UNIVERSIDADE CATÓLICA PORTUGUESA

Business Intelligence to Improve Supply Chain Management

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by

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Abstract

Nowadays, the world is constantly witnessing cutting-edge technological advances, which creates a pressing need for companies to keep up and take advantage of innovative frameworks. Despite all the opportunities these have to upgrade themselves, many still fail to adhere to simple but promising software.

One ground-breaking advancement in technology is Business Intelligence, a crucial investment for Supply Chain Management. Therefore, this dissertation explores how Business Intelligence improves Supply Chain Management through the development of three Power BI dashboards regarding Service Levels, Purchasing and Production. These should accurately represent the data available and smoothly introduce new information. To implement this, SOCORI - Sociedade de Cortiças de Riomeão S.A.'s case study was used, where an internship occurred. This study aids in Supply Chain Management decision-making and improving alignment between all the participants of SOCORI's Supply Chain by designing the referred Power BI dashboards to streamline information and aid in meeting internally predefined objectives.

To assure the dashboards were in line with processes, needs and requirements of users, Action-Research was used to continuously gather feedback and interviews were conducted to have a clearer understanding of how the dashboards contributed to meet the goals set.

Keywords: Business Intelligence, Power BI Dashboard, Supply Chain Management, Supply Chain, Decision-Making

Words: 9999

Resumo

Atualmente, o mundo assiste constantemente a avanços tecnológicos de ponta, criando a necessidade nas empresas de acompanharem e tirarem partido de quadros inovadores. Não obstante todas as oportunidades que têm para se atualizarem, muitas continuam sem aderir a software simples mas promissor.

Um avanço inovador na tecnologia é o *Business Intelligence*, um investimento crucial para o *Supply Chain Management*. Consequentemente, esta dissertação explora como o *Business Intelligence* melhora o *Supply Chain Management* através do desenvolvimento de três *dashboards* Power BI relativos a Níveis de Serviço, Compras e Produção. Estes devem representar corretamente os dados disponíveis e introduzir novas informações harmoniosamente. Para a implementação, foi utilizado o caso de estudo da SOCORI - Sociedade de Cortiças de Riomeão S.A., onde decorreu um estágio. Este estudo auxilia na tomada de decisão no *Supply Chain Management* e na melhoria do alinhamento entre todos os intervenientes da *Supply Chain* da SOCORI, através da conceção dos referidos *dashboards* em Power BI, simplificando a informação e ajudando no cumprimento de objetivos pré-definidos internamente.

Para garantir que os *dashboards* estavam de acordo com os processos, necessidades e requisitos dos utilizadores, foram utilizados o *Action-Research* para recolher continuamente *feedback* e entrevistas para compreender melhor como os *dashboards* contribuíram para atingir os objetivos definidos.

Palavras-chave: Business Intelligence, Power BI Dashboard, Supply Chain Management, Supply Chain, Tomada de Decisão

Palavras: 9999

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First Chapter

1. Introduction

This dissertation's purpose is to investigate how Business Intelligence (BI) helps Supply Chain Management (SCM) by creating a set of dynamic Power BI reports that support decision-making on three Supply Chain (SC) topics – Service Level (SL), Purchasing, and Production. Ultimately, these reports improved alignment between SC interveners and help comprehend the status of each stage of the SC by presenting and analysing relevant information. The dashboards developed support managers' decision-making by measuring customer and production SL and by elevating the Purchasing process. Thus, the proposed research question can be put as:

- How does dashboard design supports the management's decision-making in each of the three SCM subjects, SL, Material Purchasing and Production SL?

To answer this, it was crucial to meticulously study the relationships between data, software in place, and key users, and comprehensively understand SC processes and SCM beyond the theoretical framework defined. Besides, as this study assesses the implementation of BI dashboards and introduces new information, dashboard design was guided by the theoretical research to prevent unsatisfactory DV and the presentation of excessive information that users can't intuitively analyse.

To implement the mentioned steps and test the research question, SOCORI - Sociedade de Cortiças de Riomeão S.A.'s case study, where an internship

occurred, was used. Subsequently, to continuously gather feedback as mentioned, Action-Research was utilised, considering it is based on the cyclic collection of feedback until no additional comment provides fruitful results. Action-Research is particularly useful to introduce new practices into known contexts by generating improvements and knowledge from their implementation and using it to benefit those involved (Somekh, 2006). These continuous improvements enable constant feedback and progressive correction of the mistakes made, perfecting the development of the reports and the results obtained.

Ultimately, it is hoped that this dissertation inspires many other organisations to invest in emerging software like BI tools to leverage from the information they constantly generate. Despite the environment in which this study was carried out, it provides evidence of the value of using BI tools and how their integration delivers rewarding results for decision-making. These findings hold relevance independently of the context they emerge in and, therefore, this study aims to also guide the implementation of BI tools and the steps taken to develop dashboards in contexts beyond SCM.

This dissertation contains five chapters. Chapter 1 presents the state of the art behind SCM, BDA in SCM and BI. Chapter 2 reviews Amorim Cork and SOCORI, introducing the work done. Chapter 3 delves into the methodologies chosen and implementation. Chapter 4 presents the dashboards developed, the formulas for the measures created, a detailed explanation, and the main interviews results. Chapter 5 delivers the main implications of the case study over SOCORI's SCM decision-making. Lastly, the main conclusions, major contributions and recommendations for future work are presented.

Second Chapter

2. Literature Review

The current section, structured into three parts, comprehensively analyses relevant topics to the work developed throughout this dissertation. It should establish a clear framework for the subsequent discussion and lay the foundation for the remainder of this dissertation.

The first subsection aims to thoroughly define SCM and help understand that alignment between SC departments is crucial. The second subsection explores how Big Data Analytics (BDA) impacts SCM by analysing BDA's advantages and weaknesses, bridging BDA's capabilities to SCM processes. The third section delves into BI and its implications for businesses, including a comparison between BI tools and specifically one of the most prominent BI tools, Power BI. This section aims to provide an overview of the many ways in which data can be invaluable to SCM, aiding decision-making and improving the flow of information by deploying BI systems.

2.1. Supply Chain Management

The term "SCM" emerged in 1982 in a Financial Times interview with Keith Oliver, coined as a process that plans, implements and oversees SC operations to efficiently satisfy customer requirements. It encompasses the movement and storage of raw materials, work-in-process inventory, and finished goods from origin to consumer (Aschcroft, 2022). As a relatively new term for a while, SCM

was taken as a synonym of Logistics, but it is not. Cooper et al. (1997) claims the difference resides in the need to integrate SC business operations that go beyond logistics. Product development is the sharpest example, implying marketing actions, R&D, manufacturing and logistics, and finance. Moreover, SCM is built upon the logistics framework, establishes connections, and harmonises operations within the SC, creating a seamless flow between all its participants' processes. Notwithstanding, strengthening relationships by benefiting all parties in the chain poses significant challenges to SCM, such as trade-offs that lead to profitability, mainly when one self-interest must be prioritised for the benefit of the chain (Christopher, 2011).

In a Sloan Management Review regarding effective SCM, Davis (1993) highlights the importance of acknowledging the complete scope of SCM, from supplier to raw materials, factories and warehouses, and demand in a store for a finished product. The author underlines that good supplier management is not enough, nor does it represent good SCM. Although this remains true, huge amounts of data are constantly being collected and stored due to developments in information technology, making it remarkably easy to comprehend SCM (Schoenherr, 2023). These massive volumes of structured and unstructured data that traditional data management techniques are unable to handle and interpret are defined as Big Data (Wiener et al., 2020).

2.2 Big Data Analytics in Supply Chain Management

Big Data can be defined as "the general realm of problems and techniques used for application domains that collect and maintain massive volumes of raw data for domain-specific data analysis" (Najafabadi et al., 2015, p.2). However, lacking

a universally accepted definition, many authors turned to Doug Laney's dimensions to describe it: Volume, Velocity, and Variety (Laney, 2001). Volume stands for the huge amounts of existing data, Velocity implies high-speed processing, and Variety represents the heterogeneity of data. Afterwards, Veracity was added to this reasoning (Schroeck et al., 2012), referencing to data uncertainty, as well as Value (Dijcks, 2011), denoting the creation of value. Additionally, De Mauro et al. (2016) propose a broader definition that adds "analytical methods" to outline the requirements of proper data utilization and "information asset" to emphasise its purpose without restricting to any specific field or application.

The growing interest in Big Data heightened the need for analytics that boost data-driven management. The evolution of data-driven business models hinges on the thorough analysis of valuable information, managed competently with the potential to enhance decision-making and operational efficiency (Acciarini et al., 2023). Effectively incorporating data analytics in management processes accelerates businesses' ability to adjust to technological shifts, make data-driven decisions towards predefined objectives, and eventually stimulate operational and financial performance (Karaboga et al., 2022). Big Data-driven SC use BDA to facilitate data-driven decision-making within its operations. BDA encompasses all technologies, instruments and techniques that exploit digital trace data, enabling knowledge extraction and pattern recognition from large datasets (Karaboga et al., 2022). Through real-time analysis and interpretation of data, BDA improves decision-making and ensures businesses meet customer requirements (Govindan et al., 2018). BDA's relevance in SCM resides in the amount of data SC accumulate, their increasing competitiveness and complexity, and the importance of SC performance evaluation, enabling continuous improvement and success in a new business environment (Jafari et al., 2021; Dubey et al., 2019; Tarafdar & Qrunfleh, 2017).

Besides reduced operational costs and increased customer satisfaction (Sheffi, 2015), BDA enables optimised capacity utilisation, innovative business models, elevated supplier quality, and broader SC visibility (Alsolbi et al., 2023). It allows optimising SC structure and administration by minimising expenses and effectively managing risks (Sheffi, 2015). Moreover, BDA tasks, such as predictive analytics, are beneficial, allowing deeper insights, identifying areas for improvement, and making informed decisions based on a comprehensive understanding of processes (Awwad et al., 2018). Ultimately, BDA's integration with technical and analytical expertise generates valuable knowledge and guides and improves strategic decision-making but, to harness these advantages fully, organisations should invest in skilled workers and ensure appropriate training (Huynh et al., 2023; Teoh et al., 2021).

Operationally, BDA tools enable real-time monitoring capabilities, empowering production managers to increase reliability outcomes and quality standards (Koot et al., 2021). Simultaneously, these tools instigate a shift towards prioritising flexibility and speed improvements, leading to secure planning (Koot et al., 2021). SC planning decisions rely heavily on data and focus on future-oriented asset coordination among SC participants to optimise the delivery of goods, services, and information while balancing supply and demand (Xu & Pero, 2023). Wang et al. (2016) extends BDA's usefulness to strategic and operational SC planning. In strategic SC planning, BDA supports companies with sourcing, SC network design and product design and development (Wang et al., 2016); in operational SC planning, it helps with SC operations decisions, including demand planning, procurement, production, inventory, and logistics (Wang et al., 2016). However, the author adverts that employing BDA entails robust data collection and preparation processes and substantial investments in technological infrastructure. Additionally, there data sources integration is essential to benefit the entire SC and enhance end-to-end visibility and data

accessibility (Li & Liu, 2019). Nevertheless, Maheshwari et al. (2021) believe that BDA can outperform traditional SCM, logistics, and inventory management techniques by enhancing the SC's performance through informed and timely decision-making. Innovation in SCM is essential to maintain a competitive edge (Kunrath et al., 2023) and, although researchers and practitioners are aware of the enormous operations and production data pool, analysing and filtering information relevant to the improvement of Key Performance Indicators (KPI) remains a tough challenge (Dev et al., 2019).

This imperative for improvement using BDA extends beyond acknowledgment, requiring a measured approach. Performance measurement is the process of quantifying efficiency and effectiveness (Neely et al., 1995). Researchers focused more on SC Performance Measurement (SCPM) after improvements in SC performance by defining KPI at each level of the SC and aligning them with overall performance (Reddy et al., 2019). However, Big Data-driven SC imply that, for metrics and KPI to be recorded and observed in real-time, organisations should be using BDA and Big Data-driven SC KPI, with performance managers responding to them right away (Kamble & Gunasekaran, 2020). SCPM unravels the strengths and weaknesses of SC processes by analysing the KPI (Lehyani et al., 2021). Nevertheless, many companies have failed to unlock their SC's full potential due to their frequent inability to establish the performance measures needed for SC integration and maximize effectiveness and efficiency (Gunasekaran et al., 2004).

Notably, BDA has multiple advantages and must be prioritised. Its positive domino effect on an organisation's performance stems from its application in operations leading to improvements throughout the chain up to the customer, besides facilitating performance measurement. By enabling real-time data monitoring and deeper operational insights, BDA guarantees broader SC visibility and rapid reactions to problems. Applying BDA to planning and

purchasing improves SC alignment, allowing improved products and services through better supplier quality, product design, and demand planning. Furthermore, customer experience is easily improved through pattern recognition and knowledge extraction. Nevertheless, besides investing in training and skilled professionals, BDA requires robust data collection techniques and helpful ways to gather and communicate the information. BI is one BDA method of effectively utilising the data that is already available (Niu et al., 2021).

2.3. Business Intelligence

BI is a technology-driven method of data analysis and actionable information delivery (Stedman, 2023). BI systems help organisations link incongruent data sources to a single source, gather and organise data wisely, and provide an interface to create reports that clearly define a plan for better informed business decisions (Khder & Abu-Alsondos, 2021). Notably, there is a convergence between BI and the potentials and problems posed by Big Data. Besides, market analysts, investors, trade experts, and shareholders are closely tracking BI spending, acknowledging its importance in organisational outcomes (Pavan Kumar & Dhinesh Babu, 2019).

The term "Business Intelligence" was first explored and defined by Hans Peter Luhn in 1958, in an IBM Journal of Research and Development's publication, as an automatic and sophisticated system that analyses and processes various documents, creating profiles of interest for different action points in an organisation using the power of computers. Recently, BI became one of the most promising technologies for value creation (Fink et al., 2017). It significantly

supports productive, rapid and improved decisions by gathering knowledge that allows companies to know their customers, improve marketing strategies, implement potential personalisation and detect problems and perspectives in real time (Niu et al., 2021; Yafooz et al., 2020).

BI have been gaining attention in supporting SCM. The fact that SC gather information about details of key components—such as logistics, e-commerce, production planning systems, quality and information management systems, and retail—emphasises this (Maheshwari et al., 2021). Efficiently managing data from all interveners of the logistics process accelerates communication between suppliers, distributors, and customers, creating competitive advantage (Deepu & Ravi, 2021). This helps managers rely on facts, figures and evidence, replacing intuition with fact-based decision-making (Hurbean et al., 2023). Besides, BI systems can accommodate multiple SC theoretical frameworks and apply these in real-life scenarios. The Q-model and P-model for inventory management (or Continuous and Periodic Review Systems, respectively) are one example. The Q-model places an order whenever stock levels reach the reorder point. Contrarily, the P-model defines a periodicity for placing orders (Jacobs & Chase, 2018). By integrating theoretical frameworks, BI guides managers and teams by providing new and advanced tools with reliable information, enhanced accuracy, and improved risk management.

Furthermore, BDA enable factual knowledge from all the data to be further leveraged. In fact, BI tools help detecting occurrences in real-time and automate processes, enhancing acting agility (Park et al., 2017), besides facilitating the creation of KPI and metrics. This helps understand process status and optimise operations, monitoring performance, analysing consumer behaviour, identifying problems, and predicting success (Al-Okaily et al., 2023).

This study puts together a comparison between the most relevant and discussed BI software across literature according to a predefined set of features. This analysis is presented in Table 1.

Feature	**Datapine**	**Klipfolio**	**Power BI**	**Sisense**	**Tableau**	**Zoho Analytics**
Ease of use	+	+	+	+	+	-
Self-service capabilities	+	+	-	-	-	+
Licence costs	-	-	+	-	-	-
Third-party integration	+	+	+	+	+	+
Built-in data connectors	+	+	+	+	+	+
Advanced analytics	+	-	+	+	+	+
Customisation options	+	+	-	-	+	+
AI incorporation	+	-	+	+	+	+
Community support	-	+	+	+	+	+
Big Data handling	+	-	+	+	+	+

Table 1: Comparison of BI tools and their strengths and weaknesses.
Source: tools' official websites and Srivastava et al. (2022).

Additionally, there is a high association between BI, BI tools and data visualization (DV). DV entails creating and utilising interactive graphic elements or visual representations that make data easier to understand in a visual or pictorial format (Shao et al., 2022). BI tools allow the creation of useful and informative reports and dashboards that organisations should share across divisions and business units by to facilitate collaborative decision-making, particularly in areas like the SC (Abu-Alsondos, 2023). Microsoft Power BI stands out as a BI tool by providing BDA services and allowing data from many sources to be imported and transformed to produce dynamic dashboards and reports, showing the data's patterns and hidden information (Jain et al., 2023). Considering the research done and the case to be studied, Power BI is the most suitable to use, besides the fact that is the most used BI software. Hence, section 2.3.1. will be fully dedicated to it, delving deeper into it.

2.3.1. Power BI

Power BI is a unified and adaptable platform for self-service and enterprise BI, as it allows to easily work with extensive data, collaborate and share insights (Microsoft, 2023a). It is the most suitable tool for visualising, reporting, and analysing data and metrics (Singh et al., 2023). Combined with the tools related to Power Query in Excel, it facilitates advanced analyses in addition to key features such as simplicity, flexibility, and wide accessibility (Becker & Gould, 2019). Specifically, Power Query is an Excel add-in and a Power BI tool to connect different data sources, extract data quickly and easily, and simply clean, filter and transform data (Webb, 2014).

Power BI reports are thorough, detailed pages that offer in-depth analysis and insights. By exploring multiple dimensions and providing a comprehensive view of data, these are more advanced compared to dashboards (Van den Broeck,

2023). Power BI dashboards are visual and unified representations of data, enabling users to monitor performance and metrics, and obtain insights immediately (Van den Broeck, 2023). Implementation's guidelines and design rules can be applied to both. According to Few (2006), they should present the information needed to achieve specific objectives, occupy a single computer screen, be used to streamline the monitoring of information, have small, concise, clear, and intuitive visualisation mechanisms, and be personalised, principles to be followed when implementing them. Also, compliance with design rules provides better guidance in defining metrics and building dashboards and helps achieve the desired objectives, and SAP Press (2021) discloses the following:

1. Using appropriate visual elements to show and read the type of data in question;
2. Choosing relevant graphics representative of the scale for comparing data;
3. Clearly illustrating relationships and proportions in relation to the whole;
4. Associating relationships and proportions between the data geographically when necessary;
5. Using graphics to represent relationships between metrics and distributions of values;
6. Creating a consistent and uniform layout in a grid system;
7. Using colour theory appropriately;
8. Contrasting different colours by differentiating between highlights and alerts, and prioritize a neutral colour for graphic elements;
9. Maintaining a uniform design that is coherent with the corporate style and visual standards;
10. Presenting relevant and revealing information that enable users to make decisions.

