UNIVERSIDADE CATÓLICA PORTUGUESA

Enhancing organizational efficiency with data-driven dashboards

A Study in Dashboard Development and Implementation

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A Study in Dashboard Development and Implementation

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Abstract

In today's data-driven landscape, businesses rely heavily on extracting key information from datasets to gain a competitive advantage. This master thesis generally aims to improve the productivity and usefulness of Excel-based dashboards, particularly for the telecoms corporation by integrating data from NOS, more specifically its WOO and WTF divisions.

The goal of this thesis was to optimize data processing and visualization through the redesign of existing dashboards while simultaneously researching new techniques to improve user experience and inspire engagement with data-driven insights. Utilizing an Action-Research method, the study aimed to enhance Excel's capabilities by implementing new techniques for improved data integration and presentation. By analyzing the data system's structure and refining data preparation processes, the research aims to enhance the accuracy and reliability of the dashboards. Furthermore, it emphasizes the need for user participation in dashboard design to ensure alignment with chiefs' requirements and preferences.

Key findings highlight the interdependence between data preparation and dashboard design, emphasizing the need for a cohesive dataset structure to support meaningful insights. The use of color-coded visuals and intuitive graphics improve data interpretation, facilitating informed decision-making. Additionally, the research explores opportunities for future automation to further improve dashboard efficiency and accuracy.

Overall, this study contributes to the evolving field of Business Intelligence by demonstrating practical ways for optimizing Excel-based dashboards in

telecommunications companies. It promotes the continuous process of dashboard development, as well as the importance of ongoing evaluation and refinement to maintain relevance and effectiveness in a dynamic business environment.

Keywords: Data, Excel, Dashboards, Business Intelligence, Decision-Making, Efficiency

Resumo

Atualmente, as empresas dependem largamente da extração de informações-chave de conjuntos de dados para obter uma vantagem competitiva. Esta tese de mestrado visa melhorar a produtividade e utilidade dos *dashboards* em Excel para a empresa de telecomunicações, integrando na NOS e nas suas divisões WOO e WTF.

O objetivo desta tese foi otimizar o processamento e visualização de dados por meio do redesenho dos *dashboards* existentes. Utilizando um método de Pesquisa-Ação, o estudo demonstra as capacidades do Excel implementando novas técnicas para uma integração e apresentação de dados melhoradas. Ao analisar a estrutura do sistema de dados e melhorar os processos de preparação de dados, a pesquisa visa aumentar a precisão e confiabilidade dos *dashboards*. Além disso, enfatiza a necessidade de participação do usuário no *design* do *dashboard* para garantir alinhamento com os requisitos e preferências da chefia.

As principais descobertas destacam a interdependência entre a preparação de dados e o *design* do *dashboard*, sublinhando a necessidade de uma estrutura de conjunto de dados coesa para retirar conclusões significativas. O uso de visuais codificados por cores e gráficos intuitivos melhora a interpretação de dados, facilitando a tomada de decisões informadas. Além disso, a pesquisa explora oportunidades para automação futura para aprimorar ainda mais a eficiência e precisão do *dashboard*.

No geral, este estudo contribui para o campo em evolução de *Business Intelligence*, demonstrando maneiras práticas de otimizar dashboards baseados em Excel em empresas de telecomunicações. Promove o processo contínuo de

desenvolvimento de *dashboards*, bem como a importância da avaliação contínua e ajuste para manter relevância e eficácia num ambiente de negócios dinâmico.

Palavras-Chave: Dados, Excel, *Dashboards, Business Intelligence*, Tomada de Decisões, eficiência

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List of Abbreviations and Acronyms

BI – Business Intelligence

CPA – Cost Per Acquisition

e-SIM – embedded SIM

IT – Information Technology

KPI – Key Performance Indicator

OLAP – Online Analytical Processing

SIM – Subscriber Identity Model

Introduction

Information is a critical success component that influences decision-makers' performance, particularly the quality of their decisions. Data is regarded as the raw material of the twenty-first century, hence solutions must be researched and developed to handle and extract value and information from these datasets. Furthermore, decision makers must be able to extract meaningful insights from constantly changing data (Elgendy & Elragal, 2016).

The purpose of this dissertation is to show how data-driven dashboards play a crucial role in guiding important decisions within companies. Nowadays, there is a lot of data available, but it is often complicated to transform it into valuable insights. That is why it is so important to turn this data into useful insights that businesses can use. By looking at how dashboards are used in real companies, this research wants to explain how effective they are and provide helpful advice for other organizations wanting to use similar strategies. This dissertation hopes to add to the ongoing conversation about using data to make better decisions in the business world.

The dissertation was conducted to answer the following research question: How do data-driven dashboards help decision making in a company? A case study offers a practical illustration of how data-driven dashboards contribute to decision-making within a company, in this case NOS was used as practical example of a case study. Insights are gathered through observations and analysis of available data, providing a comprehensive understanding of dashboard utilization and its influence over time. Action research was chosen as one of the methods to address this question due to its emphasis on continuous feedback and communication. Relationships were established with various teams to ensure that the reshaping and remodeling of the dashboards aligned with their

objectives. This approach aimed to develop dashboards in a manner that could serve as a foundational template for any company looking to build their own dashboards.

During an internship at NOS, two Excel dashboards were developed and implemented that aimed at consolidating and analyzing critical data. These dashboards served as a pivotal tool in weekly strategic meetings, providing real-time insights into key performance indicators such as new client acquisition, expected growth trajectories, digital versus physical gross adds, channel of sale distribution, e-SIM adoption rates, app performance and others. With these indicators' decisions like resource allocation, control of the CPA and trend analysis were taken during the weekly meetings.

This thesis explores the methodology behind the dashboards' design and implementation, from the process of gathering data to the demonstration of how it merged considering these different data sources into an Excel dashboard and finally the data analysis. Furthermore, it helps understand the practical implications of these insights on strategic decision-making processes within a company, demonstrating how data-driven strategies have contributed to the overall growth and success of the organization.

Dissertation Structure

There are five chapters in this master thesis. The current chapter is chapter one, it introduces this report, giving the context of the study, the main question of the investigation and what methodology was used to answer it. It also highlights where the internship took place and the structure of the dissertation.

The second chapter dives into the theoretical framework of the project, and it touches upon the concepts of BI, Microsoft Excel and Dashboards, the evolution throughout time of data in companies. It is essential to understand the project and its goals.

The third chapter refers to the method, answering the research question, giving context, the main project objectives and talk in depth about the methodologies utilized.

The fourth chapter talks about the results, from data integration to the final dashboards and what they presented. In this chapter the remodeling of the dashboards and the changes made during the internship to improve processes and dashboards efficiency are referred to, as well as the discussion of the results and how they impacted the company.

The fifth and final chapter summarizes all the conclusions drawn, the major contributions of the internship and some future recommendations for the company and research regarding the topic of data-driven dashboards.

Literature review

Introduction

Nowadays the fast-paced and competitive business landscape, the ability to make informed decisions based on accurate data analysis is crucial for organizational success. After establishing the framework of data-driven decision-making in the telecoms business through the introduction, it is required to review the available literature on the subject. By synthesizing relevant studies and scholarly works, the following literature review aims to provide a comprehensive understanding of the theoretical frameworks, methodologies, and empirical findings relevant to the use of data-driven dashboards in facilitating strategic decision-making processes within organizations.

In todays' competitive business environment, making the right decisions based on accurate financial analysis is crucial (Aurellia, 2022). Several studies have investigated the influence of financial statement quality on investment choices in various sectors and geographies. High-quality financial statements offer dependable and relevant information to investors, allowing for smarter investment decisions. Accurate financial reporting improves a company's reputation, attracts investors, and lowers capital costs (Cohen & Karatzimas, 2017) (Chen et al., 2010). However, the process of financial analysis is often complex and time-consuming, especially when large and sophisticated datasets are involved.

