Business process transformation: the case of the cork stoppers industry

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Master's Dissertation

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Abstract

Portugal's cork trade has experienced significant growth in recent years, prompting cork companies to improve performance. This master's dissertation explores the business transformation of the current operational model of a cork stopper manufacturing company through the assessment of current processes and the design of a future model.

Through a literature review, the theoretical foundations and key components of Business Process Management (BPM) and Digital Transformation were explored. A comparison of BPM lifecycle models was conducted as well as an assessment of the need for digital transformation and the success criteria for project implementation.

By adopting a customized approach developed by PricewaterhouseCoopers (PwC), the project addressed the specific requirements of the company from production planning to the warehousing of stoppers with heads. Interviews, workshops, and shop floor visits were conducted to collect information about the company's current processes.

The assessment phase of the current operational model involved a detailed quantitative data analysis, with a specific focus on key performance indicators and the construction of dashboards. Based on this information, the four main processes were mapped and 20 constraints were identified, mainly associated with inefficiencies in processes and information systems.

The design of the operational model was achieved through the development of recommendations for the identified constraints. The process map was created to illustrate key processes based on the most effective recommendations. Additionally, a manual of functional descriptions was developed to provide detailed guidance on the tasks of various functions. The expected results of implementing these improvements were identified from both short and long-term perspectives having an increasing process efficiency and digital engagement of the company.

In conclusion, this dissertation reinforces the importance of a structured project approach for a project of this nature. Future work includes performing the implementation phase, defining key performance indicators, and enhancing the dashboard for data analysis. This dissertation presents a discussion that can serve as a basis for future research in process management, digital transformation projects, and consulting practices in the cork stopper industry, among other sectors.

Keywords: Business Process Management, Digital Transformation, BPM, Business Transformation

Transformação de processos de negócio: o caso da indústria de rolhas de cortiça

Resumo

O comércio de cortiça em Portugal registou um crescimento significativo nos últimos anos, o que motivou as empresas do setor a procurar melhorar a sua eficiência. A seguinte dissertação de mestrado explora a transformação do modelo operacional atual de uma empresa produtora de rolhas de cortiça através da avaliação dos processos e do design de uma proposta de modelo futuro.

Através de uma revisão de literatura, foram explorados os fundamentos teóricos e os componentes-chave da Gestão de Processos de Negócio (BPM) e da Transformação Digital. Foi realizada uma comparação de modelos de ciclo de vida de BPM, avaliada a necessidade de transformação digital e os critérios de sucesso para a implementação de projetos.

Ao adotar uma abordagem personalizada desenvolvida pela PricewaterhouseCoopers (PwC), o projeto contempla os requisitos específicos da empresa, num âmbito definido desde o planeamento até o armazenamento das rolhas capsuladas. Para obter informações sobre os processos existentes da empresa, foram realizadas entrevistas, workshops e visitas ao chão de fábrica.

A fase de avaliação do modelo operacional atual envolveu uma análise detalhada de dados quantitativos, com foco específico em indicadores e a construção de *dashboards*. Com base nesta informação, os quatro processos principais foram mapeados tendo sido identificados 20 constrangimentos principalmente associados a ineficiências nos processos e sistemas.

O desenho do modelo operacional foi realizado com base nas recomendações desenvolvidas e no mapeamento do modelo. O mapa de processos foi criado para ilustrar os processos-chave com base nas recomendações mais eficientes. Adicionalmente, um manual de descritivos funcionais foi desenvolvido para fornecer orientações detalhadas das tarefas das diversas funções. Os resultados esperados da implementação dessas melhorias foram identificados nas óticas de curto e longo prazo levando a uma maior eficiência de processos e agilidade digital.

Em conclusão, esta dissertação reforça a importância de uma abordagem de projeto estruturada a um projeto desta natureza. As oportunidades de trabalho futuro incluem a fase de implementação, a definição de indicadores-chave de desempenho e a potencialização do *dashboard* para análise de dados. Esta dissertação apresenta uma discussão que poderá servir de base para futuras pesquisas em gestão de processos, projetos de transformação digital e práticas de consultoria na indústria de rolhas de cortiça, entre outros setores.

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Luís Carvalho Malheiro da Silva

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Acronyms

ABPMP	Association of Business Process Management Professionals
AI	Artificial Intelligence
APCQ	American Productivity & Quality Center
API	Application Programming Interface
BOM	Bill of Materials
BPM	Business Process Management
BPMN	Business Process Model and Notation
COO	Chief Operating Officer
DT	Digital Transformation
ERP	Enterprise Resource Planning
MES	Manufacturing Execution System
MO	Manufacturing Orders
OEE	Overall Equipment Efficiency
OTE	On-time Expedition
KPI	Key Performance Indicator
PwC	PricewaterhouseCoopers
RACI	Responsible, Accountable, Consulted, and Informed
UR	Utilization Rate

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1 Introduction

This dissertation was developed within the Master in Engineering and Industrial Management at the Faculty of Engineering of the University of Porto. The developed work revolves around a consulting project aiming to assess and design an improved model for a company within the industry of cork stoppers.

The opening chapter of this dissertation serves as an introduction, providing an overview of the presented research. The chapter begins with the highlight of the underlying motivation behind the project, followed by an introduction to the Consulting company where the dissertation was developed, and a description of the Client company. Subsequently, the project's objectives are presented, followed by an examination of the planning process and team composition, of which the author of this dissertation is an integral member. Lastly, on the chapter there is a comprehensive outline of the master dissertation structure and a brief overview of the subsequent chapters' content.

1.1 Motivation for the project

Cork trade created a significant trade surplus for Portugal in 2019, over 860 million euros. This surplus ranks among the largest in all sectors of the Portuguese economy and showcases a significant growth of 31% since 2010 (APCOR 2020). Considering these trends, it becomes essential for cork firms to investigate ways to improve efficiency and capitalise on future opportunities in order to keep their competitive advantage.

To achieve these goals, for a comprehensive assessment of the existing business processes employed by cork stopper companies and the identification of areas for improvement through. BPM and Digital Transformation initiatives are good tools to conduct such an assessment (Fischer, 2020).

The motivation for this master's dissertation arises from an ambition to examine and build an improved model for a company operating in the cork stoppers industry. This dissertation strives to enable the company to enhance its processes, increase its efficiency, and strengthen its position within the competitive market landscape.

Moreover, this master's dissertation aims to make a valuable contribution to the body of knowledge in the disciplines of industrial engineering and management, Business Process Management (BPM), and Digital Transformation (DT). The results of the research have the potential to support consultants, researchers, and industry experts interested in improving operational efficiency in similar industrial contexts.

1.2 PwC

PricewaterhouseCoopers International Limited is a network of mutually independent firms supports organizations and people in creating the value they need. PwC is the brand that identifies the firms that are members of PricewaterhouseCoopers International Limited. The company was founded in 1998 with the merger of two organizations in the United Kingdom. With offices in 152 countries and almost 328,000 people, PwC is among the leading professional services networks in the world (PwC 2023).

The company's mission is to build trust in society and solve important problems. With its deep industry expertise and multidisciplinary approach, PwC offers a wide range of services. Its commitment to deliver high-quality services and its dedication to innovation have earned the firm a reputation for excellence. PwC has been in Portugal for over 60 years delivering high quality in three Lines of Service: Assurance, Tax and Advisory services.

Advisory services aim to enhance client companies' performance through a number of services, namely improving operational efficiency, providing practical support for financial performance, and assisting clients in strategic decision-making, acquisitions, and accessing capital markets. The projects are developed and formulated according to the Client company's unique needs. This Line of Service incorporates a Consulting business unit, which is divided into financial and non-financial services. This dissertation project, managed by a PwC's Consulting team, is primarily focused on business transformation in the non-financial services industry.

1.3 The Client company

The Client company specializes in the design, production, and marketing of innovative cork closures for the wine industry. Established as a family business in 1937, its technological cork closures ensure sensorial neutrality and consistency in both bottling and wine ageing. The company sells around 2.7 billion closures every year and is present in over 80 countries.

Through its commitment to quality, the company has emerged as the market leader in high-end technical cork closures for still wines, sparkling wines, and spirits. The company continually strives for improvement and sustainable development by optimizing production processes and exploring the use of new natural raw materials. This dissertation is focused on the affiliate in Portugal, which operates under the French parent company.

The Client company benefits from strong collaboration with and dependence on the parent company. This relationship requires constant coordination of technology, organizational functions, and procedures. The parent company is responsible for coordinating customer orders and delivering them to the manufacturing units spread across diverse geographical locations.

The company works according to a matrix structure, with divisions based on functional units and product business units. The company is investing in creating new heads for stoppers that are in line with their objective of utilizing technology for sustainable solutions in stoppers production. As a result, the Special Projects area within the Stoppers with Heads business unit plays a vital role in the company's growth and future success.

The Client company's production process encompasses three primary product lines: stoppers, Stoppers with Heads, and monoblocs. For the purpose of this dissertation, the focus will be on

the production process of Stoppers with Heads. In this context, the value chain refers to the sequence of actions starting from the receipt of sales orders until the final delivery to customers.