To access to these dashboards and reports, Power BI Service stands out for its consultation capabilities, working as a cloud-based service and organising projects by workspace. The measures and KPI achieved in dashboards and reports use Data Analysis Expressions (DAX), a formula expression language used in numerous tools, such as Analysis Services, Power BI and Power Pivot (Microsoft, 2023b). Although it is not the most flexible, DAX allows creating new data through several formulas that can be well represented visually (Absent Data, 2021).

Power BI is used in studies in multiple fields. Virani et al. (2023) explores the increasing prevalence of mental health issues and the imperative for effective solutions, employing machine learning algorithms and Power BI for DV, highlighting their applications in mental healthcare. The study emphasises the effectiveness of Power BI in analysing and presenting outcomes, showcasing its capacity to derive valuable insights from diverse datasets. Furthermore, Nickell et al. (2023) introduces the application of data analytics in accounting, specifically using Power BI to identify irregularities in a large dataset of invoices and introducing data analytics in an auditing context. The analysis involves creating an interactive dashboard to present the results. The case has proven effective in fraud auditing and accounting information systems.

The studies presented are two of many that prove Power BI's effectiveness in a context beyond SCM. This dissertation aims to extract all the benefits of using Power BI, but within the SC, so that the tool can support decision-making at SCM level. Using Power BI in this context, which is neither medical nor accounting, is justified by the framework given underlining the amount of data that SC accumulate and the tool's ability to organise all this information and promote clear and conclusive analyses through the development of reports.

Third Chapter

3. Amorim Cork and SOCORI

Founded in 1922, Amorim Cork is Corticeira Amorim's cork stopper business unit and the world's biggest producer, supplier and distributor of cork stoppers. The organisation is strategically present through its subsidiaries in the main wine producing markets. One of its most recent subsidiaries is Établissements Christian Bourrassé S.A., a French group whose acquisition process started 2017 and was finalised in 2022. Bourrassé owns SOCORI and Corpack Bourrassé, operating mainly in France, Spain, Italy and Chile. The group started only buying cork stoppers and afterwards moved on to producing them.

Bourrassé is present in Portugal through SOCORI, established in 1989, and currently exclusively producing cork stoppers. With 300 employees and exporting around 95% of production, in 2023, SOCORI produced 700 million cork stoppers and billing totalled 60 million euros. After the acquisition, SOCORI benefited from economies of scale and a positive impact in billing. Nevertheless, it is undergoing significant change. The migration from the old ERP to SAP is coupled with a need for alignment between departments and all the companies in the group. One of the challenges is the lack of a seamless flow of information as the existing Power BI reports from the Amorim Group do not align with the company's reality, making it difficult to align the logistics chain. Additionally, SOCORI's commitment to deliver higher quality products implies charging higher prices, which not all customers are willing to accept. Moreover, given the global circumstances of inflation and its notable impact on organisations, SOCORI's practices, budget, and initiatives for 2024 must account for such

factors. All this creates a pressing need to track performance and improve management practices, workflow, and the flow of information, ultimately reflecting the quality of product and service.

During this case study, BI will be used to tackle SOCORI's areas with more room for improvement and in deep need of information. Subsequently, the reports developed should address SOCORI's particularities. The company's data model is built upon SAP and MES databases, which in turn are stored in OLAP cubes. As previously mentioned, the main objective is to develop dynamic Power BI reports on the mentioned databases. These reports should make it possible to analyse, understand and make decisions on issues related to SOCORI's SC. Accordingly, three reports were developed: Service Levels, Purchasing and Production. To achieve the desired objectives, the following steps were taken first:

1. Analyse and understand data models carefully, so that they lead to credible results, using SAP and MES SQL databases;
2. Produce intuitive reports and dashboards using Excel and Power BI that are quickly and easily understood by end-users, built upon reliable information;
3. Diagnose the main impediments to the development of operations and gather feedback on the reports;
4. Draw detailed conclusions from the results obtained to increase the visibility and subsequently monitor SC in real time;
5. Progressively improve reports to better serve the needs of end-users (Action-Research - section 3.2.).

The main purpose of developing the reports is to provide the information necessary for successful management and to improve alignment between all the teams involved in the SC. The SL report concerns the introduction and monitoring of the SL KPI from the perspective of the customer, dispatch, and

packaging. The Purchasing report eases the process of purchasing the chemical products needed for production, from the purchase request until placing the order. Finally, the Production report introduces the Production SL metric to measure compliance with the weekly plan and simplifies DV. The reports should introduce the information in an organised and clear manner, so that all users can intuitively understand.

The methodology for these reports will be described in the following section. Also, a more detailed explanation of the assumptions and important information behind the development of the reports, the measures and visuals created and how these help meet the objectives previously defined will be explained in Results.

Fourth Chapter

4. Methodology

Keeping the research question initially defined and the objectives predefined for the study in mind, the following methodologies will be used: Case Study, Action-Research, and Interviews. The following subsections develop each of these.

4.1. Case Study

According to Yin (2014, p.55), a case study "investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not be clearly evident". The author also defends that case studies stand out from experimental studies due to its investigation happening within a real-world context. This allows capturing the complexity of the environment in which the phenomenon takes place (Yin, 2014). Furthermore, Yin (2014) distinguishes precision, process, and practicality as essential properties of case study research, implying a structured and sequential design motivated by empirical application.

Employing a case study methodology to study how BI improves SCM evaluates how the theory applies in a real business context. It will also make it possible to understand how theoretical frameworks apply to the reality of building Power BI reports and all the steps needed to ensure their quality. Despite potential challenges in applying theory to real-life scenarios, this

methodology enables the development of the reports, always considering good practices and ensuring access to relevant data. This case study was presented in the previous section.

4.2. Action-Research

The methodology chosen to carry out this case study considers that it involves the implementation of new software, which brings something new to the company. Therefore, the action-research methodology enables continuous monitoring the effectiveness of the reports created and customise them as much as possible. Furthermore, the reports aim to accomplish the above-mentioned goals.

The action-research process is useful to introduce new practices into known contexts by generating improvements and knowledge from its implementation and using it to benefit those involved (Somekh, 2006). According to Susman & Evered (1978), action research is a five-stage cyclical process. It requires the establishment of a research environment and proceeds to iterate the five stages: diagnostic, action-planning, action-taking, evaluation, specifying learning. In the first stage, diagnostic, the primary problems preventing the company from changing are identified, developing hypotheses about the nature of the organisation and its problem domain. The second stage, action-planning, is guided by the framework established and specifies the actions to be taken to solve the problems detected in the prior stage. The target and approach to change are defined in this stage. The third stage, action-taking, implements the planned action. The fourth stage consists of researchers and practitioners evaluating the outcomes, confirming or not the theoretical consequences of the planned actions.

If these did not successfully change the environment, a new framework is developed for the next iteration of the cycle. The fifth stage, specifying learning, although the last, is usually an ongoing process. This process ends when the cycle stops bringing relevant changes and no further learning unfolds.

Figure 1 compares the theoretical cycle of action-research (diagram on the left-side) with the one carried out during this internship (diagram on the right-side).

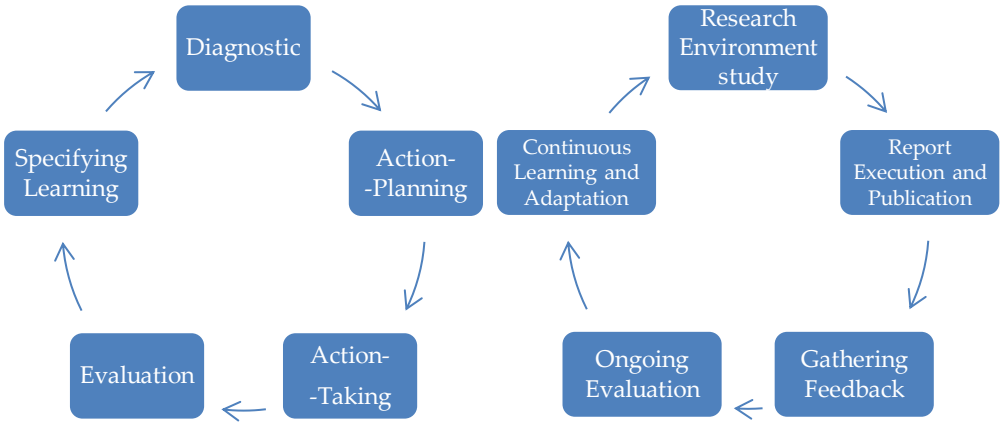

Figure 1: Theoretical Action-Research Cycle vs SOCORI's Case Study Action-Research Cycle

The Action-Research methodology was applied in the internship when developing the three reports – SL, Purchasing and Production. The first stage involved assessing the research environment, diagnosing the company's problems, familiarising with the processes and metrics, identifying required missing information, and building comprehensive knowledge of the company. This helped identify which areas of SOCORI's operations represented the bulk of the problem. The second stage was Report Execution and Publication: a first report was executed and subsequently published on Power BI Service. For the development of each report were followed the implementation's guidelines and design rules outlined by Few (2006) and the choice and layout of the visuals specified by SAP Press (2021), defined in subsection 1.3.1 of the Literature Review. The previous stage provoked a feedback loop and the progression to the following stage – Gathering Feedback. As end-users started consulting the

report, it was possible to sense the lack or abundance of information and suggestions were collected. Subsequently, such feedback was evaluated and its feasibility studied – the Ongoing Evaluation stage. This allows a "tunnel vision" towards the objectives of the case study, optimising the personalisation of the reports. Advancing to the Continuous Learning and Adaptation stage, once the usefulness and success of the changes made to the reports has been confirmed, the process ends.

As the use of the reports increases and new necessities come up, this cycle ends up having more iterations. Also, the final stage took the form of continuous feedback through informal sessions and weekly team meetings where ongoing projects were discussed, and interviews. Comments involved missing information, changing DV and, consequently, the actions to be taken additionally to the reports, which could introduce more information that needed to be covered.

4.3. Interviews

Interviews with the reports' users are the final phase of this case study. Doing this allows to evaluate the success of the reports and understand how these fulfilled the objectives initially set.

Busetto et al. (2020) defines interviews as a casual discussion with a goal, a viewpoint exchange to learn about a person's subjective experiences, opinions, and motives, not facts or behaviour. Interviews can be unstructured, structured, and semi-structured (Alvesson, 2003). The first are informal and open-ended, so the questions are not defined in advance (Qu & Dumay, 2011). The second are rigid interviews where pre-established questions have limited response

categories (Qu & Dumay, 2011). The latter are the most common and highly flexible, enabling the interviewer to adjust the style, tempo, and sequence of questions to elicit comprehensive answers (Qu & Dumay, 2011). Accordingly, since all three reports have few and different end-users for each report, interviews were the chosen qualitative research method. Semi-structured interviews were used to obtain broader results, and some unplanned questions came up as each interview progressed. This choice stems from the need to gather the maximum information while giving the interviewees room to indicate other important aspects about the reports.

The interviews guides were written following the studies aforementioned, Qu & Dumay (2011) and Alvesson (2003), and that of Knott et al. (2022), and are available in Appendix D alongside with the transcripts. The purposive sampling method was used to select the interviewees, and those who were known to use the reports were selected, ensuring a representative sample. These interviews should gather detailed feedback from users regarding their experience with the reports, including any challenges faced, suggestions for improvements and general satisfaction with functionality and usefulness. The guides were developed according to the report and the interviewee's role to meet the objectives of the evaluation: usefulness, satisfaction and improvements observed. Ultimately, suggestions for improvement should serve as the basis for future iterations of the reports, ensuring their continued relevance and effectiveness.

Fifth Chapter

5. Results

This section presents the reports built throughout this case study, the measures and tables created to support an effective and personalised execution, and a summary of the final feedback gathered through interviews.

As mentioned above, three reports were produced. The SL report follows-up on the SL KPI, which was not a priority for SOCORI. It will be explored below in subsection 5.1. The Purchasing report simplifies the purchasing process of chemicals and its development will be detailed in subsection 5.2. Lastly, the Production Report focus on the cork stopper moulding process and introduces a new KPI: Production SL. Subsection 5.3. will delve into this. It is important to note that only the SL report is in English and reaches a more global audience, while the others are in Portuguese.

Since this case study aims to implement BI to support SCM, the reports developed analyse the SL, the Purchasing process, the Production SL as these areas that represented the bulk of the problem and, therefore, those that would have the greatest impact once resolved.

5.1. Service Level Report

As mentioned before, this case study aims to promote informed decision-making, enable access to and track KPI for work-in-progress monitoring through BI, ultimately improving alignment between the various participants of the SC.

Thus, this report was organised to analyse the stages from order placement to dispatch and delivery, besides including an overview of daily quantities in stock, packed and dispatched and billing amount. There was already a SL report available tailored to Amorim Cork's headquarters, providing a view of all the industrial units. Contrarily, this SL report is tailored to SOCORI.

SL has several assumptions to it. Firstly, it can be analysed from three different perspectives: Response Times, SL and Time to Market. SL splits into compliance with the date requested by the customer (SL), compliance with the planned delivery date (Planned to Ship) and compliance with the planned date for last packaging of each sales order (SO)/item (Planned to Pack). Since SOCORI works on a Make-to-Order basis, special attention has been paid to Planned to Pack, the main SL measure, which it evaluates the teams' compliance with the planned date for the last packaging.

Furthermore, SOCORI often sends stock orders to the headquarters of Bourrassé. Since these are not determinant for SL, they were excluded using a page-level filter. Nevertheless, throughout the action-research cycle, it slowly became appealing to start looking at these orders' SL and, consequently, to publish a Stock Orders SL report on Power BI Service. This report equals the one explained in this dissertation but with the referred filter to only include stock orders, so it will not be included.

The report has five pages – *Response Times, Service Levels, Time to Market, Orders Evolution,* and *Assumptions and Data Updates* – and uses SAP cubes O2C and P2F, imported to Power BI through Azure Analysis Services. All the pages complement each other and the analysis, but they have very similar visuals. Therefore, only *Service Levels* will be detailed in this section as it offers the most interesting and important results and complex DV, while the remaining of the dashboard is described in Appendix A.

All pages contain buttons that facilitate the navigation on the report (Icon 1, Figure 2), for which bookmarks were created. The "i" button leads to *Assumptions and Data Updates*. All pages can be filtered by department using this slicer (Icon 2, Figure 2), made possible by assigning a department to each type of cork stopper in a table - Agglomerates, Technical, and Naturals.

Figure 2: Page Service Levels of the Service Level Report.

This main page delves into a deeper analysis of the KPI. The KPI visuals (Icon 3, Figure 2) show the SL metrics in the workflow's order. SL uses the date that the client asks for delivery, the first date proposed. Next, Planned to Ship uses the date the planning team gives the client as the possible date for delivery. Lastly, Planned to Pack uses the planned date for the end of production or shipping. As the target for these, the measures for all KPI's last periods (LP) (Table 2) were created to set a benchmark.

The line chart (Icon 4, Figure 2) is part of the bookmark selected "Service Level", evidenced by the dark blue background. For each metric's line chart (SL, Planned to Ship, and Planned to Pack) a bookmark was created to show their

evolution. These are accessed through the buttons below (Icon 5, Figure 2), introducing interactivity to the dashboard: by clicking on the buttons this Evolution chart and the Clustered bar chart (Icon 6, Figure 2) adapt to the KPI selected by the user, also analysing by material hierarchy. By using the drill down buttons on the right upper corner of Figure 3, the user can navigate through the material's hierarchies, being the department the default one. As these KPI were not being tracked before and new to most, this page contains an explanation of each metric (Icon 7, Figure 2).

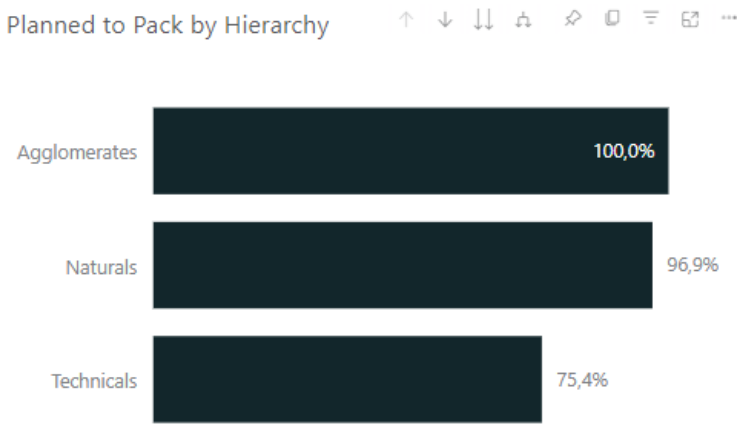

Figure 3: Metrics by Hierarchy with drill down buttons.

Measure's Name	**Formula**
Service Level LP	`CALCULATE([% Nível de Serviço], SAMEPERIODLASTYEAR('Data de Saida de Mercadoria Real'[Data de Saida de Mercadoria Real]))`
Planned to Ship LP	`CALCULATE([% Cumprimento Data Planeada], SAMEPERIODLASTYEAR('Data de Saida de Mercadoria Real'[Data de Saida de Mercadoria Real]))`
Planned to Pack LP	`CALCULATE([% Cumprimento Data do Último Embalamento], SAMEPERIODLASTYEAR('Data de Saida de Mercadoria Real'[Data de Saida de Mercadoria Real]))`

Table 2: DAX formulas for Service Levels of the Service Level Report.

The table summarises information by client (Business Partner), number of SO items, SL, Planned to Ship, and Planned to Pack (Icon 8, Figure 2). It details each

SO information easily through the "+" button in the Business Partner column. The arrow in the corner leads to the *Service Levels Metrics* page (Figure 10 in Appendix A), complementing the analysis.

This page can also be filtered by day, month and year by using these slicers (Icon 9, Figure 2), useful to have a more granular analysis, checking seasonal patterns, trends and the evolution of metrics.