The flow of information within an organization is critical to the success of that organization (Davenport & Prusak, 1998). As an organization expands, data quantity required also becomes increasingly larger. Businesses struggle in gathering data, retrieving information, and making decisions based on the

extracted information (Hansoti, 2010). A study conducted by Statista shows that the amount of data generated annually has grown year-over-year since 2010. In fact, it is estimated that 90% of the world's data was generated in the last two years alone. In the space of 13 years, this figure has increased by an estimated sixty-fold from just 2 zettabytes in 2010. The 120 zettabytes generated in 2023 are expected to increase by over one hundred and fifty percent in 2025, hitting 181 zettabytes. Making decisions about various investments and resources based on both quantitative and qualitative data is the core process of decision-making (Hansoti, 2010). A decision that needs to be taken immediately may be delayed if the correct data is not available at the appropriate moment (Hansoti, 2010).

As businesses expanded their global presence, information was used by a variety of individuals, including stakeholders, accountants, managers, customers, and others. Executives and managers spend a large amount of time scanning information and making judgments (Vedder, Vanecek, Guynes, & Cappel, 1999). Managers make both structured and unstructured decisions in any type of organization. Accounts Receivable, short-term forecasting, and inventory control are examples of structured decisions, whereas Sales and Production and Cash Management are unstructured decisions (Gory & Morton, 1971).

Management need information that is clear and specific to its needs in order to make choices. One technology that can provide a solution to the need for presenting data and information in a visually appealing and easy-to-understand visual form is the dashboard. A display that allows decision-makers to get a summary of key information quickly and easily as a basis for taking crucial decisions that will impact the organization (Jayanti and Ani, 2017). Some of the technologies that allow to create these dashboards are BI systems like Excel. In

the subsequent chapters the terms BI and BI systems will be explored as well as excel, focusing on the qualities and limitations of the spreadsheeting tool.

Business Intelligence

As previously mentioned, efficient decision-making has become crucial for the success of organizations. This is where the concept of BI develops, representing a comprehensive approach to collecting, analyzing, and leveraging data to improve decision-making processes.

The term BI was popularized throughout the 1990s and is considered to be a term spanning through a wide variety of processes and software used to collect, analyze, and disseminate data in order to make better decisions (Davenport & Prusak, 1998) that includes infrastructures, tools, technologies, databases, applications, and techniques. BI has been used as an umbrella term to represent principles and strategies to improve business decision making using fact-based support systems (Al-Okaily & Al-Okaily, 2022). The primary goals of BI are to offer interactive and easy access to different data, data processing, and transformation to create relevant and valuable information that can help business managers and analysts make choices (Wixom & Watson, 2011).

As organizations increasingly recognize the value of data-driven insights, the evolution and comparison of BI systems provides essential insights into the transformative potential of these technologies. An analysis of how BI systems have evolved over time and their impact on organizational decision-making processes will be made in this chapter.

A BI system can be defined as a process of converting data into information and eventually into knowledge (Golfarelli, Rizzi, & Cella, 2004). A BI system

overcomes the decentralization concern of the company decision making process and improves efficiency. It aids in the identification of difficulties in any project and gives an analysis of each project variant (Olszak & Ziemba, 2006).

As organizations tried to capitalize on the power of data, the introduction of BI tools altered the landscape of decision support. Initially, the data warehouse served as a cornerstone, providing a centralized depository for vital data. However, obstacles remained for non-technical users, leading the development of solutions to democratize data access.

According to Chaudhuri and Dayal (1997), a data warehouse is a subject-oriented, integrated, time varying, nonvolatile data gathering that is largely utilized in organizational decision-making. Though a data warehouse was widely used, it was only advantageous to persons who were very computer-literate. The biggest challenge faced by business users when making judgments is navigating large data marts or data warehouses and connecting information. Users must rely on the IT department to gain access to business data (Price, 2006).

Business Intelligent systems/techniques such as OLAP and also Data Mining, represent decision support tools which allow obtaining more value from data. Data value is gained by examining stored data, combining it, and revealing unknown trends (Bimonte, 2019). Many statistical and quantitative techniques explain, and predictive models enable data visualization in ways that were previously impossible, leading intelligent business systems to be a priority for successfully managing and extracting data knowledge.

In the recent past, the BI solutions focused on only structured and internal data. Consequently, much valuable unstructured and external data is hidden and unused, potentially leading to an incomplete view of reality and biased business decision making. Nowadays BI primarily uses transactional database data from

multiple sources, as well as many sources other than relational DBs (Bele et al., 2019) (Ram et al., 2016). The majority of organizations integrate their data warehouse and external applications into the dashboard to improve performance (Hurwitz, 2005).

Additionally, some examples of BI tools are IBM Cognos Business Intelligence (Volitich, 2008); Microsoft Power BI (Lachev & Price, 2018); Oracle BI Foundation Suite (Gligor & Teodoru, 2011); SAP Business Objects (Färber, 2012); MicroStrategy Analytics Platform (Halper & Stodder, 2014); Qlik Sense (Ilacqua et al., 2015); Tableau (Murray, 2013); Tibco Spotfire (Choo & Saeger, 2011).

Data quality, light architecture, and indicators are critical design challenges that must be addressed in the BI system (Golfarelli, Rizzi, and Cella, 2004). These constraints led to the development of the dashboard. Before dashboards, analysts had to go through massive amounts of data to compute earnings, expenses, and quarterly outcomes.

Microsoft Excel

As organizations strive to optimize their decision-making processes, Excel emerges as a versatile solution for analyzing vast amounts of data and presenting it in comprehensible formats. Microsoft Excel is the most advanced spreadsheet program available today. Spreadsheet programs are extremely useful tools for numerical computations, and they are computationally equivalent to many programming language-based numerical computing software systems (Baier & Neuwirth, 2007). Spreadsheet programs are distinguished by some significant characteristics:

- creation of formulas with a point and click user interface;
- relative and absolute cell references instead of named variables;
- iteration and multiple computations by copying formulas;
- automatic recalculation when input values change.

Microsoft Excel can help analyze large amounts of financial data and then visualize it in a form that is easier for others to understand. These qualities result in a distinct style of interacting with data (Baier & Neuwirth, 2007). Spreadsheets provide for an exploratory approach to data analysis because changing cell contents directly affects computed results. Furthermore, it is not difficult for the average user to update formulas, therefore spreadsheet programs are not closed application programs (like accounting systems), but rather provide end users with a simplified version of programming and even software creation (Baier & Neuwirth, 2007).

These characteristics of modeling enable a smooth transition from simple activities such as billing, bookkeeping, and relatively simplistic statistics to rather complicated statistical and mathematical models. Nardi (1993) discusses these

end-user programming approaches, while Neuwirth and Arganbright (2003) provide a full explanation of spreadsheet modeling.

Excel also has the advantage of being integrated into the Windows desktop. Transferring data and images between Excel and other apps is simple, and it is even feasible to embed parts of Excel sheets into text documents so that the text document is automatically updated when the Excel sheet contents change. Excel does provide some statistical support, both through spreadsheet functions and menu-based procedures, although these methods are not widely acknowledged by the statistical community. Some of these algorithms (for example, those based on matrix inversion) have poor numerical precision, and the parametrization of function arguments is often unusual (Baier & Neuwirth, 2007).

Dashboards

Building upon the exploration of Microsoft Excel, it is essential to dive into the specific challenges and considerations associated with dashboard design. As organizations increasingly rely on excel dashboards to facilitate data-driven decision-making, understanding the key design issues becomes essential. This section will analyze the various factors influencing dashboard design and their implications.

A dashboard is an interface that assists managers and executives acquire data instantly from multiple departments in a consistent form, making it easily accessible. The style and functionalities of a dashboard may differ depending on the individual business application for which it is utilized (Hansoti, 2010). A dashboard is a structure that displays information at the appropriate time utilizing indicators (Golfarelli, Rizzi, & Cella, 2004). An Excel dashboard provides business users with complete control over how they manage data, leaving IT to focus on technology integration, maintenance, and support.

Severing this reliant relationship leads to faster and better decisions (Price, 2006). The quality of decisions is heavily dependent on data quality. A dashboard, unlike a data warehouse, collects data from a variety of sources, including data warehouses, spreadsheets, internal applications, external services, and stand-alone apps (Farcot & Kades).