As Figure 1 illustrates, a stopper with a head is composed of two parts: the shank and the head. The shank is obtained through a series of treatments and operations applied to the raw closure, typically made of cork, in order to prepare it for gluing. The head, on the other hand, is a capsule that is commonly built from wood, plastic, or other materials and forms the upper half of the closure. When a new material is used for making heads, it is classified as a Special Project.

Figure 1 - Composition of a Stopper with Head

1.4 Project goals

The goal of this dissertation project is to support the Client company to improve its current processes, with a particular focus on the manufacturing of Stoppers with Heads. By mapping this business unit's processes, it is possible to identify improvement opportunities that will contribute to increased value creation. The main goal is subdivided into two sub-goals: creating organizational alignment and promoting Digital Transformation.

In the business transformation process, organizational alignment involves improving the company's structure, procedures, and functions to align with the transformation's objectives. The goal of Digital Transformation is to use technology and digital solutions to stimulate innovation and increase efficiency through the implementation of new digital solutions or improvement of the existing ones.

1.5 Project planning and team

The project was structured into two main phases, following PwC's Transform® Framework, which will be explored in depth in the third chapter of this dissertation.

The first phase of the project was the assessment of the current operating model of the business unit in consideration. At the end of this phase, the Client received two key deliverables: a process mapping of the existing operating model, a dashboard for quantitative data analysis, and a list of identified constraints and improvement suggestions.

Following the Client's feedback regarding the outputs from the first phase, the second phase of the project started with the focus on creating an improved processes for the company, taking into consideration the recommendations developed. At the end of the project, three deliverables were presented to the Client: a process mapping of the desired operating model, a functional descriptions manual, and a brochure representing the end-to-end process of new projects.

The project team was composed by three key elements: the monitoring committee, the project manager, and the operational team. The monitoring committee consisted of a PwC partner,

who was responsible for appointing the project team, establishing the scope of the project, and approving the results of each phase. The project manager was in charge of creating a detailed project plan, allocating resources, assigning tasks, and ensuring that the objectives and deadlines were met. Finally, the operational team was composed of three members responsible for supporting project management, executing the proposed tasks and producing the final project results. The author of this dissertation was a member of the operational team.

1.6 Structure of the dissertation

The dissertation is structured into six chapters.

The first chapter provides an introduction to the dissertation, offering contextual information on the project. It introduces the project's motivation, offers a brief overview of PwC and the Client company where the project was developed, outlines the goals, and provides the project's plan and team composition.

The second chapter presents the literature review in order to establish the theoretical foundation for the dissertation. This review encompasses the core topics necessary for understanding BPM and Digital Transformation concepts. Furthermore, it explores the interconnection between those two core areas and identifies the critical success factors for the successful implementation of projects in this domain.

Moving on to the third chapter, it details the case study and describes the approach employed to address the considered challenge. It includes a description of the problem, the scope of the project and its objectives, as well as an explanation of the PwC’s framework and data collection methods employed in this project.

The fourth chapter describes the project's Assessment phase, examining the Client company's current operating model. It discusses the results of the quantitative analysis, the formulation of the current operational model, and the identification of constraints.

The fifth chapter covers the Design Phase, which is the project's second phase. The recommendations that address the previously identified constraints are presented and highlights the main improvements resulting from the implementation of these recommendations, concluding with an overview of the expected outcomes and results.

Finally, in the last chapter, the key project results are highlighted, along with the limitations and future improvements in potential subsequent projects. The dissertation concludes with a comprehensive discussion of the core topics covered throughout the work.

2 Literature review

The Literature review chapter aims to present a detailed overview of the current state of knowledge on Business Process Management and Digital Transformation. Consequently, the literature review will serve as a support to the process transformation performed and the digital recommendations proposed.

The following sections of this chapter will explore the current state of knowledge about the Business Process Management (BPM) area of research, namely the definition of this concept, the main BPM lifecycle models identified in the literature, the Process Classification Framework developed by the American Productivity & Quality Center (APCQ), and, finally, the process modelling notation, the Business Process Model and Notation 2.0 (BPMN 2.0). Later, an understanding of the core concepts underlying Digital Transformation and the reasons why it is required will be covered. Additionally, the state of the art in BPM for Digital Transformation will be examined.

2.1 Business Process Management

A series of recent studies highlight the importance of adapting and changing for businesses to survive. In modern societies, change is an inevitable event that affects business performance and efficiency. According to Andreini et al. (2022), for an organization to produce value, ensure that it maintains a competitive edge, and satisfy consumer expectations, it should consider using Business Process Management (BPM) (Ongena and Ravesteyn 2019).

Companies that have implemented a higher degree of BPM have reported several benefits, including increased production efficiency and performance monitoring, cost savings, and increased use of automated production (Gazova, Papulova, and Smolka 2022). To totally understand BPM, it is critical to first understand business processes. Business processes, in essence, are a series of actions that take many inputs and aim to provide a valuable output for clients (Ubaid and Dweiri 2020).

Several studies regarding BPM have been developing many different models focusing on different aspects of BPM. As a result, different BPM definitions and lifecycle models have been built referring to different process levels (Grisold et al. 2022).

The following sections take into consideration the existing differences in the literature regarding BPM processes and present an analysis that will support the project presented in this dissertation. As so, an overview and comparison of some lifecycle models and correspondent steps as well as the process classification framework and process modelling notation that were the baseline for the project process analysis performed in this dissertation will be presented.

2.1.1 BPM lifecycle

BPM is often associated with a lifecycle approach, which recognises that business processes are not static and, as a result, change and improve over time. The BPM lifecycle refers to the series of stages involved in managing and enhancing business processes inside an organization (Van Looy 2021). Through the use of the BPM lifecycle, it is possible to employ a structured BPM approach to a project based on its specificities that make it unique, namely, both its internal and external factors to the company (Bernardo, Galina, and de Padua 2017).

The literature proposes a variety of BPM lifecycle models that differ among each other regarding their stages and labelling norms. Nevertheless, despite the differences, the models emphasise how BPM processes are iterative and enhance performance. In this section, four different BPM lifecycle models are presented, focusing on the steps and the baseline for their conception.

The research on BPM allowed the author of this dissertation to identify that different authors present different definitions and models for BPM and BPM lifecycles. From the findings, it was possible to select four models that are representative of the performed research. A presentation of the different definitions and BPM lifecycles based on four sources is also explored in this section. Additionally, the information is synthetised in Table 1 which is the foundation for the comparative analysis performed further on this section.

Model presented by Dumas et al. (2013)

According to Dumas et al. (2013), a process can be defined as a combination of events, activities, and decisions that work together to achieve an outcome that brings value to an organization. When a business embraces a BPM initiative, it aims to achieve consistently positive outcomes from its business processes while maximizing the value delivered to its clients (Dumas et al. 2013). Therefore, according to the authors, BPM can be viewed as a continuous cycle centred on the organizational context of the process comprising the following phases:

1. Identification: understand the business problem and collect the relevant processes and connections between them, allowing for an overview of the processes in an organization;
2. Discovery: document the current state of each of the relevant processes to establish an as-is process modelling and assemble a detailed understanding of how people in the organization perceive the performed work;
3. Analysis: identify and organize the issues associated with the as-is process and quantify using performance measures, such as impact and estimated effort required to resolve them;
4. Redesign: identify changes to the process that would address the identified issues and the organization’s performance objectives to assemble a to-be process that serves as a basis for the next phase;
5. Implementation: perform the changes required to move from the as-is process to the to-be process focusing on both the set of activities required to change the way of working and the development of information systems;
6. Monitoring and control: collect and analyse relevant data to determine how well is the process performing with performance objectives.

Models presented by Netjes, Reijers, and van der Aalst (2006)

An alternative study by Van Der Aalst (2004), defined BPM as a tool that uses methods, techniques, and software to support business processes. The objective is to transform these processes, which involve both human resources and multiple sources of information. This view is supported by Netjes, Reijers, and van der Aalst (2006), who presents a similar view on BPM and its phases, although underlining the importance of a monitoring improvements phase. Based on the contributions provided by both studies, the BPM lifecycle can be structured according to the following phases:

1. Design phase: create an alternative for the current process by defining the process structure, resource structure, and resource allocation logic through experimenting and evaluating designs;
2. Configuration phase: implement the created process designs focusing on the detailed specifications defined in the previous phase and once the organization's execution systems are prepared or configured;
3. Execution phase: perform the operationalization of the configured workflow by transferring the process definition to the workflow;
4. Control phase: monitor process performance to be able to provide feedback about their status and make changes in the process;
5. Diagnosis phase: provide information for revealing weaknesses in the process and identifying opportunities for improvement.

Model presented by Weske (2007)

According to Weske (2007), BPM encompasses "concepts, methods, and techniques to support the design, administration, configuration, enactment, and analysis of business processes consisting of a set of activity models and execution constraints between them". The author introduces a BPM lifecycle model that emphasizes stakeholder participation and management during the planning and development of business processes, ensuring alignment with the organization's strategic objectives. In addition to business processes, workers' organizational responsibilities and skill sets and the enterprise's information system, need to be accurately represented. Therefore, the BPM lifecycle is composed of:

1. Design and analysis: identify, review, and represent business processes through models using a particular business process model and notation as well as validate the information through, for example, a workshop to discuss results;
2. Configuration: select, implement, and test systems for execution according to the organizational environment of the enterprise, the interactions of the employees with the system as well as the integration with the business processes;
3. Enactment: operationalization, monitoring, and maintenance of the execution of business process instances guaranteeing that the process activities are performed according to the constraints specified in the process model;
4. Evaluation: use available information to evaluate and improve business process models and their implementations to identify the quality of business process models and the adequacy of the execution environment.