Using bookmarks and buttons to access more information allows including much more data in one single page while keeping it organised and easy to read, fostering a complete analysis. This contributes to this report's greatest contribution: as a reporting tool it introduces new and clean information, highlights SOCORI's weaknesses and promotes prompt action and decision-making.

5.2. Purchasing Report

As mentioned before, the Purchasing report seeks to upgrade the purchasing process, characterised by purchase requests when inventory is close to a stockout and order quantities out of sync with consumption, leading to stock surpluses. This majorly impacts production and consequently the fulfilment of orders. Besides, purchase requisitions are not filled equally by all members of the production teams. So, this report works like an MRP, i.e., a system that specifies consumption, orders to be received, supplier lead times and a forecast of the quantities required, addressing all the referred issues.

The report has five pages: *Evolução Compras, Stock e Consumo, Revisão Periódica, Revisão Contínua* and *Pressupostos e Atualização dos* Dados. The main pages are those that make it work like an MRP – *Revisão Periódica* and *Revisão Contínua*

(translating to Periodic Review and Continuous Review, respectively) – so the others are detailed in Appendix B.

These pages follow inventory management theory, P-model and Q-model (Periodic and Continuous Review Systems, respectively), the difference between them. Both pages can be filtered by Department and Supplier (Icon 2 and 3 respectively, Figures 4 and 5). The card (Icon 4, Figures 4 and 5) shows that the current month's data is in display. The Periodic Review page (Figure 4) includes materials bought and used in larger quantities, so it's reasonable to define a purchase periodicity, weekly in this case. On the Continuous Review page (Figure 5), the materials were filtered to those consumed and bought in small quantities or under specific circumstances.

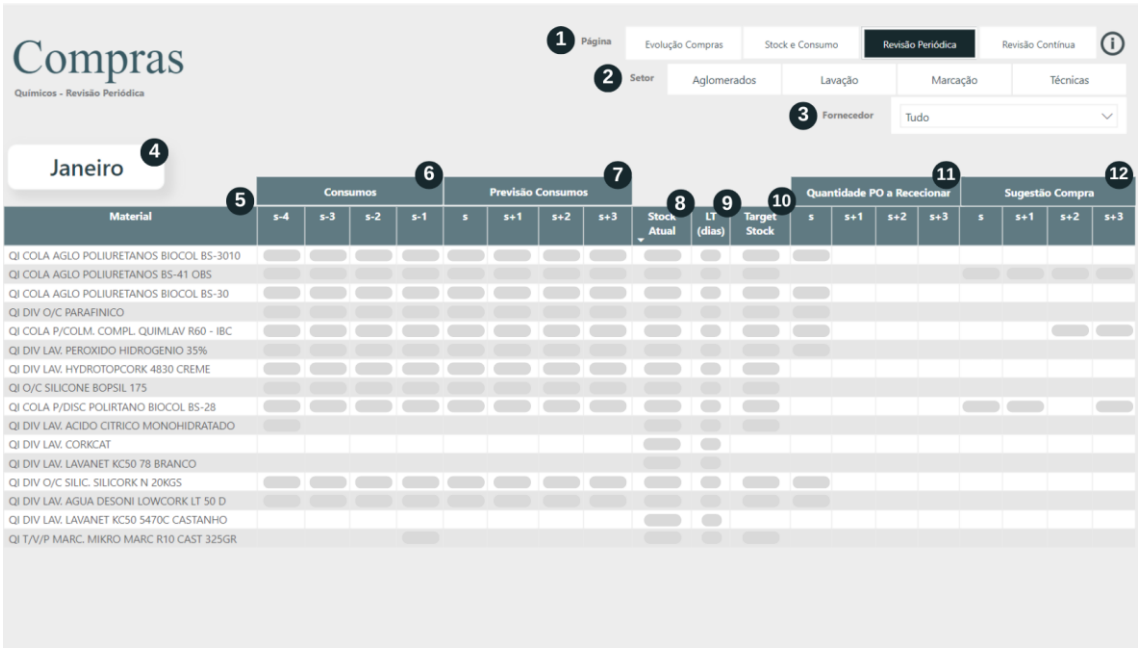

Figure 4: Page *Revisão Periódica* of the Purchasing Report.

Both pages contain a table visual to address: material (Icon 5, Figures 4 and 5), consumption over each of the past four weeks (Icon 6, Figures 4 and 5), forecast consumption for the next four weeks, *s* being the current week (Icon 7, Figures 4 and 5), stock level (Icon 8, Figures 4 and 5), lead time (Icon 9, Figures 4 and 5),

target stock (Icon 10, Figure 4) or reorder point (Icon 10, Figure 5), quantities of orders to be received each week (Icon 11, Figures 4 and 5) and, finally, the purchase suggestion for the following four weeks (Icon 12, Figures 4 and 5). For the target stock formula, stock level was ignored given the errors discovered in system.

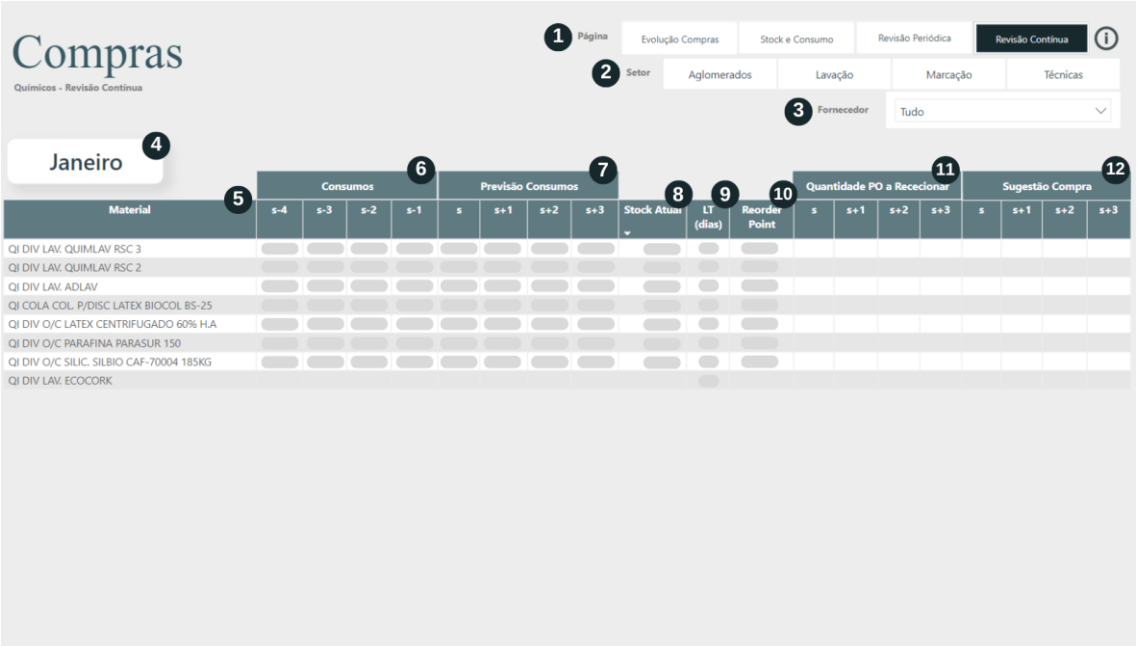

Figure 5: Page *Revisão Contínua* of the Purchasing Report.

Since the materials considered for Continuous Review (Figure 5) are only bought when the current stock reaches the reorder point, the need to make another purchase is evidenced through conditional formatting in the *Stock Atual* column: when Reorder Point Alert reaches zero or lower, a red icon appears to the left of the value. Additionally, the purchase suggestion for the current week s includes the lead time in the formula. For the remaining weeks there was no need, since lead times were short and there was no risk of the order not being delivered when needed.

To build this report, a table was manually built in Excel summarising the main chemicals, department, supplier, lead time, type of review system and the order multiple, which was considered in the purchase suggestions. Table 5 contains the formulas for the measures created, using the weeks whose formulas differed as an example. The full table is in Appendix B. Although all necessary measures were created, it was necessary to rewrite these as variables in the formulas for some measures to optimise performance. For stock level and consumption two measures were created, so that the needed filters were applied within the formula, keeping the work cleaner and more organised.

Measure's Name	**Formula**
Stock Level	`CALCULATE('Stocks - Movimentos'[Existências - Quantidade Base], FILTER('Material 2', 'Material 2'[Material PT] IN VALUES('Materiais Principais'[Material])))`
Consumption	`- CALCULATE('Stocks - Movimentos'[Movimentos - Quantidade Base], FILTER('Data do Movimento', 'Data do Movimento'[Data do Movimento] <= TODAY()), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904")`
Consumption s-1	`VAR consumo = - CALCULATE('Stocks - Movimentos'[Movimentos - Quantidade Base], 'Data do Movimento'[Semana do Ano Data do Movimento] = WEEKNUM(TODAY() - 7), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904",YEAR('Data do Movimento'[Data do Movimento]) = YEAR(TODAY()-7)))` `RETURN IF(consumo = BLANK(), 0, consumo)`

Consumption s+1	`VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]}`
	`VAR Minimo = MINX(Lista, [Value])`
	`VAR Maximo = MAXX(Lista, [Value])`
	`RETURN DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4] - Minimo - Maximo, 10, 0) * [Dias Uteis s+1]`

Target Stock	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5 VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2) VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4) VAR DT = LeadTime + 5 VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3) VAR DesvioPadrao = SQRT(Variancia * DT) VAR StockSeguranca = 1.65 * DesvioPadrao RETURN ConsumoMedioSemanal + StockSeguranca
Reorder Point	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5 VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2) VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4) VAR DT = LeadTime + 5 VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3) VAR DesvioPadrao = SQRT(Variancia * DT) VAR StockSeguranca = 1.65 * DesvioPadrao RETURN ConsumoMedioSemanal + StockSeguranca
Reorder Point s	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5 VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2) VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4) VAR DT = LeadTime + 5 VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3) VAR DesvioPadrao = SQRT(Variancia * DT) VAR StockSeguranca = 1.65 * DesvioPadrao RETURN ConsumoMedioSemanal*LeadTime + StockSeguranca
Reorder Point Alert	[Existências - Quantidade Base - Old] - [Reorder Point]

Quantity of Orders to be received s+1	`CALCULATE([Quantidade Pedido de Compra] - [Quantidade de Entrada de Mercadorias], 'Pedido de Compra'[Flag Linha Eliminada (Status)] <> "Linha Eliminada", FILTER('Pedido de Compra', YEAR('Pedido de Compra'[Data Remessa Pedido de Compra]) = YEAR(TODAY()+7) && WEEKNUM('Pedido de Compra'[Data Remessa Pedido de Compra], 21) = WEEKNUM(TODAY()+7)))`
Stock Level Forecast s+1	`[Existências - Quantidade Base - Old] + [Quantidade em Aberto s] + [Sugestão Compra s] - [Consumo s]`
Stock Level Forecast s+2	`[Previsão Stock s+1] - [Consumo s+1] + [Sugestão Compra s+1] + [Quantidade em Aberto s+2]`
Purchase Suggestion s+1 (Periodic Review)	`MROUND(IF([Consumo s+1] <> 0 && ([Target Stock] - [Previsão Stock s+1] - [Quantidade em Aberto s+1]) > 0, [Target Stock] - [Previsão Stock s+1] - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
Purchase Suggestion s (Continuous Review)	`MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base]- [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
Purchase Suggestion s+1 (Continuous Review)	`VAR SugS = MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda])) VAR PrevisaoStockS1 = [Existências - Quantidade Base] + [Quantidade em Aberto s] + SugS - [Consumo s] RETURN MROUND(IF([Consumo s+1] <> 0 && ([Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1]) > 0, [Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Table 3: DAX formulas for *Revisão Periódica* and *Revisão Contínua* of Purchasing Report.

Besides fulfilling its purpose, the Purchasing Report highlighted SOCORI's problems with incongruent consumption levels between machine and system and consequent incorrect stock level. This emphasises the importance of underlying data quality, which must be addressed to ensure accuracy, besides improving SC visibility. Moreover, this report works the most as a work tool by presenting important information and providing the team with action by suggesting an order for each week.

5.3. Production

The Production Report creates the Production SL KPI, its main purpose, enabling an analysis at all levels of what an order is for SOCORI - production in machine *x*, material *y*, week *z*. The report assesses the team's ability to reach pre-defined targets, dependent on machine capacity, through simply comparing targets *vs* actual production, provides a comprehensive view of production performance. It refers to the moulding phase in the production of cork stoppers, underlining the significance of this report, as one delay or fault here can lead to disruptions further in production. While this was being done on an Excel file, the analysis was superficial and this report complements it.

The three pages – *Nível de Serviço Produção, Produção,* and *Pressupostos e Atualização dos Dados* – are equally relevant to meet the report's objectives. Nevertheless, only *Nível de Serviço da Produção* (Production SL) will be detailed in this section, while others are in Appendix C. This report uses MES cube data and a Sharepoint Folder, created to ease the updating of the report, since weekly production plans are defined every month (left-hand side of Figure 6) and needed to be imported. To properly display it in Power BI, Power Query's feature *Unpivot Columns* was used on each week. The final table is on the right side of Figure 6.

	A	B	C	D	E	F	G
1	Material	Máquina	202401	202402	202403	202404	202405
2	CRISTAL	1	0	0	0	0	0
3	DELTA	1					
4	SPI	1	0	0	0	0	0
5	FUSION 44	1	0	0	0	0	0
6	FUSION 44 PLUS	1	0	0	0	0	0
7	SIGMA	1	0	0	0	0	0
8	NANO/DXL	1	0	0	0	0	0
9	FUSION 44	2		0			
10	FUSION 44 PLUS	2	0		0	0	0
11	NANO/DXL	2	0	0	0	0	0
12	CRISTAL	4	0	0	0	0	0
13	DELTA	4					
14	SPI	4	0	0	0	0	0

Material	Máquina	Yearweek	Objetivo
CRISTAL	1	202401	
CRISTAL	1	202402	
CRISTAL	1	202403	
CRISTAL	1	202404	
CRISTAL	1	202405	
SPI	1	202401	
SPI	1	202402	
SPI	1	202403	
SPI	1	202404	
SPI	1	202405	

Figure 6: Sharepoint Folder Excel table for Production Plan and Power BI after Power Query.

Figure 7: Page *Nível de Serviço Produção* of the Production Report.

This page contains buttons to navigate through the different pages (Icon 1, Figure 7), a group slicer (Icon 2, Figure 7) that filters data by group of analysis, the time slicer (Icon 2, Figure 7) that allows the users to select one or multiple weeks, and a machine slicer (Icon 3, Figure 7).

In the four KPI visuals there is the current week (Icon 5, Figure 7) as this report works on a weekly basis. Then, accumulated production (Icon 6, Figure 7) implied creating the actual and last month's measures. The remaining two KPI visuals are weekly Production SL (Icon 7, Figure 7) and accumulated (Icon 8, Figure 7). The measures needed to do this were created and the target value for Production SL is a single cell table with the predefined target (80%). The line chart shows the weekly evolution of the KPI (Icon 9, Figure 7). The decomposition tree visual (Icon 10, Figure 7) adds interaction to the report and allows to check the main drivers of the KPI's values.

To formulate the Production SL KPI, firstly, a measure was created for the DAX formula that works on the Production page (Appendix C) – *Production Service Level (Table)* - and then the *Production Service Level (Overall)* measure was

created to use in visuals that don't give context like the table on the page mentioned. The need to create two measures comes after trying to build the KPI under just one, for example by creating variables, which never followed the idea needed (what is an order for SOCORI, mentioned before).

The measures and columns mentioned and others used to support the execution of the report can be found in Table 4.

Setting production targets helps production teams to work towards a benchmark, easing performance monitoring. Additionally, rigorous analysing information by week, machine and material allows to closely check the impediments to achieving those targets. For SOCORI, this is particularly important, given that the company closely monitors the Planned to Pack indicator: by bringing this new KPI into the analysis, teams can go further and analyse possible setbacks to the compliance with planned dates.

Measure/Column's Name	**Formula**
Production Service Level (Table)	`Cumprimento Tabela = IF(SUMX('Objetivo/Material', 'Objetivo/Material'[Objetivo]) < [Quantidade Transaction] && SUMX('Objetivo/Material', 'Objetivo/Material'[Objetivo]) <> 0, 1, IF(SUMX('Objetivo/Material', 'Objetivo/Material'[Objetivo]) = 0, BLANK(), CALCULATE(DIVIDE([Quantidade Transaction], SUMX('Objetivo/Material', 'Objetivo/Material'[Objetivo])), 'Tab Calendário'[Yearweek] = SELECTEDVALUE('Objetivo/Material'[Yearweek]), FILTER(dimDate, WEEKNUM(dimDate[Date]) <= WEEKNUM(TODAY())))))`
Production Service Level (Overall)	`CALCULATE(DIVIDE(SUMX('Objetivo/Material', [Cumprimento Tabela]), COUNTROWS(FILTER('Objetivo/Material', 'Objetivo/Material'[Objetivo] > 0))),FILTER(dimDate, WEEKNUM('dimDate'[Date]) <= WEEKNUM(TODAY())))`
Weekly Production Service Level	`CALCULATE([Cumprimento Overall], FILTER(ALL('Objetivo/Material'[Week nr Related]), 'Objetivo/Material'[Week nr Related]=WEEKNUM(TODAY())))`

Monthly Production	`CALCULATE([Sum Quantity (<>0)], FILTER(dimMaterial, dimMaterial[MaterialName] IN VALUES(Material[Descrição Material])), FILTER(dimDate, WEEKNUM(dimDate[Date]) IN VALUES('Objetivo/Material'[Week nr Related]) && YEAR(dimDate[Date]) IN VALUES('Objetivo/Material'[Year Related])), dimTransactionType[TransactionTypeGroup] = "Produções") / 1000`
Monthly Production LM	`CALCULATE([Sum Quantity (<>0)], FILTER(dimMaterial, dimMaterial[MaterialName] IN VALUES(Material[Descrição Material])), dimTransactionType[TransactionTypeGroup] = "Produções", FILTER(ALL(dimDate), MONTH(dimDate[Date]) = MONTH(EOMONTH(TODAY(), -1)) && dimDate[Year] = YEAR(EOMONTH(TODAY(), -1)))) / 1000`
Transaction Quantity	`DIVIDE(CALCULATE(IF(ISBLANK(CALCULATE([Sum Quantity (<>0)], USERELATIONSHIP('Tab Calendário'[Yearweek]))) || CALCULATE([Sum Quantity (<>0)], USERELATIONSHIP('Tab Calendário'[Yearweek], 'Objetivo/Material'[Yearweek])) = 0, 0, [Sum Quantity (<>0)]), USERELATIONSHIP('Tab Calendário'[Yearweek], 'Objetivo/Material'[Yearweek])), 1000)`
Week year related	`CALCULATE(LOOKUPVALUE('Tab Calendário'[Yearweek ], 'Tab Calendário'[Yearweek ],SELECTEDVALUE('Objetivo/Material'[Yearweek])))`
Year Related	`CALCULATE(LOOKUPVALUE('Tab Calendário'[Year], 'Tab Calendário'[Yearweek ], SELECTEDVALUE('Objetivo/Material'[Week year related])))`
Week Nr Related	`CALCULATE(LOOKUPVALUE('Tab Calendário'[Week Number], 'Tab Calendário'[Yearweek ], SELECTEDVALUE('Objetivo/Material'[Week year related])))`
Week Name	`"Semana " & 'Objetivo/Material'[Week nr Related]`

Table 4: DAX formulas Níveis de Serviço Produção of the Production report.