User interface design is vital to any computing system because it impacts user productivity and efficiency (Few, 2006). A dashboard is a rich user interface that shows information in a graphical style utilizing various elements such as charts, tables, and gauges. Because a dashboard can be used for a variety of reasons by different people, it should be extremely customizable to suit a wide range of users and scenarios. It should only display the information required by decision

makers to complete their tasks. The display mechanism also influences decision making. The manner (method of presentation) in which information is given is critical (Few, 2006). BI systems should be created with a grasp of the human perspective in mind, taking into account elements such visual displays, interface design, and other interactions that promote human ability (Few, 2006).

Dashboard design relies heavily on color selection. Dashboards for visual mining use colors like green, yellow, and red to indicate good, satisfactory, and poor performance (Few, 2006). Color choosing should consider cultural differences and color blindness. Red and green are commonly used colors to indicate bad (red) and favorable (green) signs. The same color should not be used for many functions (Few, 2006). For example, if bright green and light red are used to represent good and terrible performances, they should not be used for other purposes. Important information should be highlighted using large boxes or vivid colors to allow the user to take immediate action (Eshraghi, 2008). A dashboard design should be carefully studied before implementing one; it should not be the product of "gauges, flashy traffic lights, meters, but rather a simple knowledgeable design" (Few, 2006, p.4). Though gauges and flashing traffic lights are visually appealing, they do not effectively communicate.

These aspects reduce the time spent analyzing data utilizing databases, hence helping to automate the business decision-making process (Malik, 2005). An effective visualization dashboard involves choosing the right metrics, building an intuitive layout, utilizing relevant graphs and charts, and having the ability to explore additional data (Yulfajar & Sofian, 2023).

Research on the use of graphics in learning reveals that basic drawings are more efficient in communication than gauges and meters, which create visual noise and distract users (Clark, Lyons, & Hoover, 2004). Different suppliers propose different dashboard designs.

There are some common pitfalls encountered while designing dashboards that should be avoided while designing the user interface for a dashboard:

- information overload (Cleverley, 2001; DeBusk, Brown, & Killough, 2003): Too much information can make the dashboard look cluttered and can easily distract the users. Detailed information should be supplied based on customer desire.;
- limited information: A successful dashboard cannot just display current or historical data. To make a dashboard usable, it should have a variety of different types of data;
- complex user interface (Collier, Marini & Minsker, 2008): Dashboards are often designed for leaders and managers with little time to master a new technology. The navigation should be created such that users may easily navigate the dashboard without any difficulty;
- according to Eshraghi (2008), creating a dashboard requires ensuring security. Data integrity should be ensured by audience targeting and role-based security;
- according to Hurwitz and Associates (2005), firms that deploy data warehouses and stand-alone databases meet less than half of their business requirements.

Method

The previous chapter was key in giving a theoretical framework for the thesis touching upon decision making, BI and excel dashboards. Moving forward from this exploration, the research methodology is outlined across three key areas: defining project objectives, situating the research within relevant contexts, and establishing theoretical foundations.

Project objectives

During the internship at NOS, a few goals were set to successfully complete the challenges the internship had to offer. These goals were carefully crafted to align with the mission of the organization and to address specific needs within company. Because this dissertation is presented in the format of an Internship Report, it does not address a specific research topic considering literature gaps.

The primary aim was to enhance the functionality and usability of Excel dashboards, focusing particularly on WOO and WTF dashboards. This goal helped improve data accessibility and allowed the company to make decisions with actionable insights. This objective connects directly to the research question as the increase in efficiency in the dashboard have a positive impact in decision-making, helping the company make more quick and efficient decisions based on an easy-to-use dashboard.

Furthermore, contributing on improving company performance was one of the main goals as well. By optimizing processes, enhancing efficiency, and mitigating operational challenges, the aim was to drive measurable improvements in organizational outcomes and overall effectiveness.

Integral to the success of these objectives was the incorporation of feedback from end-users throughout the dashboard remodeling process. This approach ensured that the developed solutions remained responsive to evolving needs and aligned closely with organizational objectives. As mentioned earlier this internship took place at NOS which will be explained in the subsequent chapter.

Research contextualization

As previously stated in the introduction NOS, SGPS was founded in 2013 as a result of ZON and OPTIMUS fusion, and it is one of Portugal's' leading telecommunications providers. NOS offers TV, internet, landline telephone and mobile internet of the latest generation. NOS is Portugal's' leading communications and entertainment group. It offers cutting-edge fixed and mobile solutions, television, internet, phone, and data to all market segments. It is the market leader in Portugal for subscription TV, next generation internet services, and film distribution and exhibition. In the commercial market, it positions itself as a long-term option in the Corporate and Mass Business categories, offering a varied range of goods and services with solutions tailored to each industry and business size, and supplementing its offering with ICT and Cloud services. NOS is listed on the major national stock market index (PSI-20) and has about 4,600,000 mobile clients, 1,600,000 million television customers, 1,700,000 million landline customers, and 1,300,000 million fixed broadband internet users.

As previously mentioned, WOO is a totally digital telecommunications provider, that only offers mobile and house internet, it is a low-cost version of NOS, excluding the TV and landline telephone. It works through an app on the phone where all issues are resolved primarily digitally, it was founded in 2020 as the first telecommunications company in Portugal primarily digital, where the app is the basis for every interaction between customer and company. The app can is used as customer support where the client can change service, cancel the service, or subscribe to a new one.

WTF on the other hand is a mobile plan, focused on younger people that supplies mobile internet, and has various partnerships which allow huge

discounts and bonuses for users. It was founded in 2013 while the company was still optimus, and it also works through an app, where the clients can redeem rewards, check how much mobile internet is left, the current plan and discounts on other companies based on the partnerships the company stablished.

The internship took place in the WOO and WTF teams, more specifically the product teams. From 4th of September to 2nd of February the internship took place, with various different tasks, from connecting data in excel to get information about clients, gross adds with variants such as dates, different mobile plans, tourists, one big excel report to calculate the cost of sales which included extracting data from various databases and then creating a dashboard so it can be represented to Executives of the company. Creation of another excel report which helped understand the clients that cancelled a subscription because the company couldn't deliver the internet service in the time stamp established and much more. As previously mentioned in this thesis the WOO and WTF dashboards are going to be the case study and explored with the contributions to the company's decision making. The dashboards served as a key tool in weekly strategy meetings, providing real-time insights into critical performance metrics.

These indicators included a wide range of topics, including new client acquisition, projected growth patterns, comparisons of digital and physical gross adds, sales channel distribution, e-SIM technology acceptance rates, and app performance. As previously stated, these insights influenced resource allocation choices, CPA monitoring, and trend analysis at weekly meetings. These dashboards were chosen as the main theme in this thesis as they represent the most impact in the dashboards that were developed in terms of decision making and overall impact and importance to the company, it will help view how different data and graphics affect different types of decisions.

Research Methodology

Two approaches were utilized to answer the research investigations: case study and action research. The first part of the chapter will focus on the case study, followed by an in-depth discussion of how action research was used to execute the tasks specified and successfully completed.

Case study

A case study is expected to capture the complexities of a particular example, and the methodology that allows this has evolved within the social sciences. Such techniques are used not just in the social sciences (psychology, sociology, anthropology, and economics), but also in practical disciplines like environmental studies, social work, education, and business studies. At least one-third of the studies address some element of case study technique (Johansson, 2003).

As stated in the contextualization, the case study included in-depth research of the adoption and usage of data-driven dashboards inside a corporation, with an emphasis on the redesign of two dashboards for decision-making reasons. This study looks at the impact of data-driven decision-making procedures on organizational performance and strategic results. The case study's findings gave concrete recommendations for improving the design, functionality, and use of data-driven dashboards within the defined departments, contributing to the larger topic of using data analytics for strategic advantage in the telecoms business.

In fact, the dashboards were critical tools for delivering real-time insights into important performance metrics during strategic discussions. The dashboards made informed decisions about resource allocation and trend analysis easier by aggregating and evaluating crucial data points such as customer acquisition and growth trajectories. These dashboards played an important role in directing strategic debates and propelling organizational initiatives ahead, emphasizing the concrete influence of smart dashboard design on business outcomes.

