck = 0
   Exit Sub
Else
   'SQL code to select the table in the data base
   sExecuteCode4 = "INSERT INTO [COMM].[dbo].[Po_Capex] " & _
             "([DateUpdate] " & _
             ",[Year] " & _
             ",[WeekReal] " & _
             ",[LastWeek] " & _
             ",[UN] " & _
             ",[Sheet] " & _
             ",[Negocio] " & _
             ",[pais] " & _
             ",[Rubrica] " & _
             ",[caracteristica] " & _
             ",[Week] " & _
             ",[Value] " & _
             ",[dt_regist] " & _
            ",[user_regist] " & _
             ") " & "Values " & _
             Returncode4 & ";"
End If

Else

   If cnt = 4 Then
       Returncode5 = GetConsumos(dData)
        If Returncode5 = 0 Then
            errCheck = 0
           Exit Sub
        Else
             'SQL code to select the table in the data base
             sExecuteCode5 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                "([DateUpdate] " & _
                ",[Year] " & _
                ",[WeekReal] " & _
                ",[LastWeek] " & _
                ",[UN] " & _
                ",[Sheet] " & _
                ",[Rubrica] " & _
                ",[Week] " & _
                ",[Value] " & _
                ",[dt_regist] " & _
                ",[user_regist] " & _
                ") " & "Values " & _
                Returncode5 & ";"
        End If

        Returncode6 = GetPL(dData)
        If Returncode6 = 0 Then
               errCheck = 0
               Exit Sub
        Else
        'SQL code to select the table in the data base
        sExecuteCode6 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
              "([DateUpdate] " & _
              ",[Year] " & _
              ",[WeekReal] " & _
              ",[LastWeek] " & _
              ",[UN] " & _
              ",[Sheet] " & _
              ",[Rubrica] " & _
              ",[Week] " & _
              ",[Value] " & _
              ",[dt_regist] " & _
              ",[user_regist] " & _
              ") " & "Values " & _
              Returncode6 & ";"
         End If
        Returncode7 = GetBL(dData)
        If Returncode7 = 0 Then
           errCheck = 0
           Exit Sub
        Else
        'SQL code to select the table in the data base
        sExecuteCode7 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
              "([DateUpdate] " & _
              ",[Year] " & _
              ",[WeekReal] " & _
              ",[LastWeek] " & _
              ",[UN] " & _
              ",[Sheet] " & _
              ",[Rubrica] " & _
              ",[Week] " & _
              ",[Value] " & _
              ",[dt_regist] " & _
              ",[user_regist] " & _
              ") " & "Values " & _
               Returncode7 & ";"

        End If
```

```
            Returncode8 = GetBL2(dData)
            If Returncode8 = 0 Then
                errCheck = 0
                Exit Sub
            Else
            'SQL code to select the table in the data base
            sExecuteCode8 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                  "([DateUpdate] " & _
                  ",[Year] " & _
                  ",[WeekReal] " & _
                  ",[LastWeek] " & _
                  ",[UN] " & _
                  ",[Sheet] " & _
                  ",[Rubrica] " & _
                  ",[Week] " & _
                  ",[Value] " & _
                  ",[dt_regist] " & _
                  ",[user_regist] " & _
                  ") " & "Values " & _
                   Returncode8 & ";"

            End If

            Returncode9 = GetBL3(dData)
            If Returncode9 = 0 Then
               errCheck = 0
               Exit Sub
            Else
            'SQL code to select the table in the data base
            sExecuteCode9 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                  "([DateUpdate] " & _
                  ",[Year] " & _
                  ",[WeekReal] " & _
                  ",[LastWeek] " & _
                  ",[UN] " & _
                  ",[Sheet] " & _
                  ",[Rubrica] " & _
                  ",[Week] " & _
                  ",[Value] " & _
                  ",[dt_regist] " & _
                  ",[user_regist] " & _
                  ") " & "Values " & _
                   Returncode9 & ";"