5.4. Interviews

Interviews were conducted to gather final feedback and obtain an enhanced outlook of what the reports provided to each user. Consequently, the interview guide was tailored to the roles of the interviewees as these imply different priorities and needs. The interviewees were chosen according to their use of the reports to gather information from those whose work had been influenced in some way by the report. All the users were interviewed except for one of the Purchasing Report. The guide and exact transcription of the interviewees'

answers are in Appendix D. Table 5 shows the interviewees by report and their role.

Report	Interviewee	Role
Service Level Report	**1**	Agglomerate Cork Stopper Production Manager
	2	Natural Cork Stopper Production Manager
	3	Technical Cork Stopper Production Manager
	4	Production Planner
	5	Production Manager
	6	Supply Chain Manager
Purchasing Report	**1**	Natural Cork Stopper Production Manager
	2	Purchasing Responsible
	3	Supply Chain Manager
Production Report	**1**	Agglomerate Cork Stopper Production Manager
	2	Technical Cork Stopper Production Manager
	3	Production Planner
	4	Production Manager
	5	Supply Chain Manager

Table 5: Interviewees by report and the respective role.

All interviews began by questioning the users' familiarisation with Power BI and consulting reports, concluding that 100% of them interviewed were familiar with it and 86% already consulted reports.

The SL report was considered clear and the navigation intuitive by all interviewees, although Interviewee 1 emphasised the importance of knowing

simple features of the visuals. Interviewees 3 and 6 highlighted the ability production teams have now to identify clients and areas where the service is failing. Interviewee 4 identified safer order planning and stated the report promoted healthy competition for higher SL between departments and greater efficiency. Interviewees 1, 4 and 6 recognise the report's support in achieving SL objectives by providing all the necessary information. Finally, Interviewees 2 and 5 suggested making the report available in Portuguese for more automatic readability in the shop floor. As an evolutionary improvement, Interviewee 6 suggested that orders to be fulfilled be integrated into this report, making it possible to predict the efforts needed not to miss any.

The main outcome of the Purchasing Report was alerting to problems in documented consumptions out of step with reality. Interviewee 2 states the report simplifies the process and predicts useful full potential once all underlying problems are solved. Interviewee 1 sees this effect of validating stock levels as beneficial, alongside with the purchasing perspective that emerges in decision-making by adding its elements to it. Since Interviewee 1's section has the correct stock levels, the analysis of orders to be received and placed was reported as automatic and useful. Interviewee 3 shares this view, underlining the impact of the report by analysing past information and generating a consequence. Furthermore, he stated that the purchasing responsible is now able to anticipate orders and production managers can track these through the report, facilitating communication. Future improvements suggested by Interviewee 3 were to recreate the report for packaging and have a monthly view, which would help negotiating quarterly contracts with suppliers.

Feedback on the Production Report enhanced this was the least explored report, despite meeting the objectives. Interviewee 5 noted its simplicity and broad applicability. Interviewees 2, 3 and 4 highlighted having faster DV, aiding in comparing production with the target and investigating discrepancies more

easily. This promotes clear, objective conversations with production managers, since the bottleneck is usually the moulding phase, as interviewee 3 reflects, and monitoring the indicator aids in safer planning and a better relationship with production teams. Lastly, Interviewees 3 and 5 emphasised the importance of complying with weekly production plans to meet the customer's SL, and Interviewee 1 added that the KPI introduced is the basis for understanding shop floor work, stressing the importance of the awareness of workers on the shop floor. Interviewee 1 suggested adding a chart of the indicator's weekly evolution and Interviewees 3 and 5 state that the overview page was not entirely useful. Given this feedback, two pages were merged, giving rise to a new one - Production SL (detailed above) - where the aforementioned chart was added.

Sixth Chapter

6. Results Discussion

The reports presented on the previous chapter meet the objectives initially set for each of them and the project. There is useful and reliable information, updating automatically and daily, and easy access to the reports for every participant of the SC, ensuring a clear information flow that allow organising and shaping weekly meetings and workflow better.

The interviewees' agreed on intuitive and faster DV, which underlines the findings of (Singh et al., 2023) regarding Power BI's capabilities for reporting, visualising and analysing data and metrics. The SL report laid the foundation for a deeper analysis by reporting the information, and its reported advantages – the usefulness to understand processes' status, optimised performance, and monitoring performance – are highlighted by Al-Okaily et al. (2023). Despite the Purchasing and Production reports disclosing information and suggesting action, whereas the SL report only works as a reporting tool, interviewees feedback leads to conclude that all trigger a reaction on SC teams either by reacting faster to weaknesses and KPI oscillations or by adjusting purchasing behaviour depending on the purchase suggestions provided. This is in line with the observations of Park et al. (2017), noting that BI tools ultimately enhance acting agility, and those of Kamble & Gunasekaran (2020) and Lehyani et al. (2021), highlighting the reports capacity to unravel SC's weaknesses and strengths and help managers respond immediately to them. Moreover, the Purchasing Report and the visibility given of consumption, necessities and stock allowed a reduction in inventory from 195 000 euros to 136 000 euros in six

months and a consequent cost reduction, which aligns with the stated by Sheffi (2015) regarding BDA enabling reduced operational costs. Additionally, the viewpoint of Awwad et al. (2018) on notable impact of predictive analytics on SCM processes was confirmed by the Purchasing Report's interviewees when highlighting the usefulness of providing purchasing suggestions.

Nevertheless, the development of these reports warns to the critical need to correct possible errors underlying the data in the system like issues like the erroneous consumption and stock levels and the lack of data in SL indicators values, as adverted by Wang et al. (2016) regarding the importance of data collection and preparation. Furthermore, the findings of Teoh et al. (2021) evidenced the importance of skilled employees and training when dealing with systems such as BI software in a SC context, which was emphasised by one of the interviewees to harness Power BI's advantages fully.

Seventh Chapter

7. Conclusion

The main objective of this case study was learning how BI improves SCM through the development of Power BI reports that facilitate an optimised analysis of the information by all the users. Ultimately, it must allow the comprehension and decision-making within all subjects that regard SOCORI's SC, the company where the internship that provided the groundwork for this internship took place.

7.1. Final Conclusions

All the predefined objectives for this project have been successfully accomplished after reaching each report's goals and conclusions have been drawn regarding BI's success in improving SCM.

The reports deliver information in a clearer and more systematic way, making it possible to continuously monitor SL KPI and new information, and automate the purchasing process, which had been at the mercy of human error and desynchronised with SOCORI's needs. Power BI's capabilities were crucial to the success of the reports: the use of bookmarks and buttons concisely provide all the necessary information, conditional formatting alerts users to urgent aspects, the subscription of report's pages sending these via e-mail (the Purchasing report in particular, which requires daily monitoring) and the correct use of visuals to promote the desired analysis.

The development of reports touch on different points of the SC, breaking down the problem of poor alignment between the various participants in the SC and providing them with the necessary information and simplified DV. Making these reports available to their users facilitates communication and synchronisation between them, so they can work in the same direction.

7.2. Major Contributions

Compared to the data available prior to the case study, the democratisation of information is established as the main contribution, something that all reports made possible. Nevertheless, it had other effects that must be recognised.

Translating a complex work tool such as an MRP into a simplified Power BI version while leveraging from predictive analytics automated the purchasing process and inherently the communication between purchasing and production teams. Also, all reports allow real-time monitoring, with the Production one being the most precise. This makes it easier to redefine quality standards, such as the targets for production, and reliability.

By displaying relevant information, end-users can now easily spot their weaknesses and act upon them. As the reports are in an initial implementation phase, this is one of the most impactful effects of making information available and shows how further navigating the reports will be beneficial.

7.3. Recommendations for Future Work

Although these reports provide significant insights, it has only been applied to one case study and one specific area, for future studies within BI, it is

recommended to apply the study to other companies in other contexts.

Within SOCORI, for future iterations of the reports and even the development of new ones, there are a few points that this study recommends considering:

1. As the use of the reports increase, facilitate conversations with users to disclose suggestions for improvements tailored to their needs;
2. Check page Assumptions and Data Updates to analyse what is underlying each report's reasoning;
3. Investigate and report any erroneous or missing data;
4. Beware of Power BI updates using emerging topics regarding BDA, such as Artificial Intelligence and Augmented Analytics.

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Appendix

Appendix A: Service Level Report

The SL Report contains five pages, and pages *Response Times*, *Time to Market*, *Orders Evolution* and *Assumptions and Data Updates* will be detailed now. All pages contain navigation buttons, created by assigning each page to a bookmark (Icon 1, Figures 8, 11, 12, 13 and 14). Pages *Response Times*, *Time to Market*, and *Orders Evolution* contain a department slicer (Icon 2, Figures 8, 11, 12 and 13), facilitating the navigation through the report and allowing more objective analyses. Since the data included cork stoppers produced in all Amorim Cork's units, the ones that SOCORI does not produce are included in "No Department". Pages *Response Times* and *Time to Market* contain three date slicers – day, month name, and year (Icon 8 and 9, Figures 8 and 11, respectively) –to check specific orders and have a more granular analysis.

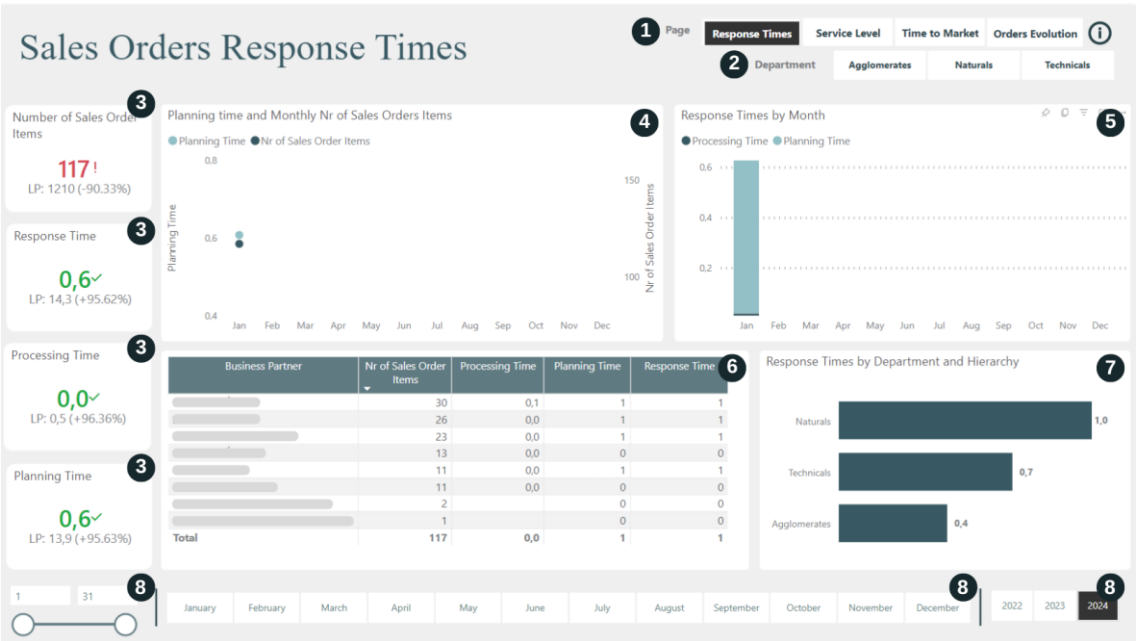

Figure 8: Page Sales Orders Response Times of the Service Level Report.

This first page covers Response Times metrics Response Time, Processing Time, and Planning Time The first calculates the time elapsed from the date of the customer's request to the date the confirmation message is sent; the second measures the time elapsed from the creation of the sales order until it is released for planning; the third corresponds to the time between the moment of release for planning and the moment when the planning department confirmed the delivery date, which is confirmed when the production order is released. These metrics are presented in days as an average of the number of SO/item. The visuals also set a benchmark using Last Period's value (LP), created using the DAX formulas in Table 6. Their values are presented on KPI visuals, alongside the number of SO/items (Icon 3, Figure 8). For all the Response Times KPI, whenever the value of the metric is below LP's, it is displayed in a bright green colour, and whenever it is above LP's value, it is displayed in a bright red colour. Also, besides LP's values, there's the percentage comparison to LP's value.

Measure's Name	**Formula**
Number of SO Items LP	`CALCULATE([Número de Linhas da Ordem de Venda],SAMEPERIODLASTYEAR('Data do Documento'[Data do Documento]))`
Response Time without Processing LP	`CALCULATE([Tempo de Resposta (Sem Processamento)], SAMEPERIODLASTYEAR('Data do Documento'[Data do Documento]))`
Processing Time LP	`CALCULATE([Tempo de Processamento], SAMEPERIODLASTYEAR('Data do Documento'[Data do Documento]))`
Planning Time LP	`CALCULATE([Tempo de Planeamento], SAMEPERIODLASTYEAR('Data do Documento'[Data do Documento]))`

Table 6: DAX formulas for Response Times.

As Service Level performance is highly dependable on the planning team's work, the line chart (Icon 4, Figure 8) allows a comparison with the planning time and the Number of SO Items for each month, helping the team understand if

there is any correlation between heavy workload and the time it takes to plan the orders. As there is a big difference in the values of each of these fields, on the left-hand side of the graph is the axis for Planning Time and on the right-hand side is the axis for Number of SO Items.

The stacked column chart (Icon 5, Figure 8) allows a quick comparison of the processing time *vs* the planning time. In a scenario where the Service Level is not being prioritised, this would rapidly draw attention to how planning times are extremely higher than processing time, which was the case for the majority of 2023. As SOCORI's increasingly paying more attention to SL, the chart becomes more consistent and failing to meet the SL's target become more evident.

The table presented (Icon 6, Figure 8) allows a more detailed analysis by specifying each customer's number of items ordered, Processing Time, Planning Time, and Response Times. This eases the identification of customers where the service is weaker, provoking a more cautionary approach for following orders.

Lastly, the clustered bar chart (Icon 7, Figure 8) besides showing the value for this metric by department, it also allows to see the Response Time to each hierarchy level of Material, already defined on the O2C cube. This was possible by integrating the Department level in this hierarchy.

As mentioned on the presentation of page *Service Level*, the arrow displayed in the table visual (Icon 8, Figure 2 or Icon 1, Figure 9 below) has direct access to page Service Levels Metrics (Figure 10).

Business Partner	Number of Sales Order Items	Service Level (%)	Planned to Ship	Planned to Pack
[redacted]	22	54,3%	54,3%	100,0%
[redacted]	20	30,0%	100,0%	100,0%
[redacted]	17	100,0%	100,0%	100,0%
[redacted]	15	80,0%	80,0%	100,0%
[redacted]	14	0,0%	85,7%	100,0%
[redacted]	9	100,0%	100,0%	100,0%
[redacted]	1	0,0%	0,0%	0,0%
[redacted]	1	0,0%	0,0%	0,0%
Total	**99**	**56,3%**	**79,5%**	**96,8%**

Figure 9: Table visual of the Service Level Report.

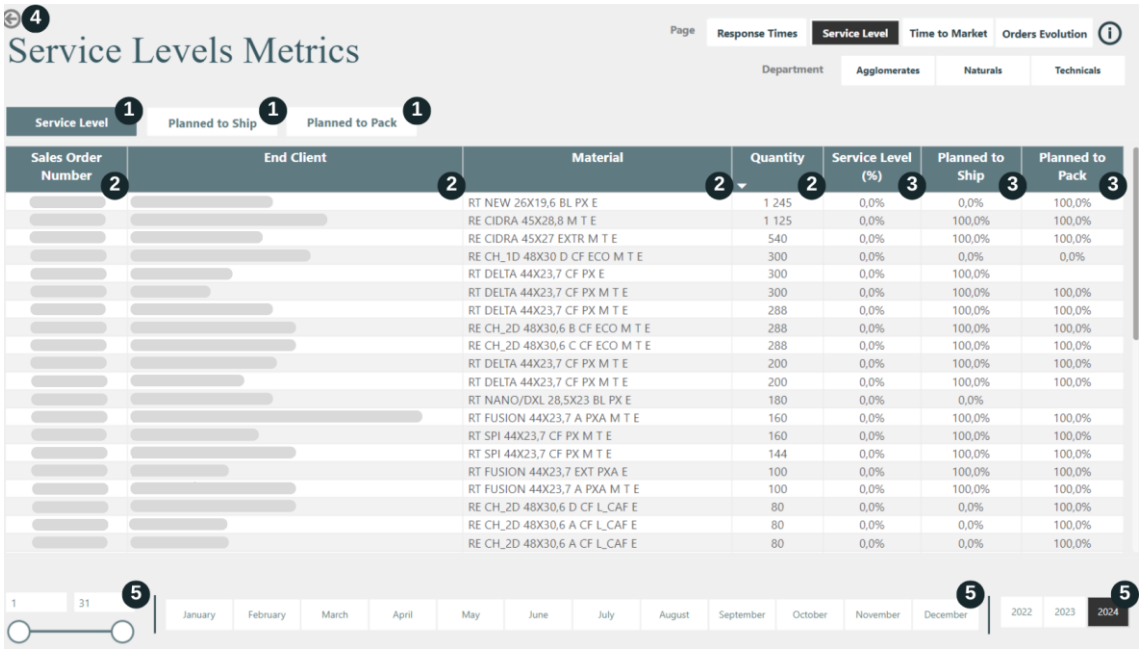

Figure 10: Page Service Level Metrics of the Service Level Report.