Aligned with the earlier context, the case study method was essential for looking into how companies use data-driven dashboards. Specifically, it focused on improving two dashboards for better decision-making. This study aimed to understand how using data to make decisions affects how well a company does, especially in telecoms. By studying how these dashboards are used, it allowed to make them more efficient, giving clear ideas on how to improve their design and use in different departments. Also, the study found that these dashboards play a key role in meetings, helping decision making about where to put resources and how trends are going.

Action research

As previously mentioned, during the internship at NOS in terms of methodology for achieving the intended goals, Action Research was chosen to motivate project implementation, and the company provided all the data. Action research is an empirical method in which researchers and participants, who are representations of the topic under investigation, engage and participate in the conceptualization and building of a common problem (Thiollent, 2022). In general, it aims to address research issues within an organization (Eden & Huxham, 1996). Furthermore, researchers using this approach deal with study

subjects and organizational difficulties rather than hypotheses (Checkland & Holwell, 1998).

This methodology was chosen as it allows for the simultaneous analysis of results and the identification of new ways to improve and it is particularly suitable for addressing complex, real-life problems in organizational settings (Carr and Kemmis, 1986). Action research is defined as comparative research on the conditions and effects of various forms of social action and research leading to social action (Lewis, 1946). The action is usually associated with identifying and exploring an issue, question, dilemma, gap, or puzzle in context of work – the classroom, the school, or the institution at large (Burns, 2007). The research in action research involves a systematic approach to collecting information, or data, usually using methods commonly associated with qualitative research. In this way, action research differs from the passing reflections or intuitive thoughts that most teachers have about their work.

Coughlan and Coghlan (2002) add to these observations that action research has the following characteristics: "research in action," rather than "action research," is participatory and synchronous to the activity; it results in a sequence of events and an approach to problem solving. It is also critical to emphasize that the characteristics should be addressed from the start of the research, i.e., they should be planned accordingly. The decision addressed its practical element, since assessing the findings leads to new ways of improvement. That is, it aims to effect change via action, study, and reflection on previous efforts. Essentially, this style is ideal for a case study that requires both action and investigation. A four-step repeating spiral of planning, acting, observing, and reflecting can be considered the basis for many of the more modern definitions of action research (Meyer, 1993). In this situation, each cycle is reliant on the previous ones, and only after each one has been completed and comprehended can the next one be

started. That does not guarantee that the following cycle will succeed, and procedures may need to be reformed upstream. To help answer the questions previously mentioned action research was chosen breaking it down to the 4-step repeating spiral of planning.

The initial step in planning and preparation was to collaborate with coworkers from the WOO and WTF divisions to define the precise aims and goals of the renovation project. Define the scope of the action study, including the timeframe, resources needed, and desired objectives. Communicate with the team about what should be introduced and what was expected to be presented in the new graphics. The second to action, dashboards were reconfigured, and graphics generated to ensure that they met the previously established particular objectives and expectations of the WOO and WTF departments. Help departmental staff understand how to use the new dashboards to effectively communicate what changes were made and provide ongoing assistance and coaching as needed. Closely monitor the implementation process, noting any obstacles or concerns that develop and responding to them as soon as possible.

Moving on to the third step of observation, departmental personnel and managers are constantly monitored in their use and engagement with the dashboards. Document any observable changes in decision-making behavior, operational efficiency, and resource allocation in the WOO and WTF departments. Determine the significance of the changes by how much employees interact with the dashboards and excel reports containing all relevant data. Finally, moving on to the last step, reflection and analysis, analyzing the initial study questions, taking into consideration how the dashboards affected decision-making processes and organizational performance. Engage in discussions with WOO and WTF to validate the results and learn more about their experiences with the new dashboards during the strategic weekly meeting where choices

were made based on the dashboard. Get input from the entire team on what to modify and how the changes affected decision making such as resource allocation, CPA, and which problems to solve, as well as the subsequent remedies that will make the firm more efficient.

Results and Discussion

Results

In the following chapter, an in-depth examination of the two dashboards, the WOO and WTF, will be presented. This chapter discusses the evolution of these dashboards from their earlier designs, demonstrating the changes made and how data is integrated into the Excel framework. The emphasis will be on explaining the significant insights and information included within these dashboards, as well as outlining the critical decisions assisted by the significant KPIs.

The following chapter will be divided into three distinct sections, each focusing on a critical aspect of the dashboard development process. The first portion will go over the process of data integration and storage. This part will describe how the procedure is used to collect relevant data sources and integrate them into an Excel structure. Furthermore, it will examine the methods used for data cleansing, transformation, and loading, outlining the measures used to assure the integrity and dependability of the data contained within the dashboard.

Secondly, this section will conclude with a full description of both the WOO and WTF dashboards. Each dashboard will be broken down, with a focus on decoding the various graphical representations and metrics. An investigation of these visualizations will reveal insights into the strategic decisions driven by dashboard outputs, explaining the goal of increasing corporate efficiency. The third and final chapter will discuss the results of implementing the WOO and WTF dashboards. It will look at the obstacles and lessons learnt during the dashboard development process, providing insights into best practices and recommendations for future implementation efforts.

Data loading and transformation

There were two techniques to collect data: automated and manual. Beginning with the automated approach, Excel has a particular edge due to its ability to link with a variety of data sources. Within the Excel framework, vital elements such as pivot tables play an important role in driving the update process for critical graphics within the dashboard interface. These pivot tables, strategically positioned to include important data and metrics, serve as dynamic repositories of data, allowing for quick viewing and analysis of relevant information.

Most importantly, these pivot tables are refreshed daily, ensuring that data is always up to date. This update mechanism is made possible by its link to a Data Cube, an integrated data management platform. A data cube is a software infrastructure that allows for the intake, storage, access, analysis, and usage of data items that are intrinsically arranged based on shared features (Nativi et al., 2017). Using this connection, the pivot tables automatically get updated data, eliminating the need for manual intervention. This automation not only improves productivity by speeding up the updating process, but it also reduces the chance of errors in data collection, therefore improving the reliability and precision of dashboard metrics.

The importance of this automation cannot be overstated. By lowering the time required to update the dashboard and limiting the possibility of data conflicts, it allows the firm to access crucial insights practically instantly. With a single refresh operation in Excel, team members and other employees may see the most recent data, allowing for informed decision-making without delay. Using the data updated to the pivot tables, the data is then copied to a table with the records of all the previous weeks, allowing the organization to see the evolution of some of the crucial data. Some of the dashboard's graphics are updated with the data

being transmitted to that archive, while others are updated with tables different from the archive, which will be explained in the following chapters.

In order to improve efficiency and reliability, the organization has attempted to completely automate data and Excel procedures. Despite advancements, total automation remains elusive. As a result, some data integration continues to be done manually. To close this gap, the organization has formed relationships that enable data extraction from a variety of sources. One approach is to extract data from a specific website, which is made possible through a collaborative partnership arrangement. This allows the organization to access relevant information quickly and efficiently, reducing manual intervention.

Additionally, another source of data extraction involves accessing another cube, although one that is currently not automated. Despite this limitation, attempts are being made to simplify the process, with the eventual goal of automatically incorporating this data into the Excel structure. Furthermore, to solve the remaining manual components of data integration, specific data sets are forwarded to different teams inside the organization. These teams are in charge of organizing the data before distributing it to other personnel. While this strategy includes an element of manual labor, it acts as a temporary solution until other automation methods can be deployed.

Final dashboards

WOO

Starting off by the WOO dashboard as this dashboard is longer and more important because WOO is a more recent business, and all the data is more relevant as decisions have a greater impact than in WTF which is a more mature business.