Model presented by the Association of Business Process Management Professionals (2009)

The Association of Business Process Management Professionals' (ABPMP) guide aims to provide BPM professionals with a comprehensive grasp of the problems, ideal procedures, and insights in the industry (ABPMP 2023). According to the ABPMP, BPM is a collection of technologies that support managing by process rather than simply a management discipline. The BPM lifecycle model proposed by CBOK (2009) is organized in six steps:

1. Planning and strategy: develop an understanding of organizational strategies and goals by defining project scope, roles and responsibilities, resources, and technology;
2. Analysis: perform interviews, documental analysis, simulations, or other instruments in order to fully understand the business processes context and the organization's desired goals and objectives;
3. Design: create new specifications for process activities and new rules and definitions for information flows among functional groups to ensure that the end-to-end work delivers value to customers;
4. Implementation: formulate training and performance evaluation indicators to guarantee strategic alignment and the understanding of the process and its constraints;
5. Monitoring and control: ensure the formal, planned monitoring of process execution by adjusting resources and evaluating performance measurements to make decisions;
6. Refining step: perform and analyse organizational changes for continuous improvement and optimization of processes to achieve efficiency and effectiveness.

Table 1 - Comparison of the BPM life cycle models, adapted from Macedo de Morais et al. (2014)

Dumas et al. (2013)	Netjes, Reijers, and van der Aalst (2006)	Weske (2007)	Association of Business Process Management Professionals (2009)
Identification	-	-	Planning
Discovery	Design	Design	
Analysis	-	-	Analysis
Redesign	Configuration	Configuration	Design
Implementation	Execution	Execution	Implementation
Monitoring and control	Control	Evaluation	Monitoring and control
	Diagnosis		
-		-	Refining

In Table 1 is possible to observe a direct comparison between the models presented. The table was built taking into consideration the definitions provided by the different authors for their respective models.

Some convergences between the models studied are visible mainly in terms of their definitions and phases of project management. The intermediate steps of the models analysed, such as design, configuration, and monitoring, are common to the four models. However, the main observable divergences are in terms of the placement and naming of the phases in the BPM lifecycle. For instance, the planning phase in the ABPMP model is observed only

partially in two of the other models, and the refinement phase is only observed in this model. Only Dumas et al. (2013) and ABPMP (2009) presented an Analysis phase.

While trying to provide a definition to BPM, the different authors seem to add a different perspective on how to address business process transformation. As mentioned before, Dumas et al. (2013) model emphasizes the necessity for providing value creation to an organization's customers. Netjes, Reijers, and van der Aalst (2006) models highlight the incorporation of both human resources and multiple sources of information when transforming a business through BPM. Weske (2007) offers a simplified lifecycle model that promotes stakeholders' participation and management involvement in the planning and development of business processes. Finally, the ABPMP model has a broader scope, and by doing so, covers all of the complementary perspectives of the models mentioned above (Vargas et al. 2021).

The comparison will prove itself of great utility when addressing the project in this dissertation in order to clearly state the various stages encompassing the project. It will present the scope of each one to perform a transformation based on BPM and that is supported by the research presented in literature. It is possible to observe that, despite the differences, a common thread is followed to characterize the BPM lifecycle.

2.1.2 Process classification framework by APQC

Processes can be classified according to several methodologies. For example, according to Porter (1985) there are two possible divisions for processes: core and supporting processes. Process hierarchy aims to understand how the processes relate to each other and how they are a part of getting things done (Krzywy and Hell 2022).

The Process Classification Framework was developed by the APQC (2023), one of the world's leading authorities in benchmarking, best practices, process, performance improvement, and knowledge management. The main goal of the organization is to help companies improve their processes. This framework allows organizations to improve their efficiency, reduce costs, and better align their operations with industry best practices. The Process Classification Framework consists of five process levels as represented in Figure 2 (Krzywy and Hell 2022).

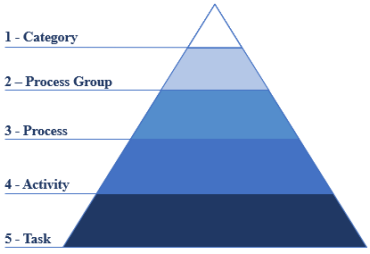

Figure 2 - Process Classification framework hierarchy (in https://www.apqc.org)

- Category (Level 1): represents the highest level of process in the enterprise;
- Process Group (Level 2): indicates the next level of processes and represents a group of processes;
- Process (Level 3): includes the core elements needed to accomplish the process as well as the elements related to variants and rework;
- Activity (Level 4): indicates key events performed when executing a process;

- Task (Level 5): represents the next level of hierarchical decomposition after activities and are more detailed, varying widely across industries.

The Process Classification Framework applied to logistics, for example, would encompass at the highest level, the Supply Chain Management Processes. Proceeding to the next level, the Process Group, an example is the Order Fulfilment Process Group. The subsequent level is characterized by the Order Processing Process, encompassing core elements necessary for the successful processing of customer orders. At the Activity level, a specific event of significance within the process is emphasized, such as the Inventory Management Activity. Finally, at the most granular level, the Task level, can be exemplified by the Picking and Packing Task.

2.1.3 Business process model and notation

Recently, organizations made efforts to systematize their internal processes by implementing standard formats for illustrating workflows and interactions between external users and internal administrative departments (Di Martino et al. 2023). A model provides organization with supplementary details that give context on how it works, how the different roles interact and cooperate with one another and facilitate the identification of potential improvement opportunities. Process Models provide graphical representations of ‘as-is’ or ‘to-be’ processes using business process model and notation (BPMN) (Nilsen 2015).

The primary goal of BPMN is to create comprehensive end-to-end business processes that cover a wide range of modelling tasks specific to business processes. In addition, BPMN is an universal notation that aims to be readily understandable by all business users (internal or external to an organization). The structural components of BPMN, such as groups, pools, or lanes, enable the viewer to distinguish between different segments of a BPMN Diagram (Lopes and Guerreiro 2023).

BPMN 2.0 is an advancement of BPMN, developed to overcome the limitations of its predecessor by enabling the modelling of complex events and introducing expanded data modelling capabilities (Erasmus et al. 2020). Furthermore, it improves support for process simulation, validation, and execution, promoting more precise and reliable business process model and implementation (Aagesen and Krogstie 2015).

2.2 Digital Transformation

Previous research has highlighted the lack of a standardized definition for Digital Transformation. As a result, executives in different industry sectors use this concept inconsistently to represent varied strategizing and organizing activities (Reis et al. 2018). Despite an increase in research interest in this area, there is a lack of a universal and comprehensive understanding of the concept and there are contradictions in the present literature regarding Digital Transformation (Gong and Ribiere 2021).

The process of Digital Transformation is a continuous, broad phenomenon that can have a significant impact on an organization and its operations. Companies may face operational obstacles if a Digital Transformation plan is not fully implemented. These challenges are related to the effect of Digital Transformation strategies on firms' value chains, particularly how the new digital activities differ from the core business (Kraus et al. 2021).

Several authors highlight the impact of digital technologies and innovations on the transformation of organizational business processes, products, services, and relationships (Pousttchi et al. 2019; Schwertner 2017). Furthermore, it is acknowledged that the adoption of a Digital Transformation strategy can enhance the efficiency of existing processes and team business models (Hai, Van, and Thi Tuyet 2021).

In the sections that follow, the definition of Digital Transformation will be presented and differentiated from related concepts, such as digitalization or digitization. It will also cover the businesses' need for Digital Transformation and the relation between Digital Transformation and BPM. Moreover, the critical factors for a successful business digital transformation will be highlighted.

2.2.1 Digitization vs digitalization vs Digital Transformation

Digital transformation is a continual and comprehensive phenomenon that affects all areas of an organization's operations, including its value chains, goods, services, and relationships. However, there is a misunderstanding regarding terms associated with Digital Transformation, such as digitization, digitalization, and Digital Transformation itself (Savic 2020).

Digitization and digitalization are occasionally used interchangeably, which may hinder the development of Digital Transformation research and practical understanding in the long term. Some languages, such as German, Spanish, and Japanese, do not distinguish between the two terms, despite the difference in their activities. To overcome this ambiguity, Digital Transformation acts as an umbrella word that incorporates both digitization and digitalization, recognising both as critical components of an organization's Digital Transformation path (Vrana and Singh 2021).

Digitization

Digitization is the process of converting analogue data into binary code using various approaches. The basis of digitalization is digitization, which involves the purchase or creation of digital items. Digitization evolutions, such as enhanced digital data availability and efficient operations, have the capacity to affect and impact the modern world (Ritter and Pedersen 2020).