Here there are three buttons that reflect the three KPI (Icon 1, Figure 10): Service Level, Planned to Ship, and Planned to Pack, and these are selected if they appear with the light blue background. Independently of the button clicked, the tables have four columns in common (Icon 2, Figure 10): *Sales Order Number*, *End Client*, *Material*, and *Quantity*. When you click on the different buttons, the remaining three columns (Icon 3, Figure 10) are displayed differently according to the button selected. If one KPI's button is selected, the table shows those four columns, the column corresponding to the selected KPI filtered to show only "0%" values (Service Level in Figure 10), and the other two KPI with the respective unfiltered value (e.g. if Planned to Ship is selected, then the column *Planned to Ship* will show only "0,0%", when Service Level and Planned to Pack will show the correspondent value).

Lastly, the arrow (Icon 4, Figure 10) allows a quick return to the report, as this page works as a more focused view, and the date slicers (Icon 5, Figure 10) promote quicker searches into particular orders or timeframes.

This page allows to understand which orders the team has failed to meet its defined dates, check for patterns between end clients, quantities, or material. It is important to note that this page was crucial to uncover errors in the cubes: for all three KPI there were blank values, where there should be a number as the date fields were filled, but the formula was not working. Here there was not any pattern, it was happening where there should have been either a 0% or a 100%. This became an assumption that had to be accounted for when analysing the value for the KPI, as it can only be solved in the root of the problem: the formula within the OLAP cubes.

Next, there is the *Time to Market* page, which analyses the time that elapses from when the order is placed to when it is shipped to the customer from three perspectives. The first is Intended Time to Ship, which refers to the customer's expectations and therefore measures the time elapsed between placing the order and the date requested by the customer for dispatch. Next, Promised Time to Ship measures the customer's expectations by returning the time elapsed between placing the order and the date promised to the customer for its dispatch. Finally, Time to Ship measures the time elapsed between placing the order and its actual dispatch. These metrics are presented in days as an average of the number of SO/item. Successfully making Time to Ship meet the customer and SOCORI's expectations is more difficult given that the company does not have stock ready to ship, having much more factors influencing the dispatch of orders.

The KPI visuals displayed (Icon 3, Figure 11) covers the number of SO/items, the metrics mentioned above and SL. Promised Time to Ship was used as a benchmark for Time to Ship, giving an idea of whether or not the company is meeting the date promised to the customer. For Promised Time to Ship, Intended Time to Ship was used, in order to understand how far the dates promised by SOCORI are from the dates required by the client. The values of the indicators

appear in green if they are lower than the values of the fields used as targets, and in red otherwise.

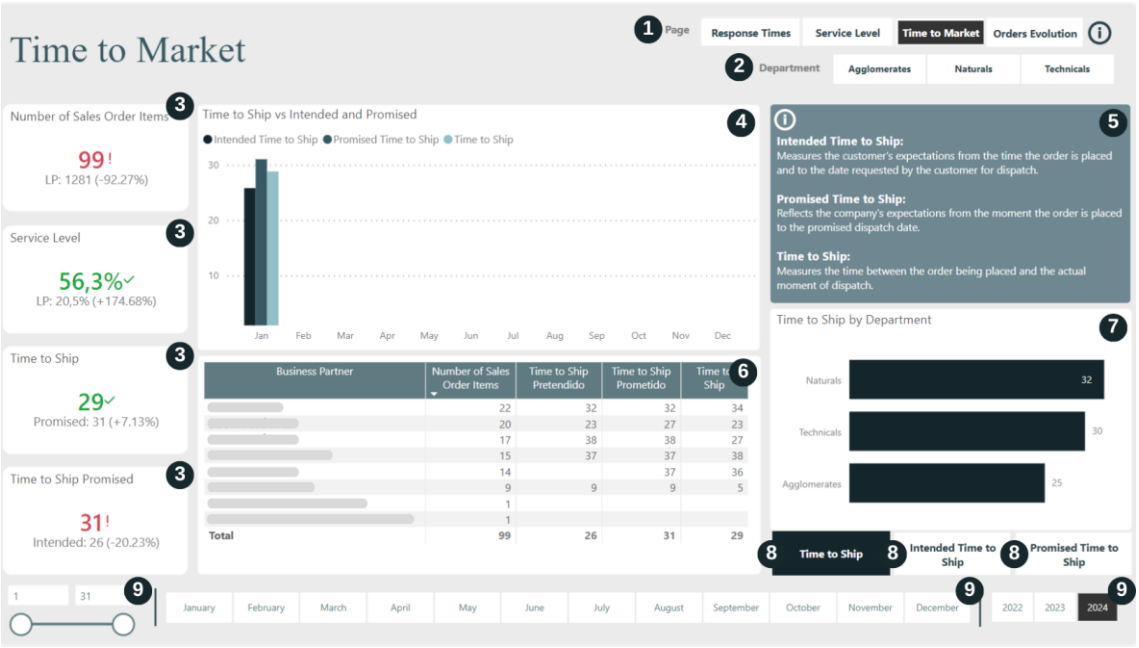

Figure 11: Page Time to Market of the Service Level Report.

The clustered bar chart (Icon 4, Figure 11) provides a monthly analysis of the three indicators simultaneously. This simultaneous analysis of the three indicators is carried out in the table for each customer (Icon 6, Figure 11). In addition, to complete the analysis, the horizontal clustered bar chart compares the same indicators by department or any other material hierarchy (Icon 7, Figure 11). Here again, bookmarks (Icon 8, Figure 11) are used to include a chart for each indicator and present this information clearly. These bookmarks are accessed via the buttons, with the dark blue background showing the selected bookmark. As in the Service Level page, this one presents an explanation of the three KPI (Icon 5, Figure 11), so that the introduction of new information doesn't become a burden by showing that it can be easily explained.

Lastly, this report contais an *Orders Evolution* page. This page uses two types of analysis, selected using the *Analysis Type* buttons (Icon 3, Figures 12 and 13) –

Atual (Figure 12) or *MTD* (Figure 13) –, where the darker background shows the type of analysis selected. These pages only show the data for the current month, evidenced by the *Current Month* card showing such month (Icon 4, Figures 12 and 13).

Figure 12: Page Daily Orders Evolution of the Service Level Report.

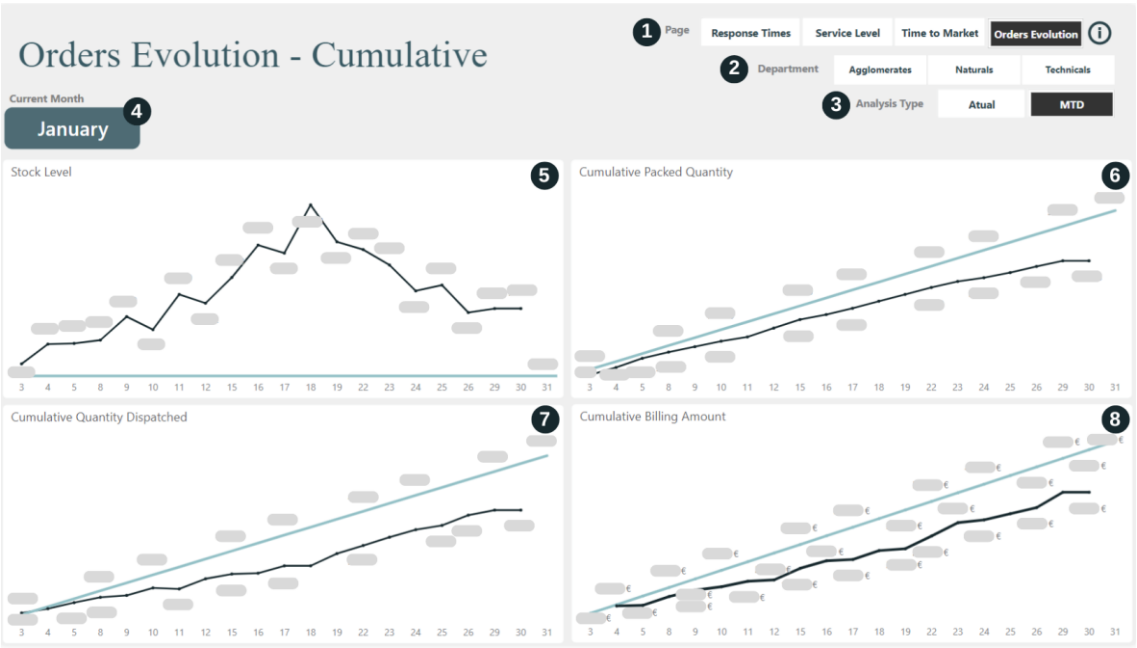

Figure 13: Page Orders Evolution - Cumulative of the Service Level Report.

The visuals only show working days in the *x*-axis, making DV more cohesive and cleaner. This implied the creation of three calendar tables. One is a Working Days Table, created in Excel (formulas in Table 8), and discriminates weekends, holiday periods and public holidays. Using column "Working Day?" in visual-level filters enabled displaying only working days in the charts. The other two tables were created in Power BI and the formulas used to create them can be found in Table 7. In the analysis type "Atual", the clustered column charts show rolling data, whereas in "MTD", the fields in the line charts are cumulative for that month. Naturally, the only exception for these differences is the Stock Level (Icon 5, Figures 12 and 13), which represents the inventory level at a certain moment and is not subjected to any analysis type. The remaining fields – Packed Quantity (Icon 6, Figures 12 and 13), Quantity Dispatched (Icon 7, Figures 12 and 13) and Billing Amount (Icon 8, Figures 12 and 13) – have both Actual and MTD analysis. The bars and lines with the values to be analysed are shown in dark blue, whereas the targets for those values are in light blue.

On the Actual analysis, the daily targets for Stock Level, Packed Quantity and Quantity Dispatched are tabulated values, put on the charts using the constant line option on Power BI's analytics pane. These values are defined on the "Objetivos" table, which contains the name of the movement (Stock, Dispatch, and Packing) and the target value. The target for Billing Amount matches the value of the previous month adjusted to the working days (*Previous Month Billing*, on Table 7).

For the MTD analysis, the targets Packed Quantity and Quantity Dispatched are the accumulated tabulated values per working day. The Stock Level target was placed as in Actual analysis. For Packed Quantity, Quantity Dispatched, and Billing Amount the measures presented in Table 7 were created. Also, in neither type of analysis the Billing Amount is filtered, matching SOCORI's previously defined monthly objectives.

Measure's Name	Formula
Previous Month Billing	`DIVIDE(CALCULATE([Valor Liquido FOB Fatura], MONTH('Tabela Calendario Fatura'[Date]) = MONTH(EOMONTH(TODAY(), -1)), YEAR('Tabela Calendario Fatura'[Date]) = YEAR(EOMONTH(TODAY(), -1))), [Working Days Faturação LM])`
Billing Amount LM MTD	`[Previous Month Billing]*[Working Days Faturação]`
Target Packed Quantity MTD	`CALCULATE(SUM(Objetivos[Objetivo])*[Working Days], Objetivos[Movimento] = "Embalamento")`
Target Quantity Dispatched MTD	`CALCULATE(SUM(Objetivos[Objetivo])*[Working Days], Objetivos[Movimento] = "Expedição")`
Calendar Table (O2C)	`ADDCOLUMNS( CALENDAR(DATE(2023, 1, 1), DATE(2024, 12, 31)), "Mes", FORMAT([Date], "m"), "Ano", YEAR([Date]))`
Calendar Table (P2F)	`ADDCOLUMNS( CALENDAR(DATE(2023, 1, 1), DATE(2024, 12, 31)), "Ano do Movimento", YEAR([Date]), "Quarter", "Q" & QUARTER([Date]), "Nome do Mês do Movimento", FORMAT([Date], "mmmm"), "Mês do Movimento", MONTH([Date]), "Dia do Mês do Movimento", DAY([Date]))`

Table 7: DAX formulas for Orders Evolution (Daily and Cumulative) of the Service Level Report.

Table	Columns	Formulas
Working Days Table	Date	First Cell – `DATE(2023;1;1)`
		Remaining Cells – `A2+1`
	Day of the week	`=WEEKDAY(A2)`
	Working Day?	`=IF(OR(B2 = 1; B2 = 7); 1; 0)`

Table 8: Excel formulas for Orders Evolution (Daily and Cumulative).

Lastly, page *Assumptions and Data Updates* (Figure 14) includes all the assumptions that guided the execution of the report, hoping to ease the analysis and answer any doubts that may occur to users.

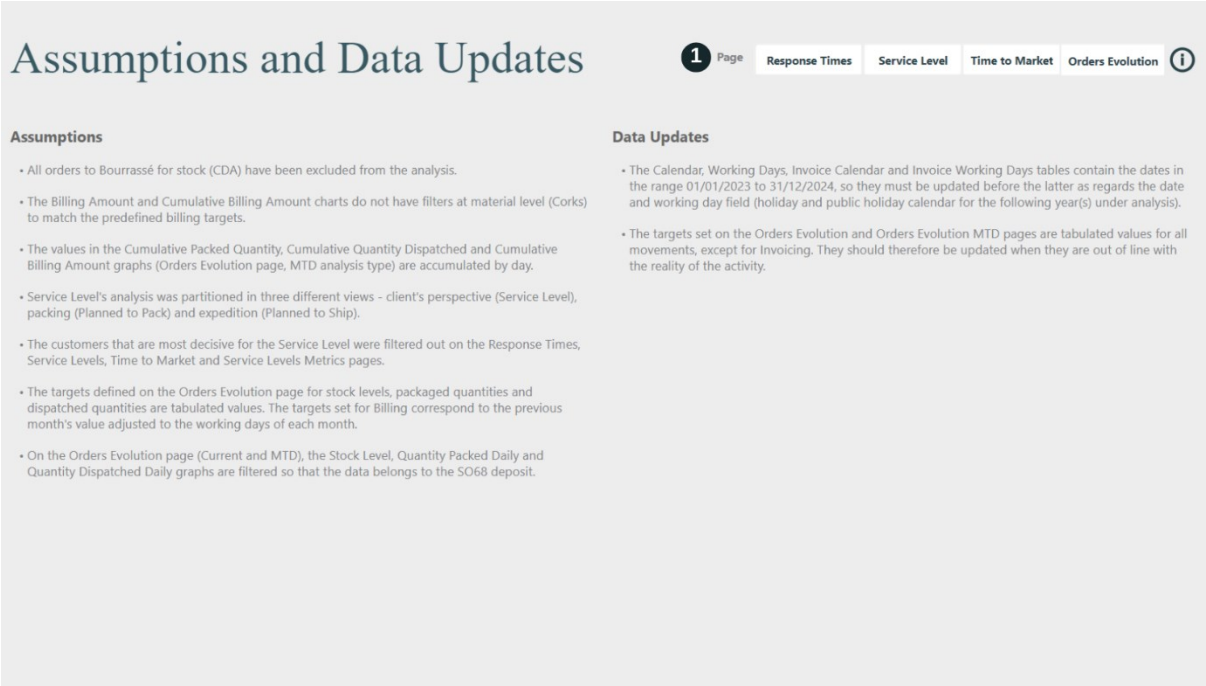

Figure 14: Page Assumptions and Data Updates of the Service Level Report.

Appendix B: Purchasing Report

As mentioned before, the Purchasing Report contains five pages – Evolução Compras, Stock e Consumo, Revisão Periódica, Revisão Contínua, and Pressupostos e Atualização dos Dados –, with Evolução Compras, Stock e Consumo, and Pressupostos e Atualização dos Dados remaining to be detailed.

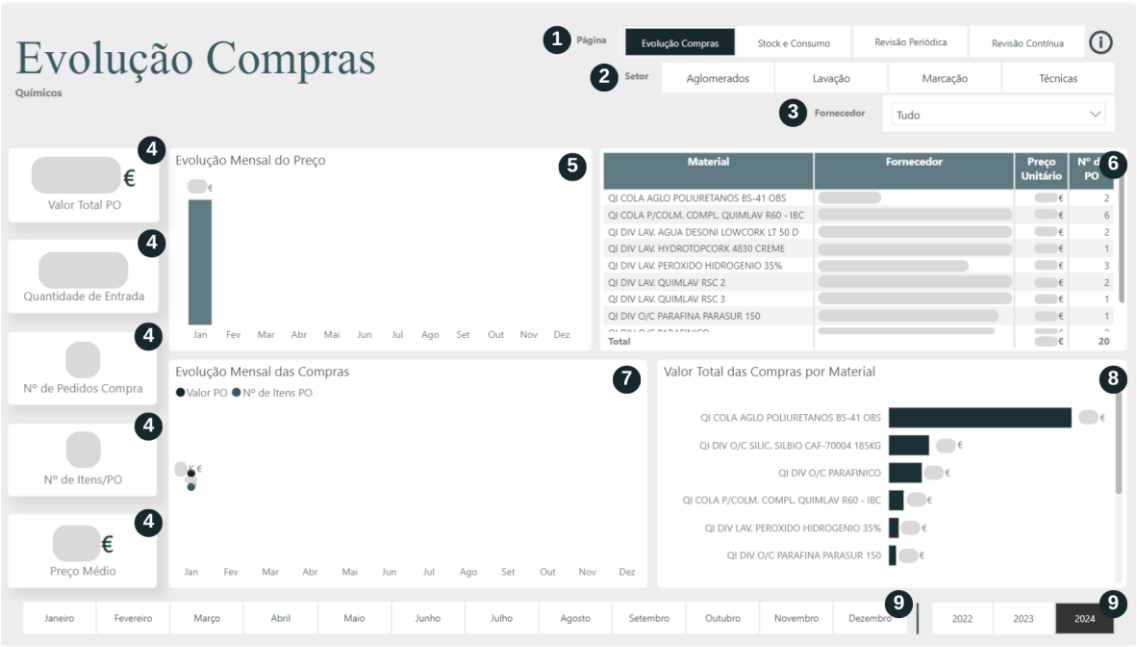

Figure 15: Page *Evolução Compras* of the Purchasing Report.