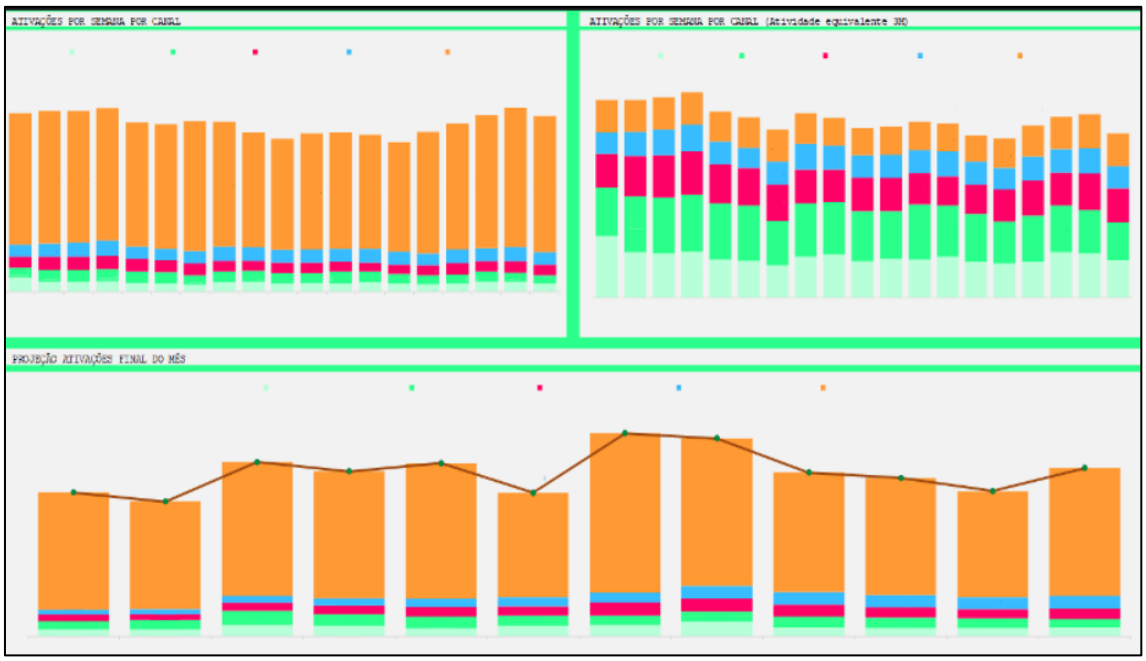

Figure 1 - WOO dashboard - Last trimester view of Gross-Adds and monthly projections

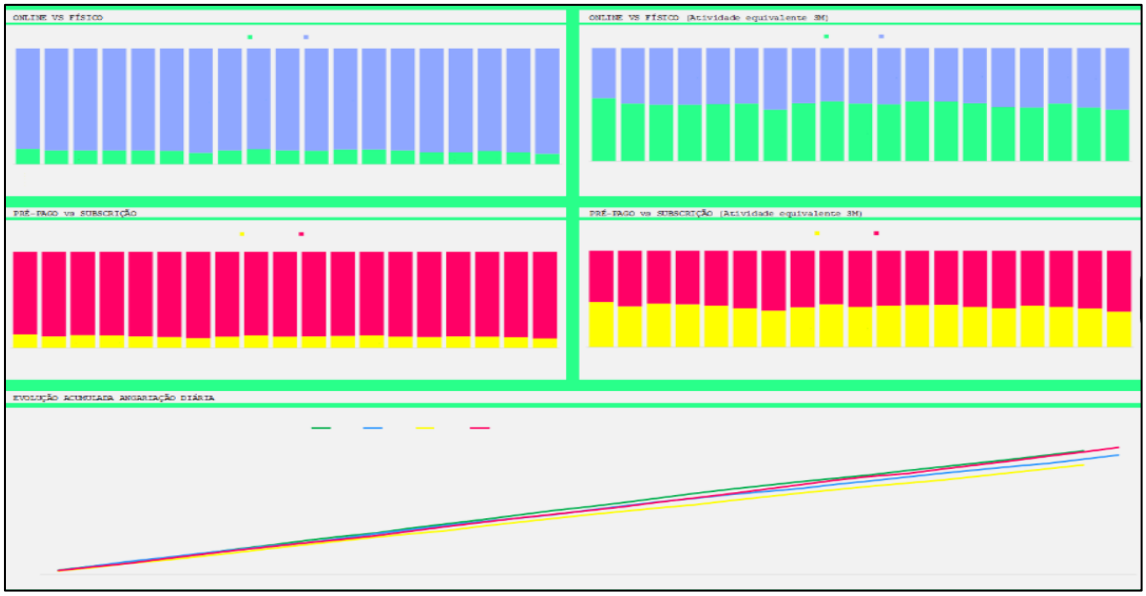

Figure 2 - WOO dashboard - Last quarter view of Online vs Physical, Pre-paid vs subscription Gross-Adds and accumulated monthly Gross-Adds

This first part of the dashboard falls on the automatic data integration mentioned before, and each graphic will be explained. Due to the company's privacy policy, only the title can be shown, hiding the numbers, description of the colors and timeline it refers to.

Starting off by the top two graphics, "Ativações por semana por canal" and "Ativações por semana por canal (Atividade equivalente 3M)". Arguably the most important data in the WOO dashboard as it corresponds to the gross adds per channel. The left one represents the gross adds per channel of sale in a weekly basis and the right one represents the projection of those new clients how many will still be in the company in 3 months' time, these are calculated with percentages different for each channel based on historical data and turnover rates (this is valid for all the graphics that say "Atividade equivalente 3M"). These two are crucial for decision making as different teams are responsible for different channels of sales, in the weekly strategic meetings the whole team discussed about the results, possible justifications of why the numbers are higher or lower and next steps to increase the numbers. The third graphic "Projeção ativações final do mês" is a monthly view of the gross adds with the current month being estimated based on the weekly gross adds of the corresponding month, it is based on the day previous to the presentation (latest data always corresponding to the previous day), so this projection is a rough estimate as some months have holidays and not all days can be considered working days.

Transitioning to the "Online vs Físico" graphic, it shows the proportion of clients who joined the company through online channels versus physical stores. This indicator is crucial for WOO, aligning with its main objective of transitioning to a fully digital model and distinguishing itself from traditional telecom companies. The data presented from this graphic not only highlights the current distribution of clients between online and physical channels but also emphasizes

the strategic importance of prioritizing digital acquisition channels. Furthermore, observations demonstrate that this data reveals that clients acquired online tend to have greater longevity with the company, thereby increasing the overall value derived from online customer relationships.

Moving to the “Pré-pago vs Subscrição”, this graphic compares between "Pré-pago" (prepaid) and "Subscrição" (subscription) within WOO, this analysis is pivotal in understanding customer preferences and consumption patterns. This comparison shows the proportion of customers that choose prepaid services versus subscription-based models. This distinction holds significant implications for WOO in adjusting their service offerings and revenue models to meet diverse customer needs. Prepaid services typically appeal to customers seeking flexibility and control over their usage, allowing them to pay for services upfront and use them as needed. On the other hand, subscription-based models offer customers access to a set of services for a recurring fee, often with added benefits such as discounts or bundled services. Subscriptions models in WOO are more valued as they show to have a longer relationship with the company and in the prepaid model the company lacks information about the client and how to retain the client in the company, in the subscription model the company has the detailed information about the customer and can improve its experience.

Finally, we have the “Evolução acumulada angariação diária”, this is a day-to-day analysis with the accumulated gross adds. This is a key graphic as it shows if a month is doing better or worse than the previous months in the same time span, it allows to adjust and make decision towards the increase of client acquisition to guarantee a positive growth trajectory during the year.