Digitalization

Digitalization is the process of employing digital technologies to transform a business model and generate new revenue and value creation opportunities. Digitalization involves a paradigm shift in business and relies entirely on the usage of digital production models. This implies a comprehensive use of digital technology on all physical products, including the production of consumer goods that incorporate digital content (Lozic 2019).

Digital Transformation

Digital Transformation is not exclusively about using digital technology, but also about using digital technology to provide new solutions to existing problems and needs. People prefer digital solutions to traditional approaches; hence Digital Transformation is a form of business transformation. Business strategy, technological innovation, consumer behaviour and expectations, as well as external environmental variables all play important roles in driving and influencing business Digital Transformation (Lozic 2019).

Despite their frequent interchangeability, digitization, digitalization, and Digital Transformation are all related but separate processes. Digitization has improved access to information and created new channels for communication, resulting in the development of digitalization. Within this framework, information technology is critical for developing competitiveness and meeting customer requirements. Nonetheless, the combination of digitization and digitalization results in Digital Transformation, in which digital technologies link all the stakeholders to company resources, allowing for the collection and analysis of massive volumes of data. As a result, Digital Transformation alters communication and interactions, transforming the existing economic, social, and political environment (Fischer et al. 2020).

2.2.2 The need for Digital Transformation

As was mentioned before, Digital Transformation is understood to be vital for business's survival, nowadays. In a dynamic and developing environment, a company's capacity to adapt and reconfigure in order to address emerging challenges and leverage new digital opportunities evolving demands is critical (Matarazzo et al. 2021). In the current section, the three key justifications provided by Verhoef et al. (2021) for why organizations need Digital Transformation are presented.

First, the emergence of new digital technologies emphasizes the importance of organizations undertaking Digital Transformation. Since the introduction and global adoption of the World Wide Web, a wide range of technologies has emerged that strengthen the growth of e-commerce, optimized logistics streams, and reduced supply chain costs. As a result, the adoption of technologies, such as robots that replace human labour, Artificial Intelligence (AI), and blockchain, affect an organization's cost structure.

Second, digital technologies are leading to a significant transformation in the competitive environment. These technologies have disrupted conventional competitiveness in the retail business, resulting in a shift in sales to relatively new digital enterprises. Companies that take advantage of digital technologies seem to perform better in the market since they are able to employ data management and process optimizations and, subsequently, understand the value on it.

Lastly, as a result of the digital revolution, consumer behaviour has changed dramatically. Consumers have grown more connected, aware, empowered, and active since digital technologies allow them to create and customize items, participate in last-mile distribution operations, and share feedback with other customers. Firms that do not adapt to these evolutions become less appealing to clients and risk being surpassed by companies that effectively exploit these technologies and opportunities.

Organizations use digital technology to achieve a variety of goals, however, in order to improve their market position and remain competitive in the global market, businesses must take a strategic approach to Digital Transformation. This innovative method aims at achieving business improvements and solving future difficulties in an evolving business environment (Kutnjak, Pihir, and Furjan 2019).

2.3 Relationship between BPM and Digital Transformation

The adoption of digitalization is imperative not only for the survival of companies but also for unlocking entrepreneurial opportunities that foster innovation and enhance performance. As

digitalization continues to permeate diverse industries, it acts as a catalyst for inspiring entrepreneurial ventures that harness the potential of digital technologies (Ferreira, Fernandes, and Ferreira 2019). As a result, the implementation of BPM with Digital Transformation constitutes a highly effective strategy for enhancing innovation performance in the digital economy. By doing so, organizations are able to establish a robust knowledge base and facilitate the continuous extraction and creation of valuable knowledge (Wang et al. 2023).

However, the process of Digital Transformation requires a critical rethinking of traditional business process management (BPM) approaches, as the ongoing changes demand the adoption of new logics to sustain and adapt business processes. The reliance on traditional BPM logics, which heavily emphasize detailed modelling and rigid procedures, proves inadequate in the context of Digital Transformation. Instead, new logics based infrastructural flexibility, and mindful actors are adopted. This idea emphasizes the need for rethinking management frameworks and advancing new BPM logics for Digital Transformation contexts (Baiyere, Salmela, and Tapanainen 2020).

In conclusion, the escalating digital transformation and knowledge-based focus of society demand a thorough reassessment of organizational structures and models. The transformation of project management practices, driven by the digitalization of process modelling, represents a response to these changing dynamics. In the pursuit of transformation, organizations are recognizing the fundamental roles played by machine-based methods and digitalization in shaping the future of process modelling. By embracing these advancements, organizations gain the ability to improve their operations, adapt to evolving challenges, and position themselves for success in the digital era (Ochara et al. 2018).

2.3.1 Success practices of implementing Digital Transformation and BPM

The adoption of Digital Transformation aligned with BPM has become a critical factor for organizations to remain competitive in today's quickly expanding digital market. A complete understanding of the principles, best practices, and challenges connected with Digital Transformation and BPM is essential for an effective execution of business development. In this section, the success practices of implementing Digital Transformation and BPM are presented.

Ivancic, Vuksic, and Spremic (2019) study emphasizes recommendations and lessons learnt from the experiences of case companies in the Digital Transformation process. The authors highlighted seven elements of Digital Transformation that they consider fundamental for successful Digital Transformation. On another view, Castro, Dresch, and Veit (2019) presented nine key critical success factors of BPM implementation. The following paragraphs result from a combination of the key concepts presented in these articles, which allowed for the systematization of a list of six important practices for achieving success in both BPM and Digital Transformation implementation.

- Alignment of technology and strategy: organizations have the ability to select from a wide range of new technologies based on their digitalization priorities. To accomplish process digitalization, businesses are standardizing their business processes, integrating efficient Enterprise Resource Planning (ERP) systems, and integrating digital technology. The lack of alignment of information technology (IT) with BPM might result in a failed project;

- Customer-centric approach: in the context of Digital Transformation, prioritizing customer needs and expectations is crucial for businesses to enhance service delivery, create added value. Incorporating customer engagement in company operations is seen as a vital element of Digital Transformation, aiming to enhance customer experience, loyalty, and gain a competitive edge;
- Building a digital culture: organizations ought to equip their staff with digital skills and encourage information exchange to build a digital culture and obtain a competitive advantage. Employee engagement in digital solution creation may be increased through internal learning and skill transfer, which includes training and recruiting professionals for BPM implementation. Achieving Digital Transformation and deploying BPM requires the participation of all departments within an organization, as well as well-defined roles and responsibilities. Continuous training is required for the successful implementation of emerging technologies;
- Management support: the success of Digital Transformation efforts relies on a shared digital vision, aligning process goals with strategic planning, adapting strategies to the organization's needs, and securing senior management support. This will enable the company to translate plans into actionable steps and drive outcomes which will lead to a successful Digital Transformation. A lack of alignment or leadership support can hinder growth;
- Structured and systematic approach: inadequate methodology hinders effective BPM implementation and leads to failure. By monitoring performance, organizations can identify problems and opportunities for improvement, ensuring the success of their Business Process Management (BPM) projects;
- Encourage innovation: systematic initiatives are necessary to generate ideas that optimize the company's innovative capacity. Organizations foster innovation through diverse approaches to idea sharing, particularly targeting young employees who exhibit inventive and proactive mindsets. Furthermore, organizations facing resistance to change may experience difficulties in implementing BPM, potentially ending in failure.

Integrating BPM with Digital Transformation is a collaborative approach that can drive organizational innovation, improve consumer experiences, and foster a sustainable competitive advantage. This dissertation highlights the significance of combining these two core ideas, laying the foundation for the analysis of the considered project. Therefore, the project focuses on the use of BPM and Digital Transformation aimed at improving the current processes of a cork stoppers' company.

In the subsequent chapter, the problem will be introduced, offering a comprehensive understanding of the challenge faced by the Client company. Furthermore, the chapter will outline the identified problem and the approach adopted to improve the operating model.

3 Case study and project approach

This chapter focuses on defining and exploring the Client's problem assessed in this dissertation and outlining the approach used to construct the desired solution. A better structure and analysis of the provided problem was achieved based on the knowledge presented in the previous chapter regarding BPM and Digital Transformation. As a result, this chapter will serve as the foundation for the subsequent chapters.

The chapter starts with a characterization of the problem context. The project scope is then defined, clearly outlining the activities and processes that are considered within the project. The aim and objectives section then presents the overall intended outcome of the project as well as the specific objectives that must be accomplished to meet the aim. The final section addresses the framework employed by PwC for this project and the data collection methods used to gather qualitative information necessary for the project.

3.1 Characterization of the Client's problem

In light of the growth in sales volume observed in recent years, the Client company aims to increase its profit margin. The company's success acted as a motivator for the development of its current business units, particularly the unit related to Stoppers with Heads. This business unit was recently installed in Portugal but was already existing in other geographies of the company.

Recently, the Client company began investing in a new range of products that fall under the Special Project development area. Taking into account the lack of innovation in the market regarding this area, an opportunity for the company to gain a competitive advantage arises by investing in development projects. Additionally, the increasing trend for circular economies and the growth of sustainability awareness in businesses contribute to setting the company apart from its competitors and, consequently, attracting new customers.