Page *Evolução Compras* (Purchases' Evolution) provides an analysis on the status of metrics relevant to the purchasing process of chemicals. This page allows rapid navigation to other pages by using buttons (Icon 1, Figure 15), where the darker blue background shows the selected one. The "i" icon has direct assess to *Pressupostos e Atualização dos Dados* (Assumptions and Data Update). By using the slicers, users can filter data by department and supplier (Icons 2 and 3, respectively, Figure 15). Besides, the time slicers (Icon 9, Figure 15) allow the users to filter data by month and year.

The cards (Icon 4, Figure 15) show total expenditure in orders, quantity of purchased products, number of orders, number of items purchased and average

price. The clustered bar chart (Icon 5, Figure 15) shows the monthly evolution of average price and, to detail the information further, the table (Icon 6, Figure 15) lays the material, supplier, unit price, and number of orders. The line chart (Icon 7, Figure 15) compares average order expense and number of items purchased by month, while the horizontal bar chart (Icon 8, Figure 15) shows total spent in each material. All the charts in this page contain data labels which not only promote a more automatic analysis but also allows the identification of relationships in the data's magnitude.

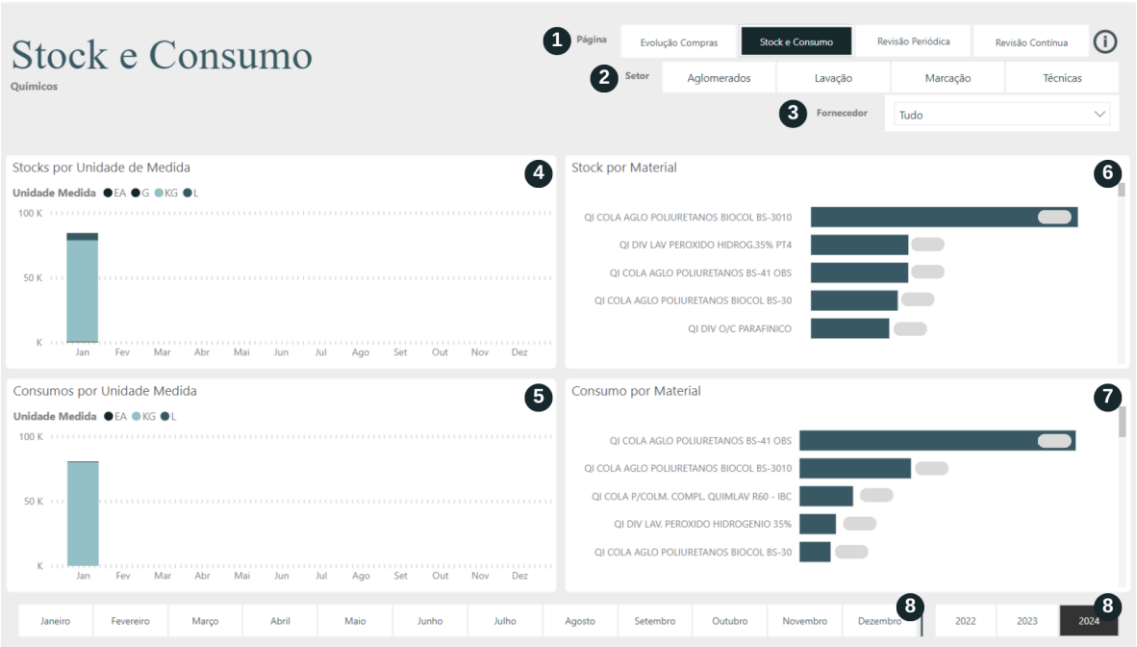

Figure 16: Page *Stock e Consumo* of the Purchasing Report.

Page *Stock e Consumo* (Stock and Consumption) fosters a simple analysis over consumption and stock levels. Just as in page *Evolução Compras*, navigation buttons (Icon 1, Figure 16) and department and supplier slicers are present (Icons 2 and 3, respectively, Figure 16), as well as month and year slicers (Icon 8, Figure 16). Subsequently, two clustered bar charts were used to display monthly stock and consumption level by unit of measurement (each, grams, kilograms and litres) (Icons 4 and 5, Figure 16), placed as legend of the charts because different

materials are bought and consumed in different units and therefore these can't be summed. The horizontal bar charts present stock and consumption level by material (Icons 6 and 7, respectively, Figure 16).

Figure 17: Page *Pressupostos e Atualização dos Dados* of the Purchasing Report.

The last page is *Pressupostos e Atualização dos Dados* (Assumptions and Data Update) (Figure 17), which presents all assumptions considered to develop the report in order to help users understand it. Besides, this may help in future iterations of the report or in case the Action-Research cycles brings new feedback that involves modifying it.

Table 9 below shows the DAX formulas for all the measures created throughout the development of the Purchasing report.

Measure's Name	**Formula**
Stock Level	`CALCULATE('Stocks - Movimentos'[Existências - Quantidade Base], FILTER('Material 2', 'Material 2'[Material PT] IN VALUES('Materiais Principais'[Material])))`

Consumption	`- CALCULATE('Stocks - Movimentos'[Movimentos - Quantidade Base], FILTER('Data do Movimento', 'Data do Movimento'[Data do Movimento] <= TODAY()), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904")`
Consumption s-1	`VAR consumo = - CALCULATE('Stocks - Movimentos'[Movimentos - Quantidade Base], 'Data do Movimento'[Semana do Ano Data do Movimento] = WEEKNUM(TODAY() - 7), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904", YEAR('Data do Movimento'[Data do Movimento]) = YEAR(TODAY()-7)))` `RETURN IF(consumo = BLANK(), 0, consumo)`
Consumption s-2	`VAR consumo =- CALCULATE(` `'Stocks - Movimentos'[Movimentos - Quantidade Base], 'Data do Movimento'[Semana do Ano Data do Movimento] = WEEKNUM(TODAY() - 14), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904", YEAR('Data do Movimento'[Data do Movimento]) = YEAR(TODAY()-14))` `RETURN IF(consumo = BLANK(), 0, consumo)`
Consumption s-3	`VAR consumo = - CALCULATE(` `'Stocks - Movimentos'[Movimentos - Quantidade Base], 'Data do Movimento'[Semana do Ano Data do Movimento] = WEEKNUM(TODAY() - 21), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904", YEAR('Data do Movimento'[Data do Movimento]) = YEAR(TODAY()-21))` `RETURN IF(consumo = BLANK(), 0, consumo)`
Consumption s-4	`VAR consumo = - CALCULATE(` `'Stocks - Movimentos'[Movimentos - Quantidade Base], 'Data do Movimento'[Semana do Ano Data do Movimento] = WEEKNUM(TODAY() - 28), 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock]= "261" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "262" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "903" || 'Tipo de Movimento de Stock'[Código Tipo Movimento Stock] = "904", YEAR('Data do Movimento'[Data do Movimento]) = YEAR(TODAY()-28))` `RETURN IF(consumo = BLANK(), 0, consumo)`

Consumption s	`VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]}`
	`VAR Minimo = MINX(Lista, [Value])`
	`VAR Maximo = MAXX(Lista, [Value])`
	`RETURN DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4] - Minimo - Maximo, 10, 0) * [Dias Uteis s]`

Consumption s+1	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) RETURN DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4] - Minimo - Maximo, 10, 0) * [Dias Uteis s+1]
Consumption s+2	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) RETURN DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4] - Minimo - Maximo, 10, 0) * [Dias Uteis s+2]
Consumption s+3	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) RETURN DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4] - Minimo - Maximo, 10, 0) * [Dias Uteis s+3]
Target Stock	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5 VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2) VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4) VAR DT = LeadTime + 5 VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3) VAR DesvioPadrao = SQRT(Variancia * DT) VAR StockSeguranca = 1.65 * DesvioPadrao RETURN ConsumoMedioSemanal + StockSeguranca
Reorder Point	VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]} VAR Minimo = MINX(Lista, [Value]) VAR Maximo = MAXX(Lista, [Value]) VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5 VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2) VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4) VAR DT = LeadTime + 5 VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3) VAR DesvioPadrao = SQRT(Variancia * DT) VAR StockSeguranca = 1.65 * DesvioPadrao RETURN ConsumoMedioSemanal + StockSeguranca

Reorder Point s	`VAR Lista = {[Consumo s-1], [Consumo s-2], [Consumo s-3], [Consumo s-4]}`
	`VAR Minimo = MINX(Lista, [Value])`
	`VAR Maximo = MAXX(Lista, [Value])`
	`VAR LeadTime = SELECTEDVALUE('Materiais Principais'[Lead Time])/5`
	`VAR ConsumoMedioSemanal = DIVIDE([Consumo s-4] + [Consumo s-3] + [Consumo s-2] + [Consumo s-1] - Minimo - Maximo, 2)`
	`VAR ConsumoMedioSemanalStock = DIVIDE([Consumo s-1] + [Consumo s-2] + [Consumo s-3] + [Consumo s-4], 4)`
	`VAR DT = LeadTime + 5`
	`VAR Variancia = DIVIDE(POWER([Consumo s-1] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-2] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-3] - ConsumoMedioSemanalStock, 2) + POWER([Consumo s-4] - ConsumoMedioSemanalStock, 2), 3)`
	`VAR DesvioPadrao = SQRT(Variancia * DT)`
	`VAR StockSeguranca = 1.65 * DesvioPadrao`
	`RETURN ConsumoMedioSemanal*LeadTime + StockSeguranca`

Reorder Point Alert	`[Existências - Quantidade Base - Old] - [Reorder Point]`

Quantity of Orders to be received s	`CALCULATE([Quantidade Pedido de Compra] - [Quantidade de Entrada de Mercadorias],`
	`'Pedido de Compra'[Flag Linha Eliminada (Status)] <> "Linha Eliminada",`
	`FILTER('Tabela Calendário','Tabela Calendário'[Data].[Year] = YEAR(TODAY())),`
	`FILTER('Tabela Calendário', 'Tabela Calendário'[Semana] <= WEEKNUM(TODAY()))`

Quantity of Orders to be received s+1	`CALCULATE([Quantidade Pedido de Compra] - [Quantidade de Entrada de Mercadorias],`
	`'Pedido de Compra'[Flag Linha Eliminada (Status)] <> "Linha Eliminada",`
	`FILTER('Pedido de Compra', YEAR('Pedido de Compra'[Data Remessa Pedido de Compra]) = YEAR(TODAY()+7) &&`
	`WEEKNUM('Pedido de Compra'[Data Remessa Pedido de Compra], 21) = WEEKNUM(TODAY()+7)))`

Quantity of Orders to be received s+2	`CALCULATE([Quantidade Pedido de Compra] - [Quantidade de Entrada de Mercadorias],`
	`'Pedido de Compra'[Flag Linha Eliminada (Status)] <> "Linha Eliminada",`
	`FILTER('Tabela Calendário','Tabela Calendário'[Data].[Year] = YEAR(TODAY()+14)),`
	`FILTER('Tabela Calendário', 'Tabela Calendário'[Semana] = WEEKNUM(TODAY()+14)))`

Quantity of Orders to be received s+3	`CALCULATE([Quantidade Pedido de Compra] - [Quantidade de Entrada de Mercadorias],`
	`'Pedido de Compra'[Flag Linha Eliminada (Status)] <> "Linha Eliminada",`
	`FILTER('Tabela Calendário', 'Tabela Calendário'[Data].[Year] = YEAR(TODAY()+21)),`
	`FILTER('Tabela Calendário', 'Tabela Calendário'[Semana] = WEEKNUM(TODAY()+21)))`

Stock Level Forecast s+1	`[Existências - Quantidade Base - Old] + [Quantidade em Aberto s] + [Sugestão Compra s] - [Consumo s]`
Stock Level Forecast s+2	`[Previsão Stock s+1] - [Consumo s+1] + [Sugestão Compra s+1] + [Quantidade em Aberto s+2]`

Stock Level Forecast s+3	`[Previsão Stock s+2] - [Consumo s+2] + [Sugestão Compra s+2] + [Quantidade em Aberto s+2]`
Purchase Suggestion s (Periodic Review)	`MROUND(IF([Consumo s] <> 0 && ([Target Stock] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s]) > 0, [Target Stock] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
Purchase Suggestion s+1 (Periodic Review)	`MROUND(IF([Consumo s+1] <> 0 && ([Target Stock] - [Previsão Stock s+1] - [Quantidade em Aberto s+1]) > 0, [Target Stock] - [Previsão Stock s+1] - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
Purchase Suggestion s+2 (Periodic Review)	`MROUND(IF([Consumo s+2] <> 0 && ([Target Stock] - [Previsão Stock s+2] - [Quantidade em Aberto s+2]) > 0, [Target Stock] - [Previsão Stock s+2] - [Quantidade em Aberto s+2], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Purchase Suggestion s+3 (Periodic Review)	`VAR PrevisaoStockS1 = [Existências - Quantidade Base - Old] + [Quantidade em Aberto s] + [Sugestão Compra s] - [Consumo s]`
	`VAR PrevisaoStockS2 = PrevisaoStockS1 - [Consumo s+1] + [Sugestão Compra s+1] + [Quantidade em Aberto s+2]`
	`VAR PrevisaoStockS3 = PrevisaoStockS2 - [Consumo s+2] + [Sugestão Compra s+2] + [Quantidade em Aberto s+2]`
	`RETURN MROUND(IF([Consumo s+3] <> 0 && ([Target Stock] - PrevisaoStockS3 - [Quantidade em Aberto s+3]) > 0, [Target Stock] - PrevisaoStockS3 - [Quantidade em Aberto s+3], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Purchase Suggestion s (Continuous Review)	`MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base]- [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Purchase Suggestion s+1 (Continuous Review)	`VAR SugS = MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS1 = [Existências - Quantidade Base] + [Quantidade em Aberto s] + SugS - [Consumo s]`
	`RETURN MROUND(IF([Consumo s+1] <> 0 && ([Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1]) > 0, [Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Purchase Suggestion s+2 (Continuous Review)	`VAR SugS = MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base - Old] - [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS1 = [Existências - Quantidade Base] + [Quantidade em Aberto s] + SugS - [Consumo s]`
	`VAR SugS1 = MROUND(IF([Consumo s+1] <> 0 && ([Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1]) > 0, [Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS2 = PrevisaoStockS1 - [Consumo s+1] + SugS1 + [Quantidade em Aberto s+2]`
	`RETURN MROUND(IF([Consumo s+2] <> 0 && ([Reorder Point] - PrevisaoStockS2 - [Quantidade em Aberto s+2]) > 0, [Reorder Point] - PrevisaoStockS2 - [Quantidade em Aberto s+2], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Purchase Suggestion s+3 (Continuous Review)	`VAR SugS = MROUND(IF([Consumo s] <> 0 && ([Reorder Point s] - [Existências - Quantidade Base] - [Quantidade em Aberto s]) > 0, [Reorder Point s] - [Existências - Quantidade Base] - [Quantidade em Aberto s], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS1 = [Existências - Quantidade Base] + [Quantidade em Aberto s] + SugS - [Consumo s]`
	`VAR SugS1 = MROUND(IF([Consumo s+1] <> 0 && ([Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1]) > 0, [Reorder Point] - PrevisaoStockS1 - [Quantidade em Aberto s+1], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS2 = PrevisaoStockS1 - [Consumo s+1] + SugS1 + [Quantidade em Aberto s+2]`
	`VAR SugS2 = MROUND(IF([Consumo s+2] <> 0 && ([Reorder Point] - PrevisaoStockS2 - [Quantidade em Aberto s+2]) > 0, [Reorder Point] - PrevisaoStockS2 - [Quantidade em Aberto s+2], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`
	`VAR PrevisaoStockS3 = PrevisaoStockS2 - [Consumo s+2] + SugS2 + [Quantidade em Aberto s+2]`
	`RETURN MROUND(IF([Consumo s+3] <> 0 && ([Reorder Point] - PrevisaoStockS3 - [Quantidade em Aberto s+3]) > 0, [Reorder Point] - PrevisaoStockS3 - [Quantidade em Aberto s+3], 0), SELECTEDVALUE('Materiais Principais'[Multiplo Encomenda]))`

Table 9: Complete DAX formulas for the Purchasing Report.

Appendix C: Production Report

As mentioned before, the Production Report comprises three pages – *Nível de Serviço Produção*, *Produção* and *Pressupostos e Atualização dos Dados* –, with the last two remaining to be detailed.

Figure 18: Page *Produção* of the Production Report.

Page *Produção* contains navigation buttons (Icon 1, Figure 18) and group and week slicers (Icons 2 and 3, respectively, Figure 18), just like the page presented earlier, Service Level Production.

The page presented is quite simple in terms of the visuals presented, but it is very useful as a daily work tool. The matrix visual (Icon 4, Figure 18) displays information by machine in the first column and can be expanded to the various material hierarchies, the presentation shown in Figure 18 being the default. The columns contain the number of the week, the objective according to the weekly plan and the quantity produced. Conditional formatting was used in this last field, using the Conditional Formatting measure: for cells containing a target, the background of the cell in the produced quantity column is red if this value is

lower than the target and green if it is higher or equal. In addition, blanks were excluded from the matrix, i.e. cases in which a particular material or machine was not produced or intended to be produced in the weeks being analysed and where the target was not set. This was done by introducing the *Blanks* measure into the visual filters, requiring it to be greater than zero.

The second matrix (Icon 5, Figure 18) has two columns, machine and comment, which stems from the need during meetings to add the particularities of the machines and production and simples notes important for the next meeting that should be reminded when analysing the matrix.

The formulas used to create the measures mentioned can be found in Table 10. To make it possible to execute this report and this page specifically, it was necessary to enter all the necessary information in the Sharepoint Folder (the machine and material designations as presented, weekly production plan and comments) and subsequently in Power BI create the relationships with the MES cube, so that fields from both sources could be used in the visuals, the information filtered smoothly and missing information avoided.

Measure's Name	**Formula**
Blanks	`SUMX('Objetivo/Material', 'Objetivo/Material'[Objetivo]) + [Qtd Transaction]`
Conditional Formatting	`IF(CALCULATE(SUM('Objetivo/Material'[Objetivo]), USERELATIONSHIP('Tab Calendário'[Yearweek], 'Objetivo/Material'[Yearweek])) < 0 && [Qtd Transaction] >= 0, BLANK(), IF(CALCULATE(SUM('Objetivo/Material'[Objetivo]) <> BLANK(), USERELATIONSHIP('Tab Calendário'[Yearweek], 'Objetivo/Material'[Yearweek])) && CALCULATE(SUM('Objetivo/Material'[Objetivo]), USERELATIONSHIP('Tab Calendário'[Yearweek], 'Objetivo/Material'[Yearweek])) <> 0, CALCULATE(SUM('Objetivo/Material'[Objetivo]) - [Qtd Transaction])))`

Table 10: DAX formulas for Produção of the Production Report.