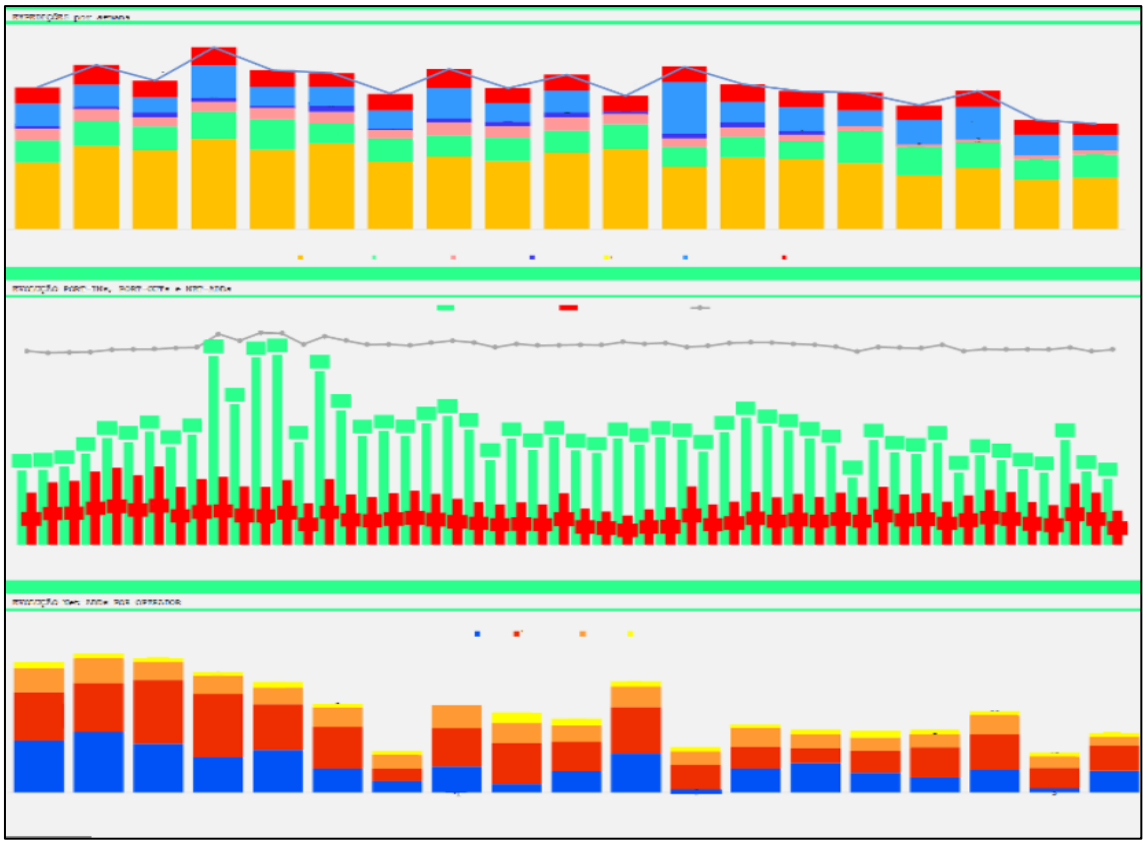

Figure 3 - WOO dashboard - Weekly expeditions and Portabilities Net-Adds

Figure 4 - Weekly Portabilities per operator

Moving on to the manual part of the data, in this part of the dashboard, data had to be copy pasted from different sources as previously mentioned. The first graphic "Expedições por semana" keeps track of the expeditions on a weekly basis considering the SIM cards with different amount of GB offered with different prices, the data presented here is collected from another cube, this one not automated. An Excel sheet was downloaded for every single channel of sale, then a pivot table was created to ensure the numbers of expeditions were correct for each week, and then copy pasted to the Excel with the dashboard in an archive type table to keep track of historical data. This process is critical for ensuring service activation and facilitate customer access to network connectivity. The delivery of SIM cards involves the timely and accurate dispatch of these essential components to customers who have subscribed to WOO services. Whether it's for new activations, upgrades, or replacements, the efficient handling and delivery of SIM cards are key to maintaining customer satisfaction and service continuity. A SIM card, short for Subscriber Identity Module, is a small, removable card that is inserted into mobile devices such as smartphones, tablets, and certain types of routers. It plays as a crucial component in enabling cellular communication and connectivity. The primary function of a SIM card is to securely store information that uniquely identifies a subscriber within a mobile network.

The following graphics from the image are updated via e-mail received from another team as previously mentioned. The email contained an Excel with the number of port-ins, port-outs and net-adds with the description of the company the clients went to or came from. This information was copy pasted just like the previous one to the Excel with the dashboard in an archive type table to keep track of historical data. Starting with the "Evolução Net-adds, Port-Ins e Port-outs" tracks the data of portabilities in WOO, portabilities in the field of telecommunications, refers to the process of transferring a phone number from one mobile network operator to another. This process, known as number

portability, allows customers to keep their current phone numbers after they switch to a different service provider, which can be a significant convenience. Port-ins refer to clients transferring their cell phone number to WOO, Port-outs from WOO to other companies and Net-adds is the number of Port-Ins minus the number of Port-outs. The main objective is to keep the net-adds positive and it was discussed during the weekly meetings with the team responsible, being sometimes difficult to draw conclusions of why the numbers had so much variability.

The next three graphics can be explained simultaneously, referring to "Evolução Net-adds por operador", "Evolução Port-ins por operador" e "Evolução Port-outs por operador" where the data shows the various telecoms companies, firstly showing the net-adds, then port-ins and finally port-outs. The last one represents Port-ins excluding the main channel of sale, to discover the weight of the of this channel in Port-ins, the title is "Rácio Port-ins nas ativações por semana". All the graphics had a weekly vision.

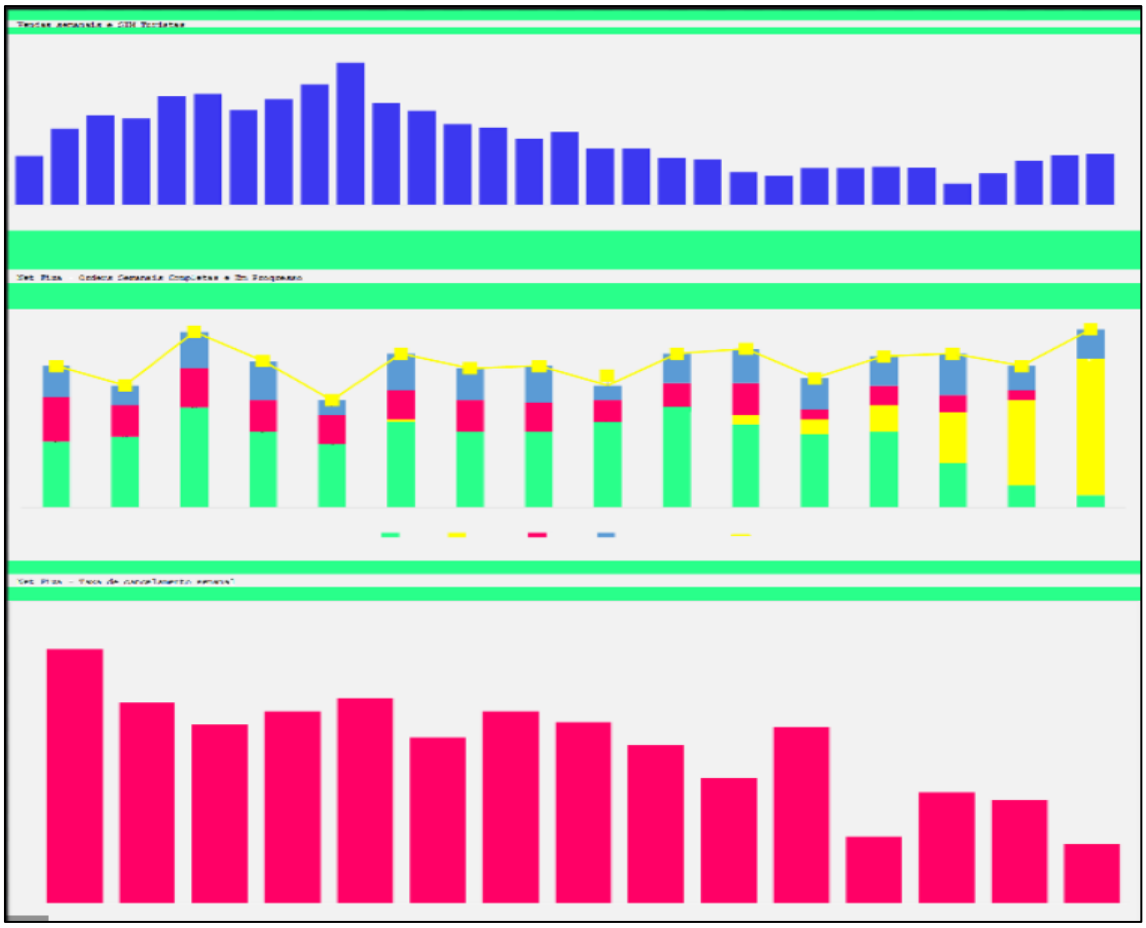

Figure 5 - WOO dashboard - Tourists e-SIM and fixed line Internet

The final part of the dashboard starts with "Vendas acumuladas e-SIM turistas" keeping track of the number of sales of e-SIM for tourists. This data is stored by one of the partnerships the company has, then the data is copy pasted to Excel every week, keeping historical data. For tourists, an eSIM offers a convenient solution for accessing cellular networks while traveling without the need to purchase a physical SIM card or change SIM cards when crossing borders. An eSIM is a virtual SIM card embedded directly into a device, such as a smartphone or tablet, without the need for a physical SIM card slot. With an eSIM, tourists can easily activate cellular service in their device by scanning a QR code or downloading a mobile app provided by the network operator. This

quicker activation process allows travelers to immediately connect to a local network upon arrival in a new country, providing instant access to voice, text, and data services without the problem of purchasing and installing a physical SIM card.