However, given the reduced dimension of the business unit, the established processes and resources efficiency are not robust enough to support the desired progress and results in a sustainable way. Moreover, the absence of defined and formalized processes, as well as the lack of definition regarding roles and responsibilities, create significant challenges for the company. As a result, the company's day-to-day operations lack efficiency as employees are uncertain about activities sequencing and tasks accountability.

Hence, in order to address this problem, the case was established in order to look for a change that would increase process efficiency, improve departmental alignment, and assess the current digital resources and development potentialities.

3.2 Project scope

The project is developed in the context of the Consulting business unit of PwC, framed in the Business transformation area. According to the proposal that PwC set for the Client company, PwC commits to propose an adequate solution to the identified problem within the agreed time span and in line with the predefined financial budget.

In order to fulfil the agreed project scope, PwC will address the processes of the Stoppers with Heads business unit, with particular attention to the Special Projects development area opportunities. The analysis and suggested recommendations will be directed at the activities of the value chain included in the process stages from planning to warehousing.

3.3 Aim and objectives

The primary objective of the project in which this dissertation is developed, is to provide the Client, a company in the national cork stopper manufacturing sector, with a diagnostic of the current state of internal processes and the design of a short-term future solution in order to improve its efficiency.

To address the challenges presented by this project, three fundamental principles were established to ensure the successful fulfilment of the defined objective:

- Transparency: to improve internal communication flows between the different departments inside the Client company in order to encourage collaboration and facilitate the construction of robust and efficient processes;
- Operationalization: to provide the company with the necessary tools and mechanisms for answering quickly and effectively the requests of customers regarding new projects in the Special Projects business unit;
- Quality: to improve control over the quality of the production processes in order to increase production volume.

Through the successful execution of this project, several benefits are expected to arise from the transformation and improvement recommendations provided by PwC. By aiming to achieve organizational alignment, it is expected to establish a common shared vision over the business processes instead of a silos vision, therefore mitigating risks associated with efficiency losses and duplication of efforts. Additionally, this will result in an improvement in the knowledge management mechanisms inside the company and the increase of a sense of accountability.

3.4 Project approach

To address the challenge stated in this research, a structured and methodical approach to the project was adopted. This section of the chapter aims to provide an understanding of the project's framework and of the data collection methods employed. The framework chosen for this project functioned as a course of action to correctly frame the project and identify the necessary tasks to follow to achieve the desired project goals. In addition to the project framework, reliable data collecting methods were used to gain significant insights into the processes under study.

3.4.1 Transform® Framework

In order to answer the Client's needs, the proposed project was structured using as a baseline the Transform® Framework created by PwC. This framework is a holistic and transversal approach to transformation projects that combines knowledge, consistency, and time efficiency to provide successful outcomes. It is built around a project's framework, using a step-by-step guided method and taking into account the basic tasks in every transformation process project. The Transform® Framework is structured around five stages: Assessment, Design, Construct, Implement and Operate & Review, as illustrated in Figure 3.

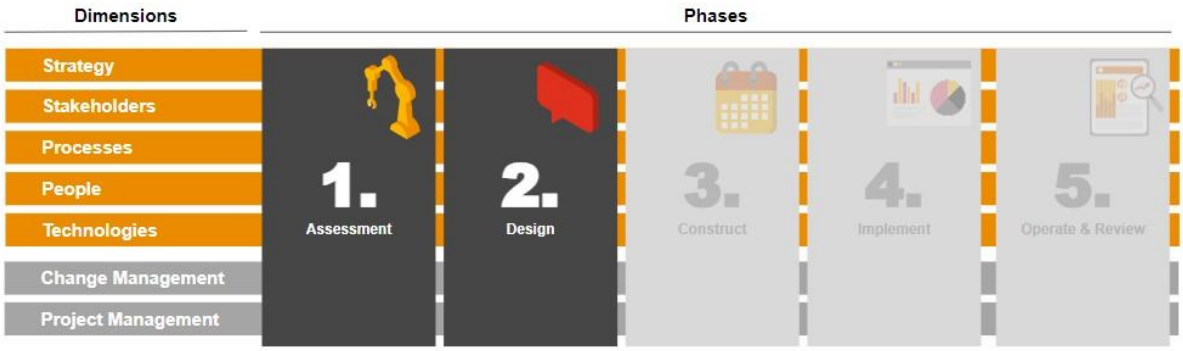

Figure 3 - Diagram of the Transform® Framework

As a tool, the Transform® Framework enables PwC to develop projects that focus on delivering valuable solutions to clients in every project. Nevertheless, the methodology has to be tailored when used, since replicating it without any adjustment will not produce optimal outcomes. As a result, it may be regarded as a flexible framework since the composing phases must be adapted to the particular transformation project at hand. Only then, high-quality outputs can be produced, and project scope demands met successfully.

The PwC Transform® Framework is consistent with current models and theories about BPM lifecycles presented in the literature review. While the PwC Transform® Framework has its own particular structure, insights gained from comparing it to other models can provide a better understanding of the aim of the phases selected for this project. Given the Client's goal of improving the major processes in the Stoppers with Heads business unit, the project entails analysing the present process, finding limitations, offering recommendations, and building a new process (to-be process) to fulfil the improvement goals. These activities fit into the first phases of the lifecycle models addressed in the literature study.

For the project under consideration, the Transform® Framework was adapted and only the phases of assessment and design were considered.

Assessment phase

The assessment phase's main goal is to develop an extensive understanding of the company's existing strategy, stakeholders, processes, people and technology to identify which areas or activities need improvement. Through data analysis it is possible to build a detailed diagnosis of the current state of the organization, to identify the main constraints that prevent the company from achieving its goals.

Based on the Transform® Framework, the assessment phase of this project was structured in order to facilitate the representation of the current state of the business. The following tasks were executed:

- perform individual interviews and group workshops with relevant stakeholders from different areas of the value chain to understand current processes;
- map current processes (as-is) taking into account the activities identified by stakeholders, the systems and applications used and the data to be recorded;
- visit company facilities and operations to observe the reality on the shop floor, comparing it with the theoretical process previously mapped with the stakeholders;
- make adjustments to the mapped processes based on the information collected in the shop floor visits;
- perform quantitative analysis based on data collected;
- identify potential inefficiencies, manual tasks, duplication of tasks, among others and determine the execution times of the activities (in specific cases, to be validated with company);
- identify constraints with an impact on company's value chain;
- validate the results obtained with relevant stakeholders.

The agreed deliverables that come as an output from this phase include: an as-is process mapping representation with information regarding the different responsible elements for each activity and needed systems; a list of the constraints and recommendations identified; a dashboard for quantitative data analysis. As a consequence, the client organization would have not only a complete understanding of their actual process reality, but also a quantitative analysis of the process.

Design phase

The design phase of the transformation project corresponds to the representation of the change to the operational model in order to maximize the delivery of benefits. After the suggestions are structured and the quick wins identified, it is possible to develop a desired to-be process map that optimizes the process and facilitates the communication of the changes that must be implemented to achieve efficiency improvements.

The following tasks are part of the project's design phase:

- design a to-be organizational chart of the company;
- compare current processes in accordance with best practices and with improvements to the value chain identified in the Assessment Phase;
- map future processes (to-be) taking into account the necessary activities, systems/applications, and data to be recorded;
- identify for each activity of the future processes (to-be), the execution times;
- perform discussion and alignment workshops to validate future processes (to-be);
- produce the functional descriptions manual, taking into account the future processes designed;

- restructure information regarding responsibilities inside the company;
- perform a RACI (Responsible, Accountable, Consulted, and Informed) matrix analysis (the RACI matrix will be presented in the subsequent chapter);
- systematize in a brochure the future processes of the Special Projects area.

Three main deliverables were planned to be delivered to the Client company for this phase. The first deliverable consists of a to-be process mapping representation based on the identified recommendations and including information on the activities' responsible parties, the required information systems, and the timings for each step. Furthermore, a functional descriptions manual was delivered with an outline of the responsibilities assigned to each job. The third deliverable, was a brochure of future processes of Special Projects that systematizes the information regarding the development steps of this specific product range which aimed to be used as a tool for process alignment with the commercial area and customers. As an outcome from the design phase, the Client company received a clear depiction of how the recommendations will be implemented into the process, but also tools that allow the company to be aware of the responsibility and duties performed by the different agents throughout the process.

3.4.2 Data collection

Data collection is a critical step when starting a process transformation project. To create an accurate and comprehensive representation of the company's operating model and systems at use, well-established and reliable data collection processes are required.

Three key methods formed the basis of the data collection strategy: interviews, workshops, and shop floor visits. The success of these methods relied on active stakeholder engagement and thorough documentation. When the information collected through the three methods was analysed and synthesized, a comprehensive understanding of the process was built.

The order in which the methods were performed followed a specific rationale. Firstly, interviews were conducted to establish a baseline for the workshop and provided an individual and open environment for participants to share their perspectives. Then, the workshops were important to build an integrated baseline of the process mapping by allowing for the construction of a collective understanding of process sequencing. Finally, shop floor visits provided direct observations to validate the constructed processes assembled in the previous stages and make adjustments.