Just like the previous two reports presented, the Production Report also contains an Assumptions and Data Update page, accessed on every page through the "i" icon and containing the buttons necessary to navigate back to the other pages of the report (Icon 1, Figure 18). This page presents all assumptions made to develop the report, helping users analyse it, as well as aiding future iterations or modifications of the report.

Figure 19: Page *Pressupostos e Atualização dos Dados* of the Production Report.

The Production Report replaces the Excel file in which the production of cork stopper moulding was tracked, improving the visualisation of information and allowing quick comparison and analysis through the concise presentation on a single page of the matrix containing the production and objectives, the performance shown by the conditional formatting and the space for comments.

Appendix D: Interviews

The interview guides were written according to the role of each interviewee and their use of the report. Therefore, the reports, these roles and the questions defined for each will be defined below.

1. **Service Level Report**

Role	**Production Managers**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	Do you find navigating the report intuitive?
	Does the report present the information in a clear and understandable way?
	How do you integrate the Service Level report into your daily work?
	How does the report contribute to your daily tasks or decision-making?
	Is there any information specific to your department that you feel is missing?
	Any suggestion for improvement or comment?

Table 11: Interview Questions for Production Managers regarding the SL Report.

Role	**Production Planner**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	Do you find navigating the report intuitive?
	How has the report changed or complemented your day-to-day tasks? What differences have you noticed since implementing the report?

	Has the report influenced your planning decisions?
	How do you perceive the report as a reporting tool for achieving the 90% Service Level target?
	Are there any factors not represented in the report that you consider necessary for daily activities?
	Any suggestion for improvement or comment?

Table 12: Interview Questions for Production Planner regarding the SL Report.

Role	**Supply Chain Manager**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	Do you find navigating the report intuitive (especially for new users)?
	How has the report changed or complemented your day-to-day tasks? What differences have you noticed since implementing the report?
	How do you perceive the report as a reporting tool for achieving the 90% Service Level target?
	Are there any factors not represented in the report that you consider necessary for daily activities?
	How would you assess the contribution of this report to improving alignment between the various teams?
	Any suggestion for improvement or comment?

Table 13: Interview Questions for the Supply Chain Manager regarding the SL Report.

2. Purchasing Report

Role	**Purchasing Responsible and Supply Chain Manager**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	How often do you consult the Purchasing Report or the pages automatically sent over e-mail?
	Have you seen improvements in stock levels, consumption and inventory efficiency since you started using the report?
	Are there any areas where the report could better support the Chemicals purchasing workflow?
	What benefits do you see in introducing this report as a working tool?
	Do you see any opportunities for improving the materials purchasing process with the help of the report? (If yes: what are the impediments?)
	Any suggestion for improvement or comment?

Table 14: Interview Questions for the Purchasing Responsible and Supply Chain Manager regarding the Purchasing Report.

Role	**Natural Cork Stopper Production Manager**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	How often do you consult the report or the pages sent by e-mail?
	Have you seen improvements in stock levels, consumption and inventory efficiency since you started using the report?
	Do you find it useful for management support?
	What benefits do you see in introducing this report as a working tool?
	Any suggestion for improvement or comment?

Table 15: Interview Questions for the Natural Cork Stopper Production Manager regarding the Purchasing Report.

3. Production Report

Role	**Production Manager, Supply Chain Manager and Production Planner**
Interview Questions	Were you familiar with PBI?
	Have you consulted reports before?
	Do you find the navigation in the report intuitive and the information clearly presented?
	Can you talk about your experience of using the report?
	Can you give examples of how the report has influenced your approach to decision-making or daily activities?
	How relevant do you perceive the introduction of a production service level metric?
	How has the report helped you fulfil the weekly plan for production?
	Any suggestion for improvement or comment?

Table 16: Interview Questions for regarding the Production Report.

Subsequently, the translated transcripts of the interviewees' answers to the questions presented above will be presented. The order of the reports as has been done so far and as described in Table 5 will be followed.

1. Service Level Report

Interviewee 1 - Agglomerate Cork Stopper Production Manager

Question 1: Were you familiar with PBI?

Yes, more or less. I've had training but I don't use it, I'm just an information consultant, so as a consultation, yes.

Question 2: Have you consulted reports before?

Yes.

Question 3: Do you find navigating the report intuitive?
Yes.

Question 4: Does the report present the information in a clear and understandable way?
Yes. I think it's intuitive because it's a matter of having experience in consulting reports, but yes, it's clear. As soon as new users realise the tricks (of using CTRL and making a selection, for example) and see the potential of it, for example if in a Power BI [report] we have several graphs and from the moment we select a component in a graph if they know the potential it has, that all the others are altered accordingly, yes, it has very great potential and it's very easy from that moment on. Where I come from, that was the biggest difficulty.

Question 5: How do you integrate the Service Level report into your daily work?
At the moment, as I'm also in a transition phase, I haven't integrated it yet, but I'm going to because it's in my interest to consult, it's also in my objectives. What I'm going to do, I won't say every day, but at least twice a week to see where we stand, and we consulted today at the planning meeting.

Question 6: How does the report contribute to your daily tasks or decision-making?
At Amorim [headquarters] we already had this culture [of following the Service Level] and we had many indicators that we measured on a daily basis, not in Power BI but which are now being transferred, but we also followed them. Here, the attempt is always going to be to make people realise the importance of this, because making them see that, especially and even more importantly in the case of dependencies, such as marking and technical stoppers, if we don't do our part,

it's impossible for our partners (in this case we're their internal suppliers) to fulfil their obligations and we all have to work towards this, and the same goes for what goes directly to the customers of the agglomerates. Making those in charge of production and on the shop floor aware of this is very much a matter of raising awareness, and I don't think there's any other way to do it either, it's to show examples and show some of the consequences they might have.

Question 7: Is there any information specific to your department that you feel is missing?
From what I've seen, no.

Question 8: Any suggestion for improvement or comment?
Not at the moment.

Interviewee 2 -Natural Cork Stopper Production Manager

Question 1: Were you familiar with PBI?
Yes.

Question 2: Have you consulted reports before?
Yes.

Question 3: Do you find navigating the report intuitive?
Yes.

Question 4: Does the report present the information in a clear and understandable way?
Yes.

Question 5: How do you integrate the Service Level report into your daily work?
I don't use it.

Question 6: How does the report contribute to your daily tasks or decision-making?
It's very useful, it's very intuitive, even though it's in English.

Question 7: Is there any information specific to your department that you feel is missing?
I don't think so, I think it's quite centralised. Also a lot of indicators and a lot of searches, sometimes wanting to scrutinise too much also ends up with you not having the information you need and here I think it's compacted, it's fine.

Question 8: Any suggestion for improvement or comment?
I don't have anything.

Interviewee 3 - Technical Cork Stopper Production Manager

Question 1: Were you familiar with PBI?
I was, I'd learnt about it at college. I'd had training at college because they offered it and I took it.

Question 2: Have you consulted reports before?
Yes.

Question 3: Do you find navigating the report intuitive?
Yes, it's easy to see by section what level of service we have, yes.

Question 4: Does the report present the information in a clear and understandable way?
Every time I look at it I can understand what's there, so yes, it's intuitive.

Question 5: How do you integrate the Service Level report into your daily work?
We always have the 4 Planning meetings every week and in those meetings we always see what level of service we're at in each section.

Question 6: How does the report contribute to your daily tasks or decision-making?
I can see which customers I need to focus on the most, where we can have the lowest level of service, and that's where I then focus.

Question 7: Is there any information specific to your department that you feel is missing?
In terms of televisions [in the shopfloor], there are some reports that could be there because we only have the packaging report and, for example, that service level report would be good for people to see how we're doing and be either shocked by a customer we're not fulfilling or happy because we're managing to fulfil everything. We have the televisions, but they haven't put the report up yet. For example, the television is there in the dispatch and it was important to have the level of service. We're now going to have the objectives and one of their (factory staff) objectives is the level of service, it's not official yet but if we have the level of service there [on the televisions] where we're going they can see if we're meeting the objective or not.

Question 8: Any suggestion for improvement or comment?
I don't have anything at the moment.

Interviewee 4 - Production Planner

Question 1: Were you familiar with Power BI?

Very, very little. I didn't have any experience of Power BI on the course, I only had it here at the company and it was basically for consulting our sales. In other words, my experience with Power BI is only that of consultation, but yes, I was already familiar with the application. We had a presentation to understand what Power BI was going to give us, but nothing special, just simple queries.

Question 2: Have you consulted reports before?

Yes.

Question 3: Do you find navigating the report intuitive?

Yes, I think it's intuitive, I think it's very easy to understand what it's trying to convey and I think that's important so that the factory can also access the report as easily as possible. The only thing about the Service Level report is that it's too slow, it takes too long to load (...).

Question 4: How has the report changed or complemented your day-to-day tasks? What differences have you noticed since implementing the report?

As far as my work is concerned, it's improved immensely because I can get the people in the factory much more aligned with our objective and I've used the report in at least 3 of the 5 meetings I usually attend to show the level of service. What's more, it's going to be an objective of ours in 2024 and it's important for people to realise that this is important for our objectives.

Question 5: Has the report influenced your planning decisions?

Yes, a lot. We didn't follow it so much before, now we're starting to. My planning is much safer, there you go, the safety coefficient has increased a lot since we started having the report, plus the customer will benefit from it, because if we're safer, the customer won't expect the order on the day they asked for it, but if it's the day I've communicated, at least we'll fulfil it, which we didn't even do before.

Question 6: How do you perceive the report as a reporting tool for achieving the 90% Service Level target?

I think the most important thing is for those responsible for production to be aware of what the Service Level is in each area and it's also important to be able to see by area, for example at the moment there's a sector that's clearly below the others and it's healthy competitiveness, in other words, people are always going to be looking for the goal and they're always going to improve their efficiency and their work.

Question 7: Are there any factors not represented in the report that you consider necessary for daily activities?

I don't think there's anything special that I can think of in this Service Level report. Okay, we have this problem of keeping track of orders that have failed, but that's being resolved in the meantime. But I think we have all the information.

Question 8: Any suggestion for improvement or comment?

Nothing.

Interviewee 5 - Production Manager

Question 1: Were you familiar with Power BI?

More or less.

Question 2: Have you consulted reports before?

I have.

Question 3: Do you find navigating the report intuitive?

Yes.

Question 4: Does the report present the information in a clear and understandable way?

Yes. I think it needs to be explained a bit [for new users], because the very fact that some concepts are in English may not be quick to understand for those who are in the factory, but perhaps that could also be solved by adding an explanation or switching to Portuguese.

Question 5: How do you integrate the Service Level report into your daily work?

I haven't started using it on a regular basis yet, but since we're going to be monitoring it this year, I'm going to start using it. Every morning before we have the reports, I update the cubes in SAP to find out about stocks, shipments and other indicators, so I'm going to start using it too, and even in my team meetings.

Question 6: How does the report contribute to your daily tasks or decision-making?

Yes, basically at the moment it's still a bit about awareness, but then it's also about follow-up and monitoring to take action to avoid deviations, namely, for example, the fact that last week we were already where we have the worst level of service, I already held a meeting yesterday to take action to prevent some of the problems that happened this week from happening again and to anticipate problems.

Question 7: Is there any specific information that you feel is missing?

At the moment I think we're going through a phase where we don't have any information and now we're starting to have a lot of information, so maybe now we have to digest it and then maybe over time we'll realise what we need most. But there are a few things, particularly impairments, which we haven't monitored much because we don't have a very high level of impairments, but over the course of this year we'll have a history and so we'll need to monitor them. Basically, as we get more, we'll also be more aware of more and want more.

Question 8: Any suggestion for improvement or comment?

I don't have any at the moment, because I haven't started using it yet either.

Interviewee 6 - Supply Chain Manager

Question 1: Were you familiar with the PBI?

Yes.

Question 2: Have you consulted reports before?

Yes.

Question 3: Do you find navigating the report intuitive (especially for new users)?

Yes.

Question 4: How has the report changed or complemented your day-to-day tasks? What differences have you noticed since implementing the report?

In the specific case of this report, I think the main thing that was done was also to define the indicator, which was something that didn't exist before. So we basically created the indicator here for SOCORI and it ended up making our

weaknesses evident in the various areas and for the various clients, so I think that this realisation was the great added value, at least at an early stage in the implementation of the report, which immediately had results because people then started working to improve this value.

Question 5: How do you perceive the report as a reporting tool for achieving the 90% Service Level target?

The report is very concise and straightforward, on one page we can practically see the result and immediately draw all the conclusions regarding the load, regarding the distribution between the various areas of SOCORI, regarding SOCORI's various clients and even regarding the client's expectations vs. our level of production. So I don't think it will be for lack of information and this context that we won't achieve the level of service we set ourselves.

Question 6: Are there any factors not represented in the report that you consider necessary for daily activities?

I think the next step we could take in this report is, based on the orders that have been placed, which ones would be the next to default. Basically, it would be to have a list of the next ones that we would have to pack in order not to default, almost like an airport list of the next orders to be completed. This is an evolution of the report, it's not something that at the moment, based on what we set out to do, fails. What you set out to do is being fulfilled, I think the next level is for us to know which order is going to have an impact. In the logic we were talking about, what is reporting and what is action, this is a bit of reporting and if you had that you'd already be conditioning action, because you're already saying "be aware that this [order], if you don't do it, you're already going to fail [the service level]" and then people would consult and say "let me just see if my work plan for today means I'm going to fail something, let me see if there's anything I've

missed", you know? And that doesn't do it, it only does the result of the day, you can't use it to plan the day.

Question 7: How would you assess the contribution of this report to improving alignment between the various teams?
I think the report fulfils the purpose of making visible all the weaknesses we may have and it's a report that both the logistics team and the various production teams that interact with each other, which is the case of the agglomerates for the techniques or the techniques for marking, and even quality, all manage to be involved and realise the impact it has on the service. So I think it fulfils the objective and the premise of involving everyone towards our common goal.

Question 8: Any suggestion for improvement or comment?
I'd just say that it's an improvement, but it's an evolutionary improvement, not a corrective improvement of trying to make this more of a tool for action and not for reading what's happening.

Purchasing Report

Interviewee 1 - Natural Cork Stopper Production Manager

Question 1: How often do you consult the report or the pages sent by e-mail?
I only look at it when I receive the e-mail, so that's when I see it, very quickly. I only look at that part where you're advising a purchase for three weeks, but one thing I'd like is for the person who places the orders to receive the report and it could be more interesting because I see it and I always have to comment on it with them.

Question 2: Have you seen improvements in stock levels, consumption and inventory efficiency since you started using the report?

We have it right because an inventory is made every Friday, but maybe the person who makes the purchases would have a more critical spirit that I don't have because I look more at whether we have to buy or not and since he makes the inventory he would be more aware of it.

Question 3: Do you find it useful for management support?
Yes.

Question 4: What benefits do you see in introducing this report as a working tool?
It allows us to act on the validation of existing stocks and give us a purchasing perspective, so we're not buying too much or too little, so I think it's a great help because doing this management without elements is not what we want, we want to [buy] at the right time and in the right measure.

Question 5: Any suggestion for improvement or comment?
For the rest, it looks good.

Interviewee 2 - Purchasing Responsible

Question 1: Were you familiar with Power BI?
Yes, I'd had a presentation but had never had the opportunity to use it.

Question 2: Have you consulted reports before?
I've only had this 2 or 3 hour presentation on the tool. It's a very useful and interesting working tool. The presentation was about how we could consult it, but I didn't explore it much.

Question 3: How often do you consult the Purchasing Report or the pages automatically sent over e-mail?

Every day. Some days I look more closely at the information there, others I just glance at it, but every day I receive [the pages in the e-mail], I see the stocks and quantities to buy and what's already ordered to see if it's there on the map.

Question 4: Have you seen improvements in stock levels, consumption and inventory efficiency since you started using the report?
Yes, I went to the field yesterday and the quantities that are there don't correspond to reality, so it's not what's in the report that's wrong. It could be the consumption that's wrong.

Question 5: Are there any areas where the report could better support the Chemicals purchasing workflow?
I think it's fine the way it is.

Question 6: What benefits do you see in introducing this report as a working tool?
It's a very useful working tool that gives us the stock, that gives us the weekly consumption, that gives us the quantities that are already delivered and to be delivered, that gives us the quantities to order in the following weeks. We haven't put the purchase suggestions into practice yet because the stocks aren't correct, but once we get this right it will be a very useful working tool. We're still physically adjusting it here.

Question 7: Do you see any opportunities for improving the materials purchasing process with the help of the report? (If yes: what are the impediments?)
Yes, I see added value in the sense that it will tell us what to order on a weekly basis, so we don't have to wait for a colleague to say "place this order" or "place a requisition". Looking at this map, the aim is to see here the quantities to order

for the near future. I don't see anything stopping it, and once the quantities are all fine-tuned it could be a very useful working tool.

Question 8: Any suggestion for improvement or comment?
I don't have anything to say at the moment.

Interviewee 3 - Supply Chain Manager

Question 1: How often do you consult the Purchasing Report or the pages automatically sent over e-mail?
I consult the pages sent by e-mail every day, I open the report every day, because the premise of the report, especially the Continuous Review, is that we review it every day, and the Periodic Review is weekly, but at this early stage I think it's pertinent to analyse it every day. So the answer is that I consult the report every day.