The following graphics “Net fixa – Ordens semanais completas e em progresso” analysis the number of installments of fixe lined internet services in a household, dividing it by confirmed, in progress and cancelled. Thia data was updated automatically by a team to a document, and this document was then emailed to various teams, this data was then copy pasted, keeping historical data. The last graphic “Net Fixa – Taxa de cancelamento semanal” keeps track of the ratio of cancelled/number of requests of the service. This cancelled have a particular distinction as these clients cancelled after making an appointment to get the service installed at home, so this graphic is key information to try and keep below a certain percentage, trying to reduce the number of lost clients. All of these graphics have a weekly view of the data.

WTF

Transitioning to the WTF dashboard offers an easy switch, due to its alignment with existing data integration processes and representation of similar data to the WOO dashboard. This simplifies the updating process significantly, saving time consumption and reducing potential errors. The reliability of the data remains intact, presented in an efficient manner. In this subchapter the comparisons between graphics will be made between the two dashboards so it can be easier understood what type of data the graphics are presenting as well as the data integration behind it.

Figure 6 - WTF dashboard - Last trimester view of Gross-Adds, Online vs Physical and monthly projections

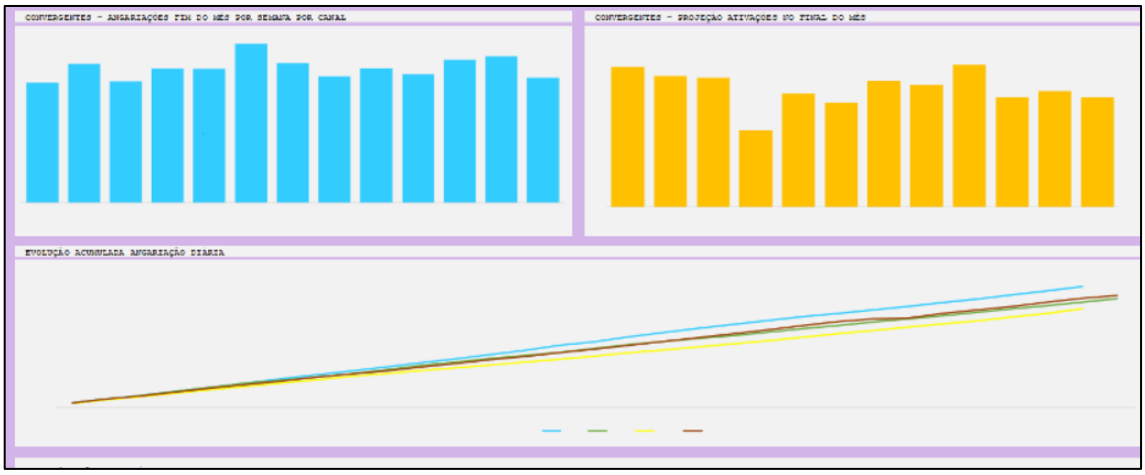

Figure 7 - WTF dashboard - Last trimester view of Converged services Gross-Adds, monthly projections and accumulated monthly Gross-Adds

The initial segment of the dashboard is very similar the corresponding section in the WOO dashboard, benefiting from automated data integration. Comparing the two dashboards, the first graphic titled "Pré-pagos – Angariações ativações semana por canal" aligns with "Ativações por semana por canal," presenting weekly gross adds by sales channel, using the same data integration method. Similarly, "Pré-pagos – Online vs Físico angariações ativações" mirrors "Online vs Físico," displaying gross adds via online or physical channels. "Pré-pagos – Projeção ativações angariações" is equivalent to "Projeção ativações final do mês" providing an estimate of gross adds for the current month, complimented with historical data for month-on-month comparison. Lastly, the graphic "Evolução acumulada angariação diária" shares the same daily data as its WOO counterpart, illustrating daily gross adds and the trajectory for the current month, alongside historical data for trajectory comparison with past months.

One of the main differences between the two dashboards in the automated data integration graphics is the two graphics regarding “Convergentes”, which means converged services. It refers to the integration of different types of communication services, such as voice, data, and video, onto a single network infrastructure. This integration allows users to access various services easily through one platform, often resulting in increased efficiency, flexibility, and convenience. The first graphic regarding converged clients is “Convergentes – Angariações fim do mês por semana por canal” showing the gross-adds on a weekly basis of converged clients”, the second graphic “Convergentes – Projeção ativações no final do mês” display the projection for the end of the current month based on previous days of that same month ((30*number of gross adds in the month)/number of days passed) and show historical data to compare to the previous months.

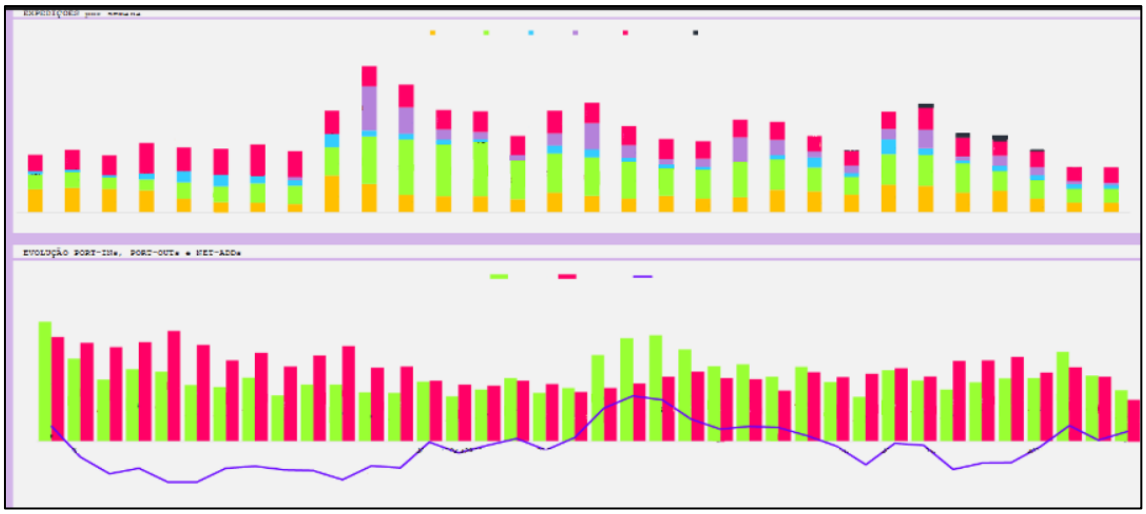

Figure 8 - WTF dashboard - Weekly expeditions and Portabilities Net-Adds

Figure 9 - WTF dashborad - Weekly Portabilities per operator

The final section of the WTF dashboard closely resembles the corresponding section in the WOO dashboard. The opening graphic titled "Expedições por semana,"is similar to the equivalent graphic in WOO, but instead of displaying SIM cards with varying amounts of internet offered and prices, it indicates sales channels. The following four graphics all focus on portability, a concept previously explained. "Evolução Port-Ins, Port-outs e Net-adds" mirrors "Evolução Net-adds, Port-Ins e Port-outs" in WOO, showcasing the portabilities gained, lost, and the net additions, providing a comprehensive overview of business growth or decline. Similarly, "Evolução Net-adds por operador" aligns with its counterpart in WOO, indicating net additions by other telecommunication companies. Lastly, "Evolução Port-ins por operador" and "Evolução port-outs por operador" match those in WOO, illustrating the portabilities gained from and lost to other telecommunications companies.