Interviews

The main goal of the interviews with the most relevant stakeholders of the process was to collect insights on how those who are responsible for the different areas inside the business unit perceive the process activities. These interviews gave participants the chance to voice their biggest concerns and identified challenges, as well as suggest potential improvements that might be covered in the upcoming operating model.

Six meetings were held with the main responsible from different areas that are part of the Stoppers with Heads' business unit. The participants of the interviews were chosen, in collaboration with the Client, to have an overview of the main areas identified as part of the process: Planning, Gluing, Supply Chain, Preconization (area that will be explained in the subsequent chapter), Quality and Special Projects.

The stakeholders received a full introduction of the project at the start of each meeting. This included explaining the project's goals and scope as well as introducing the team in charge of its development. This allowed the management of stakeholders' expectations regarding the project development steps and the role they would play in it. A standardized template was followed during the meetings to guarantee reliable data collection. The discussions helped to clarify the project's processes, each area's tasks, and the information systems architecture used at the time. Additionally, the participants were also questioned about the communication effectiveness with other areas and the main performance indicators used.

To record the information discussed in the meetings, individual minutes were prepared beforehand. These facilitated analysis and systematization of critical points identified, regarding processes, people, and systems. Each meeting concluded with a reflection on the identified strengths, weaknesses, and limitations, and asking for potential improvements. After the meeting, the meeting minutes were analysed in order to synthesize the main points of the interview and properly organize the information. The template used for the Interview's minutes is provided in Appendix A.

The meetings produced valuable insights and significant findings. Some of the main takeaways regarding the interviews were: a better understanding of the collaborations between the different areas, a highlight of the pain points experienced by employees in each area and the exploration of the information systems employed by each area.

Through the meeting minutes' analysis, the project team developed valuable knowledge of the challenges, opportunities, and potential areas for improvement. The following steps of the diagnosis process will complement this first diagnosis and allow for the construction of a complete and detailed picture of the whole production process.

Workshops

The workshop on process analysis and improvement for the Stoppers with Heads business unit had three main goals. Firstly, it intended to establish a broad and complete awareness of the present processes inside the business unit, integrating the most relevant stakeholders in the value chain. The workshop also aimed to bring together various teams in order to stimulate conversation, information exchange, and raise awareness about the processes. Finally, this collaborative approach was essential to create a common ground and engage participants in the process transformation project.

Participants' were selected by both the management team on the Client company's side and the project transformation team. This was critical in providing the information and insights from all key fields required to develop an accurate picture of the process as it is. The participants' list included: the planning responsible and two team members, the gluing responsible, the chief of projects who is also responsible for preconization, the Development responsible, two representatives from the financial department (one being the financial manager), the corks and shanks production responsible of the company's core business unit, and the supply chain responsible.

Two main criteria were essential while preparing the workshops to guarantee its success: the right resources and an efficient agenda. In terms of resources, while preparing the workshop it was considered that the necessary materials were available, visual support was clear and that feedback forms were in place. The workshop agenda was structured to include dynamic exercises, the construction of the process map and discussion moment. The facilitators also

reviewed the time allocated for each part, preparing presentations and interactive activities to promote active participation.

The workshop followed an agenda that encompassed different moments. It started with an energizer exercise to set an engaging environment, followed by a moment for participants to share their expectations. They were then divided into three groups to represent the entire process and presented to the rest of the participants the outcome. In the presentations, it became clear that the participants had difficulties in transcending their individual responsibilities and explaining the complex nature of the overall process. In the workshop's main activity, participants worked together to create a thorough process map that included all the activities, systems, and interactions. This essential component of the workshop lasted three sessions or days. At the end of each workshop day, a wrap-up of the progress and main findings was held, and participants were given the opportunity to provide feedback on the workshop for continuous improvement.

The consulting team divided their roles to efficiently handle the tasks at hand. Two team members concentrated on laying the process map on the wall with post-it notes based on participant inputs, ensuring correctness and clarity. One of these team members was responsible for facilitating the session by encouraging active participation and constructive dialogue. Simultaneously, one team member documented the information on the Microsoft Visio platform, and another took minutes to note additional points and relevant facts for posterior revision. The author of the dissertation had the responsibility of taking the minutes during the workshop, analysing the information, and listing the identified constraints.

The workshop was quite useful throughout the project's assessment phase. It functioned as a critical method for gaining useful insights and data regarding the business unit's present activities and systems. The knowledge gathered during the workshop served as the baseline for creating the process map. This data, combined with the information gathered in the interviews and insights from shop floor visits, was systematized into one final as-is process map.

Shop floor visits

Shop floor visits were undertaken as part of the assessment phase to validate and acquire first hand insights into the business processes and day-to-day operations. These visits ensured the validity of the information gathered during the interviews and workshops.

An initial shop floor visit with the Chief Operating Officer (COO) was planned to familiarize the PwC team with the company and its operations. This tour provided an opportunity to learn about the company's functional areas, available product lines, facility structure, and industry-specific terminologies. Consequently, the team obtained valuable contextual insights before going into the interviews with the representatives of the different areas.

After the workshops, shop floor visits were conducted in three key areas: gluing, preconization, and Special Projects development. These areas were chosen in accordance with the project scope and due to their complexity and potential for development. The visit to the gluing area allowed for direct observation of the procedures associated with quality control, data monitoring and machinery setups. In the preconization lab, it was possible to get valuable insights into the limitations of this area and how it collaborated with all the others. The Special Projects visit was fundamental to understanding what the opportunities for improvement were and to understand how to enhance the development of this growing area.

The visits began with an overview of the area's facilities and activities. For example, during the gluing area visit, it was possible to see the machinery working and the warehouse organization. In the preconization area, it was possible to see the material testing procedure in the lab. After that, a walkthrough of the process was conducted, led by the responsible for the area, while the consulting team recorded the information and procedures. Direct contact with the employees revealed important insights into their experiences and issues. At the end of the visit, essential data such as production quantities and activities timings were collected either directly or by asking for supplementary documentation.

To complement the qualitative data collection methods, throughout the interactions with the main areas of this business unit, quantitative data was requested if available. The aim was to gather objective information that could support the identification of constraints. In the next chapter, the analysis performed will be presented in detail.

This comprehensive approach enabled a full examination of the unit's operations, highlighted possible areas for improvement, and gave significant insights into the process. This chapter sets the foundation for the upcoming chapters, where a full examination of the Client's processes will be performed, and the identified constraints will be addressed. Through the problem characterization, presentation of the approach to the project, and data collection methods, it will be possible to effectively accomplish the intended results.

4 Assessment of the current operating model

The current chapter explores the assessment phase of the presented process transformation project. By comprehensively understanding the current operating model of the Client company processes as well as the challenges and systems currently implemented, improvement opportunities can be identified to allow for the construction of the desired optimized process.

The emphasis of the project is on the Stoppers with Heads business unit of the Client company's operations, spanning from production planning to warehousing of finished goods. According to the project approach presented in the previous chapter this is the first phase of this project.

This chapter starts by exploring the quantitative data analysis performed for this project. Then, an exposition of the organizations' main areas and systems is presented followed by a depiction of the mapping of the four core processes of the considered business unit. The chapter ends with a list of the main constraints identified and introduces the subsequent chapter, where the recommendations addressing these constraints are presented and the to-be model is assembled.

4.1 Data quantitative analysis

A quantitative analysis was carried out to supplement the data collected and develop a better understanding of the processes. The aim was to reveal hidden trends, identify possible bottlenecks, and assess overall process performance in both the supply chain and production (gluing) area. This analysis not only validated the findings but also provided the foundation for developing a successful process improvement approach.

We focused our quantitative analysis on two key data sources: supply chain data and production data. Regarding production data, an Excel file was provided by the Client that contained the expedition dates for three product types: Stoppers with Heads, stoppers and monoblocs. The production data was provided directly on two emails, which for the Stoppers with Heads business unit included:

- number of production shifts, their length, and planned breaks;
- maximum production capacity for each line of production (in pieces per hour);
- number of units produced per line, month, and product;
- number of units produced with no defect per line, month, and product;
- number of effective production hours, per line, and month;

- number of available hours for production, per month.

The supply chain data analysis focused On-time to expedition, orders per month, and orders by product, revealing process efficiency, bottlenecks, and optimization opportunities. Important metrics such as Overall Equipment Efficiency (OEE), Utilization rate, total production per product, number of products per production line, defect rate, defect rate per production line, effective production hours, total production, and defective products were evaluated in the production data analysis.

The primary measures for the quantitative study were OEE, utilization rate, and on-time expedition because of their considerable effect on operational performance and customer satisfaction. By evaluating these indicators, a full picture of the overall efficacy of the processes is drawn and opportunities for improvement are identified.

Due to the confidentiality and sensitivity of the information provided by the Client company, the numerical data regarding the analysis cannot be disclosed in the following section. However, the key findings and outcomes that resulted from the study will be presented in order to support the performed research.