Question 2: Have you seen improvements in stock levels, consumption and inventory efficiency since you started using the report?
Here the challenge is a little different because once again, when we create the report, the first impact is always to make it clear that certain things may not be happening correctly. In this respect, the report is playing its part because, on the one hand, we detect errors in consumption, which are being corrected, there is a plan to correct them related to the systems, with faults in the connection between the machines and the system, on the other hand, there are errors, and because of the errors in consumption, there are errors in the stock because if consumption isn't being made, the stock is constantly increasing, and so in the cases where this happens, it has a bit of an impact on the analysis and suggestions that the tool makes. In other cases, I think the tool is working as expected and alerts us, as it has already done, to cases in which the stock level was relatively low and we

should already be placing an order and there is none placed, so it is already fulfilling its purpose in cases where there are no such production issues, although the cases in which we would be most interested are those with the highest volume of activity, which are those with consumption errors. Why is that? Because in the case where you consume an IBC every two months, if you have three IBCs in stock there, it's very easy for people to realise the error. In cases where you have fifteen, twenty IBCs in stock, in management, having twenty or eighteen or twenty-five are figures that don't shock you and that, if they aren't constantly confirmed physically, aren't corrected. The report is returning correct calculations, according to the premises it's given, we just have to correct the premises, not by the report, by everything. In other words, even by our management because we're not including the chemical in the consumption of that material and so the material is becoming cheaper, and then a stock adjustment is made which cancels out the chemical stock. So the answer is, in the case where stocks and consumption are correct, the report is working as expected and fulfils our expectations. The point is: we still haven't managed to realise the full potential because in products such as the top 5 materials with the most sales, we still have a lot of consumption errors and even inventory errors that make this impossible. In any case, (...) for example, in this material the purchasing manager already has orders placed for a fortnight, in other words, you'd never see orders placed for a fortnight, and here's the suggestion to place orders for the future, which is what she's going to formalise. Therefore, our intention is that in a large part of the materials there will start to be orders for more than one month, which is also the purpose of this report, as you can see there are already initiatives starting to be taken here so that in the most consumed materials we don't order when there's a shortage, but we order based on the forecast of what we're going to have and then adjust, obviously.

Question 3: Are there any areas where the report could better support the Chemicals purchasing workflow?

I think that the fact that this is already going to the purchasing manager and the production managers who make the requisitions, I think that's support in itself. In the event that the purchasing manager wants to influence, and she can, certain materials and go ahead with purchase orders even before she has the requisition (because the requisition doesn't always have to give rise to the purchase order, if we already have the purchase order in place they can place a requisition for something that is already formalised). What does this mean? This means that what she has done, placing orders for a fortnight, even without having a requisition, means that the person who is going to place the requisition and who receives this every day (...) already interacts based on what is actually placed and therefore it is the way that the purchasing manager has to place orders herself because she knows that the next day they will receive the report and they will be aware of what is in the system, because before if she had the audacity to do this there would be confusion here because the people in the factory didn't know what was already ordered from the supplier. In this respect, I think it was the way we had to take the next step, which was to make it clear to the purchasing manager that she's going to miss products because she's not in the field and here she's starting to be aware because she's starting to give alerts, and to them that the requisitions they've put in or the analysis the purchasing manager has done have already led to orders and that the orders are already formalised and in what quantities and for what weeks. So, I think we've achieved what we wanted to do by making the purchasing manager much more comfortable with what's happening in production, and production also more in line with what it has already formalised with the supplier.

Question 4: What benefits do you see in introducing this report as a working tool?

I think this report is the one of those that have been developed that will have the most impact on actions because it has consequences. In other words, this is the report that suggests something that, from the outset, will be carried out just as much as the suggestion, the better the consumption and stocks are recorded. And that's why we're focussing a lot on these areas at the moment.

Question 5: Do you see any opportunities for improving the materials purchasing process with the help of the report? (If yes: what are the impediments?)
I see an improvement, (...) we can evolve to the packaging part, in addition to the chemicals, we can evolve to the possibility of a monthly view, the same as this one but monthly, why?, because here we are very much in daily management but we do the negotiation of chemicals by the quarter, for example, at the moment we are closing the chemical contracts until the end of June and based on this report I don't have the input for that. Obviously I only do it every three months and this is done every day, so the report is much more interesting because it takes the daily effort out of people's lives and another thing is that once a quarter the purchasing manager and I have to do a different analysis, which is practically just to go to this report to these metrics and change them to monthly instead of weekly and that's it. It's easy to implement, but the report we get isn't something out of the ordinary either, in the sense that we're only going to look at that page once a quarter. (...) Finally, but this is something that I think is more difficult, is to integrate this with what is in the orders for stoppers. In other words, we're always positioning our needs based on past consumption, but it would be interesting if we had some input on what's on order, because we know the future, it's in the order book, it's what's firm, especially for this horizon. For the quarter, I'll admit it's difficult, you don't have firm orders, but for next week the planning has the orders, for two, three and four [weeks] from now too, because if an order comes in now, the likelihood of it being planned for three weeks or four weeks

from now is much greater than it being planned for today. Therefore, an improvement we could have for the future could be to integrate this with firm orders, where the difficulty is much greater in the integration, because you're no longer just talking about a purchasing and consumption model, you'd be moving on to a part where you'd have to look at the sales cube and include the relationship between the material at the final stage of the process and explode the needs up to these areas of moulding and washing, which is already a different complexity. [To do this in Power BI,] you'd have to change the paradigm a bit: instead of looking at chemicals, you'd have to look at all the sales materials, the open contracts, and say "For this material, per thousand stoppers that I sell, what are the chemicals that I consume" and then based on what's in the portfolio for the week, you'd have to think "For me to sell in week s+3, the consumption of chemicals in moulding will be in week s and in washing will be in s+1", In other words, the paradigm would change a little because you wouldn't be looking at what's happening in the chemicals, your base would no longer be the chemicals but the order book. It's doable from that perspective. It can happen that in a low sales phase, three-week visibility is very low, because we don't have that much volume of orders, they come in and they come in for now because we have availability and we don't have to plan very far ahead, and in these moments of low visibility because sales aren't so high, it's more interesting to look at history because if you look at the backlog you can say "I don't have visibility for three weeks" and suddenly your backlog is full and you say "I do after all". So at the moment we're looking at consumption and predicting what we're going to consume, then if we see that there's a lot of stock left over, the suggestion will readjust itself and say that we don't need as much, in other words, it also works like that. You predict consumption, but imagine that a new week comes along, then the next week passes and instead of consuming seventeen you consume five, all this will be readjusted and so we also react to consumption, but only when

the week has passed. So I think there would be benefits and difficulties with both models, but it would be interesting to have a 50/50 weighting, one linked to consumption and the other linked to sales.

Question 6: Any suggestion for improvement or comment?
That's it.

Production Report

Interviewee 1 - Agglomerate Cork Stopper Production Manager

Question 1: Do you find the navigation in the report intuitive and the information clearly presented?
From what we see in the meetings, it's basically the moulding, the articles that are being made, I have the objective and I have the information on whether we're behind or ahead of our weekly objective, but yes I think it's useful, we always see it in the meetings and I can see if we're behind, if not, and from the values we can see if at that rate we can reach the objective.

Question 2: Can you talk about your experience of using the report?
My experience is still what I see as a third-party consultant, which is what they show at the follow-up meetings and you can tell if we're behind or ahead.

Question 3: Can you give examples of how the report has influenced your approach to decision-making or daily activities?
Looking at the Indicator page and realising whether we have room to slow down or, if not, whether we have to chase the loss. Maybe in the case of moulding it's not so possible, but in rectification if we realise that we're not making the pace, we try to correct the delay we were going with.

Question 4: How relevant do you perceive the introduction of a production service level metric?

For self-awareness of our performance, basically. All of us and the business area have objectives and any company must always be guided by the level of service, whether it's services, products or whatever. And I think that's the basis for realising what we're doing on the shop floor. Of course, I'll talk about this with an operator and he'll tell me that he doesn't care, but this is the first person who has influence and it's about trying to raise awareness so that we're all in the same boat and rowing in the same direction.

Question 5: How has the report helped you fulfil the weekly plan for production?

I think the approach is different from the outset in that Power BI, the great potential it has for me is sending daily reports, subscribing to some reports, and I think that with zero work, apart from the developer of course, I can get to my workstation at 8 o'clock in the morning and realise from the previous day's photo what my performance was in relation to the plan and be able to take some action to go back and fulfil the plan as quickly as possible. With an Excel file, maybe, either because it took a long time to update, or because it took a long time to get there, people didn't do it every day, they did it every two days and that's enough. In other words, we can react much more quickly with Power BI reports.

Question 6: Any suggestion for improvement or comment?

None.

Interviewee 2 - Technical Cork Stopper Production Manager

Question 1: Do you find the navigation in the report intuitive and the information clearly presented?

Yes, I'd like it to have some graphs too. It would also be interesting to have a graph of the indicator's weekly evolution underneath the table.

Question 2: Can you talk about your experience of using the report?
In the morning, when I arrive, I always tend to look at the work we did the day before. Then for the rest of the day I don't look at it so much because my focus is on arriving in the morning and seeing what was done the day before, that's basically how it is.

Question 3: Can you give examples of how the report has influenced your approach to decision-making or daily activities?
On a weekly basis, as we end up focusing a lot on the moulding indicator, I can see what I'm going to end up receiving more or less of, in other words, if I notice that the moulding machine is weak, I'll say straight away "Be aware that if the moulding machine continues to produce what it's producing, during the week I'll stop the machines because I won't have enough bodies to produce [the stopper]".

Question 4: How relevant do you perceive the introduction of a production service level metric?
We've kept to the weekly plan. There's one customer who's getting away from us a bit at the moment, but the most important ones we have, which are direct to my area, we've always fulfilled their orders.

Question 5: How has the report helped you fulfil the weekly plan for production?
In my opinion, as people didn't have as much vision in the sense of visualisation [of information], they knew what was being done. But visually realising what was being done I think was more important for them to understand whether

we're producing well, whether we're producing badly, what we need to do to perhaps produce more and to start to get a sense of reality and what production is like.

Question 6: Any suggestion for improvement or comment?
I don't have anything at the moment.

Interviewee 3 - Production Planner

Question 1: Do you find the navigation in the report intuitive and that the information presented clearly?
I think the navigation is very intuitive (...) In production I think everything is clear, we can see the production and what the objective is. I don't use the front page very much, maybe when you open the report I'd go straight to production, which is what people want to see. But yes, I think the navigation itself is very intuitive, it's easy.

Question 2: Can you talk about your experience of using the report?
We use the report basically every day, if it's not 5 days a week it's 4, there's only one meeting where I probably don't need it, but I use it every day and it's been quite important. In other words, I stopped using what I used to use before to use this one. I use it in meetings to align what we're producing this week and what we're supposed to produce next week and in the following weeks, in other words, I do the monthly planning for each machine, in this case the moulding machine, and it allows us to keep track of all the production we've done with the production managers.

Question 3: Can you give examples of how the report has influenced your approach to decision-making or daily activities?

With the introduction of this report, we are much more able to demand from production what we want in a factual way, in other words, we have data to present to say that this machine didn't actually produce, what it had to produce. By presenting the report, people are much more aligned and there's no way of evading the issue, I think that was the main help. Because in meetings we often didn't have such good follow-up on production before, people would say that [a certain machine] had broken down but they couldn't give concrete justifications. We had this in Excel, the report is much more intuitive in terms of comparing the target and the quantity, in other words, in Excel we actually had the production but the target value wasn't close, so we couldn't see how it compared with the target.

Question 4: How relevant do you perceive the introduction of a production service level metric?

Just monitoring the indicator is half the battle so that we can have better planning and a better relationship with production in order to fulfil the objectives. In our factory this is the starting point of production, in this case it's the main one, and this will have a big influence on our overall service level, it doesn't influence everything because there are other processes ahead that may even be more bottlenecked than this one but I think that in general the bottleneck is always moulding because it has to be aligned with the orders at the end of the process and I think that following the indicator will allow me to have better planning, to have safer planning and to miss many fewer orders.

Question 5: How has the report helped you fulfil the weekly plan for production?

By presenting the productions it's much easier for them to be clear about what the objective is for the week and to follow this up for their area so that they're aligned with production. Then in the report it's possible to filter by families,

which means that we can have a more objective conversation in the meeting and that questions can be put to the right person in charge of each section. It's also possible to put comments on each machine and this has been important so that in the meetings we don't forget any important issues and can align so that we don't miss anything.

Question 6: Any suggestion for improvement or comment?
I don't think the first page is used much, the table isn't used that often. And maybe it could even be the first page, but with a graph related to the production of each machine, more intuitive for people to look at, to see the level of production service and production. The cards probably don't say much to those who are going to consult the report, they don't help much. The graph divided by machine is just to make it more automatic.

Interviewee 4 - Production Manager
Question 1: Do you find the navigation in the report intuitive and the information clearly presented?
Yes.

Question 2: Can you talk about your experience of using the report?
It's more just for reference.

Question 3: Can you give examples of how the report has influenced your approach to decision-making or daily activities?
For example, if we can't make the planned quantities, we're probably going to have to intervene on the machines, either in terms of potential breakdowns or in terms of approving materials to be put into the machines, because if we haven't made the production, why not? In previous weeks we had some moulding

machines stopped because we didn't have any orders, in other words, we may not be making production not because we haven't managed to fulfil our orders, but because we intentionally didn't do it so as not to stock up. In normal situations in which there are fewer orders, of course the fact that we don't fulfil production immediately triggers corrective action to prevent it from happening again.

Question 4: How relevant do you perceive the introduction of a production service level metric?
I think it's important, because whether it's a customer or an internal supplier, it's very important for us to be aware of how we're responding to those who ask us for something. Of course, this is a bit of a fad, the logic of seeing things in terms of service level is a relatively recent concept. But I think that if we carry out a certain process, we should be evaluated for what we do and therefore the level of service is the consequent evaluation of the effectiveness of our work.

Question 5: How has the report helped you fulfil the weekly plan for production?
It's quicker and much more systematised, because before we had to make all those corrections by hand. Basically, we were already doing it using the same logic as the report.

Question 6: Any suggestion for improvement or comment?
I don't have any, but I think they will happen as we use the report.

Interviewee 5 - Supply Chain Manager

Question 1: Do you find the navigation in the report intuitive and the information clearly presented?

Yes. I think this is the report that still has the most things that are little explored, in other words, the first page I think is a little used page, the information it gives is not that direct, then, for example, the table (...) says little, it's not doing much here. I think the second page is very interesting, it's our working tool, planning uses it for comments, it's used to align everyone on what needs to be done on each machine, it monitors how the moulding machines are doing, whether we're doing well or badly, it's our working tool four days a week for aligning with production, so it's even the report that's used the most. Basically, this [report] is the one that has both, although it's more basic, but they don't have to be complex to be useful, it has the reading of what happened, the result, and it has the action, which is the objective. This works with kanban, as a weekly production order, and it works as an interpretation of what has been done, in other words, from that perspective it's very useful, because it's a simple thing that has a lot of applicability, and then the indicator is a plus, it basically compares our level of production with our actual level of service to the customer so that we realise that if there is a fluctuation in the result of production planning, this also has an impact on the level of service. In other words, this report ends up helping to partly explain our service problems, it doesn't explain all the issues, but it does explain those in terms of moulding production, more specifically.

Question 2: Can you talk about your experience of using the report?
This report, as I was saying, we use four times a week, which is when we sit down with production to monitor the difficulties and the fulfilment of the production plan, so we use it at least four times a week and I think that already makes it a very useful report because of that.

Question 3: Can you give examples of how the report has influenced your approach to decision-making or daily activities?

We had the premise of our objective and then we read the actual quantity that is carried out on each machine. The result of the indicator and especially the result of the indicator per machine gives planning inputs on the degree of reliability in each machine and each product, because there are machines that have weaknesses and we know that what production and maintenance expect it to do doesn't always happen. If it doesn't happen in an acceptable percentage, we'll have to lower our expectations so that we don't disappoint the customer. And the same goes for materials, which we know we have difficulty with due to the particularities of the raw material used to produce them, we know we're not going to achieve what's in the budget, so to speak, here in this definition of objectives we're already influencing them because the combination of the definition of the objective with the premise that we encourage them to do more and better, but at the same time that what we've defined has a greater result in the production indicator, so that this also gives us the confidence to commit to the dates we give our customers in the orders. That's why, on the one hand, we want them to produce a lot (...) but if we consistently have these [high production quantity] values, we'll probably help the machine's objective, but if I have that result in a specific week, I'd rather keep the expectation (...) and always have 100% service on this machine and commit myself correctly to my customers and even manage to anticipate some needs sometimes, than to say that it does x and use that to give dates and then be defrauded because it can't consistently achieve that.

Question 4: How relevant do you perceive the introduction of a production service level metric?

As I explained before, the higher the production service level, the easier it is to fulfil the customer service level. Obviously, we know that we have ongoing production and so we have a buffer here and we've managed to absorb some of

these failures, not least because we also have redundancies and safety coefficients in the planning, but even so they can't cope with 30 per cent production service level, they can cope with 70 per cent, not much less. So it's important that this is achieved and monitored to ensure that we continue to have safety. And don't forget that planning has to give dates within 24 hours, which puts a lot of pressure on us. An order that comes in right now to fulfil, if it's with non-standard stoppers and the planning has to go to actual moulding, we probably have a lead time of three weeks and so this all has to happen in sequence and aligned so that things reach the packaging at the right time.

Question 5: How has the report helped you fulfil your weekly plan for production?

Since it was implemented I think the difference is that people have a different visual perception, even with the conditional formatting, it makes it much simpler to interpret by group and it makes it accessible from their side because the report is available for them to consult and if they have any doubts about how much was planned, therefore, In this respect, I notice that everything is much clearer for the chipboard moulding team, and even for the technical team that will be receiving chipboard production, because they have an idea of what is planned and what is being done, so they also have to be aware of what is to come based on the production that is being done. And if we're already creating the logic of the service level from the customer's point of view, i.e. converting orders placed into a percentage, I think we should also start converting the number of machine-material-week plans successfully executed into a number, which already exists, we just need to make it more visible.

Question 6: Any suggestion for improvement or comment?

I agree with the suggestion made about the graph and I would say that we should be a bit careful here because it's almost better to stretch out the graphs and have less information than to have a map here that nobody uses. (...) Even following on from what I said about the level of service, which is that there isn't even a presentation page, you go straight to the indicators page and it works. These are quick working tools, it's not exactly a company management report that's 15 pages long and so we're going to put a cover here with some introduction cards, it might not make sense here, because it might even make more sense in the service level report to go into those details, or in the purchasing report, than in the production report where people want to go into detail straight away. That's not to say that the overview isn't there, I'm just saying that either it's more streamlined, i.e. the production person comes in and sees and they're retained and every day he can monitor that value (...), or you go to the report and see how much the accumulated production is, how much the service level is, maybe it's worth more than being here in the overview in a table than in a table with lots of scrolls. (...) It's not filtering, but even if the table filtered, this table is the objectives that are also in this table [on the Production page] and that are also in this table [on the Indicator page]. Do we want to see this in the Overview as well or are we blurring it? Does it make sense for this graph to be filtered by that? Because then if it's an overview it shouldn't have a filter, in other words, here you're forcing it to be impossible to move.