Remodeling of the dashboards

In this subchapter all the changes made during the internship will be investigated, with the main objectives being to make the dashboard as efficient as possible, but also easy-to-use so that anyone in the company who accesses the dashboard easily understands the data and the graphics displayed.

Starting with efficiency, one of the most significant modifications made during the internship was the update of the graphics. Previously, upgrading the dashboard required extending each row to accommodate new data, resulting in manual updates to each data series displayed in the graphics. For example, updating data for each sales channel. A required altering data series, adjusting cells to reflect the most recent data (for example, from cell A33 to A34), and repeating this step for each element within the graphic. To simplify this process, a more efficient method was implemented. Data was expanded downwards by 100 rows, leaving them blank. Then, using the filter options within the graphic, only the latest week with updated data was added. This strategy simplified the updating process significantly, reducing the need for manual adjustments and enhancing overall efficiency, reducing the time to update the dashboard by around one hour.

In line with the principles offered in the literature, NOS's approach to dashboard design during the internship was founded on the understanding that user interfaces have a significant impact on productivity and efficiency (Few, 2006). The dashboards built were intended to meet a variety of user needs, with a focus on customizable interfaces. Colors such as green, yellow, and red were employed to symbolize acceptable, adequate, and poor performance, respectively, in accordance with established visual mining concepts. One of the

adjustments made to the dashboards were the color shift, the visuals representing gross adds, the green represented gain, and the red showed loss.

During the internship, a few graphics were added and removed based on the needs of the organization and to aid decision-making. The previous images show two new additions to the WOO dashboard. The first, "Net fixa - Ordens semanais completas e em progresso," looked at service installations that were marked as completed, in process, or cancelled. The organization wanted to reduce client attrition by limiting the number of cancellations after scheduling installation dates and meeting deadlines. To collect the necessary data for this research, a second Excel report was created to filter the data obtained via email. This data included client identification, order statuses, and other critical components for identifying customers and tracking installation progress. However, it was difficult to identify clients who cancelled their orders after establishing installation dates. The document automatically updated the status, making it impossible to identify these clients. To fix this, a second Excel sheet was developed, and clients were added weekly using their unique client IDs. This enabled the tracking of clients who moved from "in progress" to "cancelled," showing cancellations after scheduling. This data was then imported to the main Excel containing the dashboards, and a graphic displaying this specific data was generated. The second graphic is just below it and it's the "Net Fixa – Taca de cancelamento semanal", as previously explained it shows the ratio of cancelled/number of orders, these cancelled are the clients who cancelled after setting a date, and this was achieved by simply making a formula that divided cancelled and number of orders and set as percentage.

In addition, a new graphic was added to the WOO dashboard, however it does not appear in the screenshots because it was uploaded during the internship's last week. This chart is similar to the "Rácio Port-ins nas atividades por semana,"

but focuses on the ratio of Port-Ins through digital or physical channels. This innovation enabled the corporation to identify the channel via which clients made their portability requests. To gather this information, another Excel report was created. Data was retrieved from a.txt file and loaded into an Excel file, including all Port-Ins recorded during a given interval. This data was then combined with gross-add files from another source, which included information on via what channel the customers joined the company. A pivot table was developed to facilitate data analysis by matching client IDs from the portabilities file to the gross-add file and extracting the channel using a formula. The data was then copied and pasted into the Excel file containing the dashboard. Finally, the number of port-ins via digital channels was divided by the gross adds via digital channels, and the same for physical channels, producing the appropriate ratio for the company's analysis.

Results discussion

The implementation of the dashboards resulted in considerable improvements in several aspects of the company's operations. One of the most noticeable improvements was a significant boost in efficiency due to improved data integration and update operations. By enhancing the overall efficiency of the dashboards, we saved time and optimized our resources. This productivity improvement enabled users to focus on data analysis and decision-making rather than routine maintenance duties.

Furthermore, the dashboards' user-friendly interfaces played an important part in improving user experience and promoting a better understanding of the data displayed. The use of color-coded images proved especially successful in delivering complex information in a straightforward and intuitive way. This tool allowed users to immediately detect patterns, anomalies, and areas that needed attention, improving their ability to make informed judgments. This insight goes in line on what was stated in the literature review with the findings of Hansoti (2010), who highlighted the importance of intuitive data presentation methods for facilitating decision-making.

The dashboards' versatility also emerged as a significant advantage, allowing for customization based on user preferences and unique company requirements. Decision-makers used this freedom to modify the data to their own requirements, allowing for more targeted analysis and strategic planning. This adaptability aligns with the insights provided by Golfarelli, Rizzi, & Cella (2004), who emphasized the importance of dashboard design in converting data into actionable knowledge.

Decision-makers were able to better manage resources, optimize sales channels, and design client retention strategies thanks to real-time access to vital data insights. Although the implementation process experienced difficulties, such as data integration problems, these issues were effectively overcome by collaborative efforts and problem-solving activities. Moving forward, ongoing refinements and updates to the dashboards will ensure their continued effectiveness in meeting the company's evolving needs and driving sustainable growth, with a greater emphasis on automating processes as this is the future of data integration, reducing time consumed and human errors. These finding Overall, dashboards have shown to be useful tools for improving operational efficiency, promoting data-driven decision-making, and driving company success.

Conclusions

This thesis examines the impact of dashboard implementation on organizational dynamics, with a special emphasis on data integration, visualization, and decision-making. By combining the insights obtained from the introduction, methodology, and findings, numerous major takeaways emerge, each contributing to a comprehensive understanding of the issue.

1. Enhanced Data Integration and Visualization

While full automation of data integration was not the primary goal, significant progress was accomplished in enhancing efficiency and data clarity. Instead of focusing primarily on automation, efforts were directed into improving the dashboard update process, making data more accessible and understandable. Additional graphics were included to meet the identified demands of organizational leaders, offering a clearer perspective of crucial indicators, and aiding informed decision-making. The introduction of color-coded visualizations was important in boosting data interpretation, giving the company's many departments an accessible approach to monitor performance patterns.

2. Influence on Decision-Making Processes

Despite the focus on enhancing data presentation, dashboard implementation continued to shape decision-making processes profoundly. The dashboards provided NOS with real-time access to crucial data insights, allowing them to make confident and precise decisions. Decision-makers acquired significant insights into organizational performance by defining KPIs and metrics, which allowed for optimal resource allocation and strategy optimization. The user-friendly interface promoted a culture of data-driven decision-making throughout the firm.

3. Addressing Challenges and Charting Future Directions

Moving forward, overcoming problems such as data integration complications would require collaborative efforts and problem-solving activities. The future emphasis should be on automation, particularly in data integration and updating procedures, to improve operational efficiency and reduce errors. Continuous refining and upgrades to the dashboards will ensure their continued efficacy in meeting the organization's changing needs and promoting sustainable growth.

4. Implications for Future Research

Future research could investigate how dashboard customization affects user engagement and decision-making outcomes. Integrating sophisticated analytics techniques such as machine learning and predictive modeling could improve dashboard forecasting capabilities. Furthermore, examining the effect of dashboards in establishing a data-driven organizational culture and facilitating cross-functional collaboration represents an interesting route for additional research.

5. Limitations

One limitation of this study is the focus on a single organization, which may limit the generalizability of the findings to other contexts. Additionally, the study's timeframe may not capture long-term effects or changes in organizational dynamics that occur over time.

In conclusion, while the focus was on increasing efficiency and data clarity, future initiatives should highlight automation and its potential benefits. Dashboard installation is a game-changing step toward increasing operational efficiency, promoting data-driven decision-making, and driving long-term success within organizations. Dashboards have the ability to redefine how organizations use data through constant refinement and adaptation, allowing them to handle difficulties and seize opportunities with confidence and agility.

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