4.1.1 Indicators

Overall Equipment Efficiency

Overall Equipment Efficiency is regarded as a crucial practice in manufacturing, providing significant insights for systematically detecting and correcting losses in the manufacturing process (Muchiri and Pintelon 2008). This metric evaluates the efficacy and efficiency of a manufacturing process by determining the percentage of time the equipment runs at its maximum capacity and produces high-quality output. Figure 4 shows how OEE, as the fully productive time, can be measured. As a result, it offers a comprehensive overview of equipment performance.

Figure 4 - OEE calculation diagram (in https://www.oee.com/oee-factors/, accessed in 2023-04-10)

The formula for calculating OEE is given by Equation (4.1).

$$OEE = A \times P \times Q \quad (4.1)$$

Where:

OEE, is Overall Equipment Efficiency
A, is Availability
P, is Performance
Q, is Quality

Availability measures the equipment's ability to be available for production when required. It considers both unplanned and planned stops in the manufacturing process. A high Availability percentage indicates that the equipment is reliable, with little downtime and interruptions.

The formula for calculating Availability is given by Equation (4.2).

$$A = EPH_1 / PPH \quad (4.2)$$

Where:

A, is Availability
EPH_1, is Number of effective production hours available (for OEE Availability), and
PPH, is Number of planned production hours

Planned production hours were calculated by multiplying the number of shifts by their length, then subtracting i) the breaks available to workers in each shift and ii) one shift change. Due to the lack of accurate data for cases where three shifts were reported, the analysis assumed an equal number of planned production hours for every month. The information obtained on setups and downtimes was deemed insufficiently accurate, resulting in their exclusion from the calculation.

In OEE, Performance is regarded as how effectively the equipment produces output in relation to its maximum attainable production rate. A larger percentage of Performance implies that the machine is running at or near its maximum intended speed. OEE takes into account performance loss, which includes factors that cause the manufacturing process to run at a slower speed than its maximum capacity.

The formula for calculating OEE's Performance is given by Equation (4.3).

$$P = ICT \times TUP_1 / EPH_2 \quad (4.3)$$

Where:

P, is Performance,
ICT, is Ideal cycle time,
TUP_1, is Total number of units produced (for OEE Performance), and
EPH_2, is Number of effective production hours (for OEE Performance)

Based on the data supplied, the maximum line capacity per hour was used to establish the Ideal Cycle Time. Using the information provided on the different lines maximum capacity, the time required to produce one piece under optimal conditions was calculated.

Quality measures the effectiveness of the equipment in producing products that meet the required standards. It takes into account both the overall number of good units and any quality losses, such as parts that do not match the required quality requirements.

The formula for calculating OEE's Quality is given by Equation (4.4).

$$Q = UPND / TUP_2 \quad (4.4)$$

Where:

Q, is Quality,
UPND, is Number of units produced with no defects, and,
TUP_2, is Total number of units produced (for OEE Quality).

The OEE was calculated individually for each line, and an overall OEE was calculated as an average of the 3 values obtained, assuming equal weights for the 3 lines. In the period considered, for some months, it was not possible to calculate the OEE for specific production lines as it was not possible to calculate OEE Quality.

On-time Expedition (OTE)

On-time expedition refers to the timely delivery of a product. It assesses the proportion of orders or shipments delivered within the agreed-upon delivery dates. This metric is critical for measuring supply chain performance and guaranteeing reliable and consistent product delivery to customers.

The formula for calculating On-time Expedition is given by Equation (4.5).

$$OTE = EP / TE \tag{4.5}$$

Where:

OTE, is On-time expedition,
EP, is Number of expeditions within the agreed period, and
TE, is Number of total expeditions.

Utilization rate (UR)

The utilization rate is an important metric for determining the efficiency and productivity of resources or equipment. This metric indicates how efficiently resources are being used and aids in the identification of possibilities for optimizing resource allocation and increasing overall operational efficiency.

The formula for calculating Utilization rate is given by Equation (4.6).

$$UR = EPH / APH \tag{4.6}$$

Where:

UR, is Utilization rate,
EPH, is Number of effective production hours, and
APH, is Number of available hours for production.

The number of effective production hours was set according to the production data. For the available hours for production, it was considered 22 days of work, each with 3 shifts of 8h, summing up to 528h.

4.1.2 Dashboards

Dashboard structure

A dynamic dashboard was designed to show the information interactively and graphically to improve accessibility and understanding, as it can be observed in Figure 5. This dashboard empowers stakeholders to make informed decisions and drive process optimization based on data-driven insights.

Figure 5 - Dashboard's template

The dashboard has two interfaces that provide a full overview of important indicators and organized data for efficient analysis. The first interface displays on the upper part, the key metrics of this analysis: the OEE of the process, the utilization rate, and the on-time expedition. The main part of the interface provides an OEE study, showcasing the total OEE by production line and its evolution during the time period under consideration, as well as an average calculation of the contribution of each OEE factor.

The second interface focuses on important indicators linked to production performance. The top area displays the defect rate, total quantity produced, and effective production hours, allowing for a fast assessment of both efficiency and quality. The information in the main section of the interface is organised by product, with statistics such as total production per product type and business unit, number of orders per month, number of products per production line and percentage of defects per line.

Data Analysis

The dashboard provided valuable insights into the performance of the company based on the data provided by both supply chain and production areas. However, it is important to recognise that since the data was provided through Excel files manually constructed, it may contain errors and therefore the accuracy of the data is questionable.

Regarding the production lines, it was possible to analyse that line 3 produced a single type of product, resulting in lower production volume compared to other lines. On the other hand, line 1 had the highest production volume and produced a wider range of products.

The dashboard data revealed that all manufacturing lines had low OEE, with line 2 having the lowest OEE score. Further analysing the OEE criteria, it was possible to find that the quality factor had the biggest contribution, while availability contributed the least. This indicates that the company's production equipment may be facing frequent downtime or unavailability, indicating possible problems with production planning. Additionally, it was observed that the factor of OEE performance had potential for increase. Production delays, idle time, and lost productivity can all result from low OEE performance. It underlines the need of adjusting work practices and detecting the issues that cause long cycle times and production bottlenecks.

A low utilization rate represents a variety of underlying concerns, including resource underutilization and inefficient scheduling practices. Improving resource allocation, enhancing production planning, and optimizing production processes are possible solutions for maximizing utilization. However, it is important to note that when particular lines did not produce and when no available data was provided regarding that period, the utilization rate was recorded as 0%. This may result in an underestimation of the facility's real utilization rate which highlights the need for a thorough collection of data regarding the number of effective production hours.

The low on-time expedition rate observed in the manufacturing process may be caused by a combination of events, such as logistical inefficiencies and production delays. Inadequate coordination and communication among departments and stakeholders in the supply chain can be the cause of these events. Furthermore, production scheduling concerns, such as bottlenecks or disruptions, might lead to delays in delivering orders within the agreed deadline.

These metrics gave a full picture of the production and supply chain operations, allowing for the identification of areas for improvement, resource utilization measurement, and evaluation

of the quality and efficiency of the production outputs. The conclusions taken in this part will play an important role when analysing the current as-is model and in the identification of constraints.

4.2 Construction of the as-is model

Based on the conducted data analysis, we have progressed to design the as-is process mapping model of the processes within the Stoppers with Heads business unit. The "as-is" model is a visual representation or framework that accurately depicts the current state of a process inside an organization. It gives a thorough overview of how the process works, including activities, decision points, information flows, and information systems.

This section comprises both a representation of the company's current organizational structure as well as an exploration of the business unit of Stoppers with Heads four main sub-processes. A thorough knowledge of the operational context can be accomplished by briefly describing both the main areas of the company and the information systems at use. Once the context is provided, a description of the constructed flowcharts will be provided, detailing the process sequencing, the activities' accountability, and the systems employed throughout the processes.

4.2.1 Current organizational context

In order to provide a context of the organization as it was, two main elements are shared. Firstly, the main areas' responsibilities are presented with the aim of explaining how responsibilities are distributed and organized inside the company and how the areas intervene in the sequence of activities that compose the processes of Standard Process and New Projects. Six core information systems are used by the company, therefore, it is important to explain what they do to understand how they are incorporated in the processes.

The areas that are involved in the core processes according to the defined scope in the previous chapter of this dissertation are:

- Planning/Sales: executes planning, sales, and order management activities, and works with other areas to ensure efficient order processing, transportation scheduling, and resource allocation. Additionally, it is responsible for customer communication and collaboration with gluing area in production scheduling;
    - Manufacturing Orders Planning Team: team incorporated in the Planning/Sales area that manages the creation and closing of Manufacturing Orders (MO);
- Development: manages specific projects and activities related to the manufacturing of Special Project heads. This involves tasks such as examining raw materials and glue inventory, placing purchase orders for necessary supplies, molding materials into heads, and performing additional production steps such as sizing, drilling, laser marking, and surface treatment for special heads;
- Quality: ensures that products or services meet the desired standards and specifications. They implement quality control processes, perform inspections, and conduct audits to identify and rectify any defects or non-compliance. Additionally, they identify corrective measures and communicate them to the respective areas;

- Gluing: manage and perform the production process, equipment and machinery, and ensure that production targets are met. This area elaborates the production planning and performs gluing operations;
    - Warehouse Technician: responsibility inside the Gluing area that records stock movements, inspects truck conditions and loads products;
- Supply Chain: manages the sales and planning activities and is responsible for the creation of the pro forma and dispatch documents;
- Preconization: involved in product approval and the conceptualization of new products. Preconization encompasses activities such as prototyping, testing, and conducting feasibility studies to ensure the viability of the products. Additionally, they are responsible for creating preconizations of products based on customer requests. Preconizations are documents that contain the technical specifications and characteristics of products);
- Chief of Projects: responsible for supervising activities associated with new projects. He sends requests for samples, manages project feasibility analysis and communicates project status to the commercial area;
- Finance: manages the financial aspects of the company's operations by handling budgeting, financial planning and reporting;
    - The Management Controller is a responsibility inside this area that oversees activities such as cost price range analysis, analyses production costs and is responsible for invoicing.