            End If

            Returncode10 = GetCFmi1(dData)
            If Returncode10 = 0 Then
                 errCheck = 0
                 Exit Sub
            Else
            'SQL code to select the table in the data base
            sExecuteCode10 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                  "([DateUpdate] " & _
                  ",[Year] " & _
                  ",[WeekReal] " & _
                  ",[LastWeek] " & _
                  ",[UN] " & _
                  ",[Sheet] " & _
                  ",[Rubrica] " & _
                  ",[Week] " & _
                  ",[Value] " & _
                  ",[dt_regist] " & _
                  ",[user_regist] " & _
                  ") " & "Values " & _
                   Returncode10 & ";"
            End If
            Returncode11 = GetCFmi2(dData)
            If Returncode11 = 0 Then
                 errCheck = 0
                 Exit Sub
            Else
            'SQL code to select the table in the data base
            sExecuteCode11 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                  "([DateUpdate] " & _
                  ",[Year] " & _
                  ",[WeekReal] " & _
                  ",[LastWeek] " & _
                  ",[UN] " & _
                  ",[Sheet] " & _
                  ",[Rubrica] " & _
                  ",[Week] " & _
                  ",[Value] " & _
                  ",[dt_regist] " & _
                  ",[user_regist] " & _
                  ") " & "Values " & _
                    Returncode11 & ";"
            End If
            Returncode12 = GetCFmi3(dData)
            If Returncode12 = 0 Then
                 errCheck = 0
                 Exit Sub
            Else
            'SQL code to select the table in the data base
            sExecuteCode12 = "INSERT INTO [COMM].[dbo].[PO_Consumos_pl_bl_cfmi] " & _
                  "([DateUpdate] " & _
                  ",[Year] " & _
                  ",[WeekReal] " & _
                  ",[LastWeek] " & _
                  ",[UN] " & _
                  ",[Sheet] " & _
                  ",[Rubrica] " & _
                  ",[Week] " & _
                  ",[Value] " & _
                  ",[dt_regist] " & _
                  ",[user_regist] " & _
                  ") " & "Values " & _
                    Returncode12 & ";"
                End If
            End If
        End If
    End If
  End If

 cnt = cnt + 1
Loop

    Set rs1 = conn.Execute(sExecuteCode1)
    Set rs2 = conn.Execute(sExecuteCode2)
    Set rs3 = conn.Execute(sExecuteCode3)
    Set rs4 = conn.Execute(sExecuteCode4)
    Set rs5 = conn.Execute(sExecuteCode5)
    Set rs6 = conn.Execute(sExecuteCode6)
    Set rs7 = conn.Execute(sExecuteCode7)
    Set rs8 = conn.Execute(sExecuteCode8)
    Set rs9 = conn.Execute(sExecuteCode9)
    Set rs10 = conn.Execute(sExecuteCode10)
    Set rs11 = conn.Execute(sExecuteCode11)
    Set rs12 = conn.Execute(sExecuteCode12)
    Set rs13 = conn.Execute(sExecuteCode13)
    Set rs14 = conn.Execute(sExecuteCode14)
```

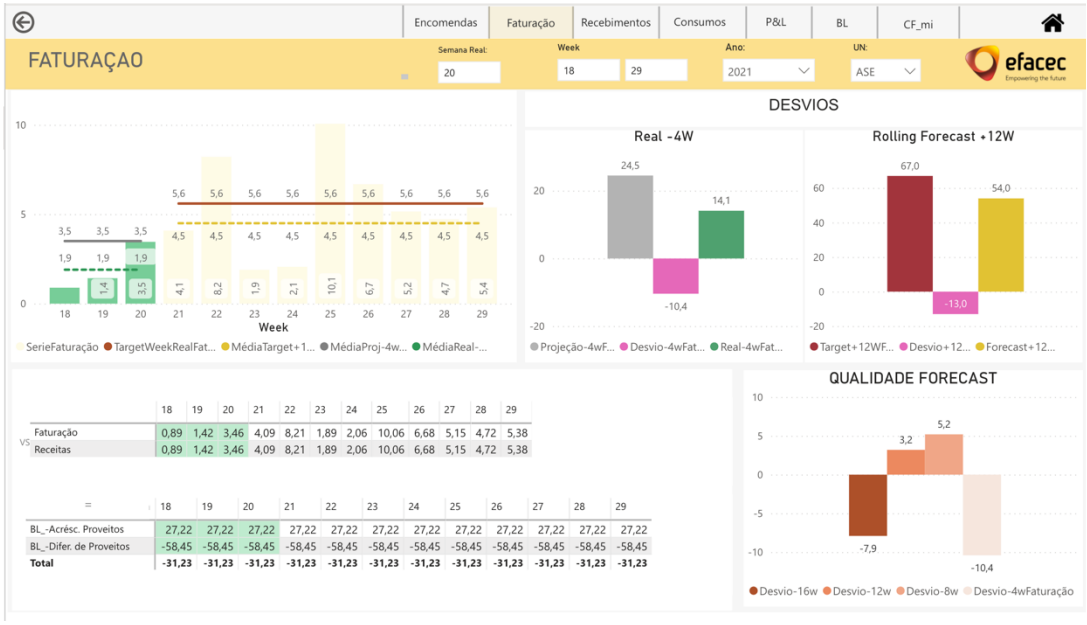
```
ThisWorkbook.Worksheets("Menu").Range("J4") = dData
errCheck = 1
err:
  If errCheck = 0 Then
    conn.RollbackTrans
    conn.Close
    MsgBox "Erro! Algo correu mal, por favor tente de novo" & vbNewLine & "Erro: " & err.Description, vbCritical, "Erro"
  Else
    conn.CommitTrans
    conn.Close
    MsgBox " Valores guardados com sucesso!", vbInformation, "Success"
  End If
  Set conn = Nothing
  Set rs = Nothing

End Sub
```

APPENDIX H: Power BI order elements steps



APPENDIX I: Business Intelligence Tool dashboards

'Faturação' Dashboard



'Recebimentos' Dashboard