Some additional areas that are involved in the process but do not belong to the business area structure include:

- Methods: creates customers' details in System D and items' information in both System C and D (detailed bellow). Also responsible for labelling adjustments;
- Legislations and Regulations: performs food contact tests as per French regulations;
- Commercial: receives customer requests and communicates with the Preconization area and Chief of Products when special requests are considered.

Efficient and reliable systems are critical for manufacturing companies. They facilitate processes and allow for better data management. For the considered company a number of Information Systems are used throughout the value chain. The systems functionality are presented to allow for the understanding of how they are incorporated into the process. A code has been allocated to the systems used in this project to safeguard the confidentiality and sensitivity of the Client company's information. Therefore, the considered systems are:

- System A: a software used mainly by the parent company in France. The Planning/Sales area uses it to register orders on a daily basis and generate order prints. There is limited access to the system, however it is necessary to use it for recording stock movements and for printing labels;
- System B: an Excel tool designed to facilitate communication between the Client company and its parent company in France. It works through the use of macros to collect order data from System A. It stores critical information on shanks and heads stock, and it is used for managing raw materials orders;

- System C: is a manufacturing order management software where the planning team operates in their creation and closing. Therefore, the information needs to be consistent with the information in the other systems;
- System D: a software used for order processing where the information of item and customer details received from System A, are manually inserted. It is also used to print the delivery note and issue invoices;
- System E: an Excel file where the Planning/Sales area can do order analysis and stock management;
- System F: an Excel file used for scheduling product transportation by the Planning /Sales area.

4.2.2 Mapping of the core identified processes

The chosen visual representation or format used to construct the "as-is" model in the case of the Stoppers with Heads was the BPMN 2.0 (Business Process Model and Notation). This notation was introduced in the literature review and is supported as comprehensive end-to-end business processes that cover a wide range of modelling tasks specific to business processes.

The BPMN 2.0 is composed of graphic elements that clearly and intuitively identify the logical sequence of activities that make up the process as well as the interactions maintained between players with related activities (Geiger and Wirtz 2013). Through this notation, which promotes the uniform design of processes, a language that is intelligible to all stakeholders is established. Appendix B has a representation of the core elements of this language and their meaning. Additionally, for the construction of the model, it was considered the level 4 of the process classification framework by APQC, which is referring to activities.

The data collected through the various data collection methods was critical in identifying and recording the many activities, decision points, information flows, and key metrics throughout the organization. Through the presented notation, BPMN 2.0, and using the information collected, it was possible to fully represent the "as-is" model of the four main processes of the Stoppers with Heads business unit in the Microsoft Visio platform. To understand the mapping procedure, the four major processes are detailed below. Appendix C has a representation of the mapped processes.

A. Standard Process

The standard process refers to the production process of products that do not require product preconization. The order to delivery subprocess within the standard process is the sequencing of activities that are followed when products have undergone previous testing and approval.

A1. Order to Delivery

The process begins with order registration. The Planning/Sales area prints orders from System A on a daily basis and sends them to System B. For the order to be processed, several requirements have to be met. First, the Planning/Sales area inserts the customer information in System C, and the Methods area creates it in System D. Second, the order-related item is created in both System D and System C. Only the Manufacturing Orders Planning team has the necessary authorizations to create products in System C. The order is inserted in System D after the Planning/Sales area ensures that these two requirements are met by communicating with the necessary parties through email.

The second stage of the process comprises order analysis by the Planning/Sales area. They analyse System B and copy the order information to System E. Different paths might be taken once they investigate the product type provided in the order.

If the order is for Stoppers with Heads, two different paths may be pursued depending on whether the heads will be manufactured internally or externally.

For internal production of the heads, the Manufacturing Orders Planning team creates the MO in System C. The Development area examines the raw material and glue inventory, sets purchase orders for missing supplies, and molds the materials into heads. The Quality area then evaluates the quality of the heads and, if necessary, communicates corrective actions to the Development area. Once the Quality area approves the heads, production can start. The heads are delivered to the Development area in order to go through a sequence of actions: sizing, drilling, laser marking and surface treatment. In between the different production steps, the Quality area tests the output and communicates the necessary corrective measures to the Development area.

For external production of the heads, the Planning/Sales area orders the heads on System E and schedules their transportation to the Client company facilities. Then a request is sent via email to the Manufacturing Orders Planning team to create the MO in System C. Once the heads arrive, they are sent to the Quality area for testing. After the Quality area approves the heads, the Planning/Sales team records the stock entry in System A, validates invoicing, and updates the stock information in System E.

After the collection of heads through either internal or external production, the Gluing area analyses and evaluates whether the gluing process can be carried out internally or if the services of an external service provider are required.

If internal gluing is selected, the heads can be either kept as stock for future use by the Gluing area or produced immediately. If the heads are kept as stock, the manufacturing order is closed in System E, and a request to close the manufacturing order in System C is issued to the Manufacturing Orders planning team. On the other hand, if the process moves to production, then it is ready for use according to the production planning. Twice a week, the Gluing team works with the Planning team to build a thorough production plan. In order to do so, stock is checked on System E and, after that, quality control in both the laboratory and the production line are performed by the Quality area and the results recorded in excel files. If Quality does not approve the capsules, corrective measures are performed by the Gluing area. Otherwise, production continues, and data is documented. If samples need to be sent to the customer, the warehouse technician collects the samples, prints new labels, and places them on the products. The Quality area then conducts analysis on the samples, coordinates with the Methods area for label adjustments, if necessary, and sends the products to the warehouse for storage.

If external gluing is selected, the Gluing area requests the external service provider for the service and waits for the end of the production in order to collect the heads. Once the Stoppers with Heads arrive, the Quality area performs control of the final samples and sends them to the warehouse.

Then, the Warehouse technician records the stock movement (inward) in System E and the production process is completed. The Planning/Sales area proceeds to schedule transportation via System F, taking pictures if required. Subsequently, the same team generates the delivery note using System D and forwards the documentation to the Warehouse technician for

printing. The technician then inspects the truck conditions and loads the product. Finally, the Warehouse technician records the stock movement (outward) and notifies the Planning/Sales team. This team, in turn, issues the invoice in System D, requests the Manufacturing Orders planning team to close the MO, and records the final stock movement in System C.

The presented process focuses exclusively on the manufacturing of Stoppers with Heads. However, it is worth mentioning that the same process was developed for ordering and delivering of stoppers without heads. The full process with all product ranges considered is provided in the Appendix C for reference. Despite the fact that the project scope is focused around the Stoppers with Heads business unit, the inclusion of a full mapping of the stoppers without heads processes was beneficial for both the project team and the customer. This extensive mapping offered a full grasp of the processes involved and enabled a thorough assessment of the workload of the individual teams.

B. New projects

The new project's process refers to production processes for the development of innovative products and need to be approved through a series of preconization tests in order to be commercialized. This process is split into three subprocesses: Product Preconization, Special Projects and Sample Shipping.

B1. Product Preconization

The process initiates with an email request received from either the commercial team in France or, in rare cases, directly from the customer. If the request is for Stoppers with Heads, a temporary preconization is necessary. The customer may choose to send a physical bottle along with the request, enabling internal tests to be conducted as part of the temporary preconization process. In cases where a physical bottle is not provided, the preconization is performed based on a technical sheet of the bottle, with a disclaimer indicating that it was carried out without a physical reference. All these activities are performed by the Preconization area.

Following the conclusion of the preconization, the management controller conducts a price range analysis and presents the results to the commercial team. At this point, there are two paths that may take place according to product type (monobloc or a stopper with head). The focus of this process description is on cases in which the customer is looking for a stopper with a head for their product.

The process for Stoppers with Heads involves two simultaneous paths: the preconization of the shank and the preconization of the head.

Regarding the shank, the chief of projects sends an email to the internal department responsible for shank production, or occasionally to an external supplier, requesting a sample. Once the samples are received, the Quality area conducts tests on them. If the results meet the required standards, there is no need for another sample, and the process proceeds to the gluing of the sample.

Based on the material characteristics, there are three possible paths for the head's development: wooden, plastic, or Special Project heads.

- Wooden heads: the preconization procedure for wooden heads starts with the Preconization area sending an email to the supplier to request a sample. The Quality

area tests the sample upon delivery, and if the findings fit the specified requirements, the procedure advances to the gluing step;

- Plastic heads: the Preconization area asks the Gluing area for molds since the person in charge of the Gluing area is the most knowledgeable about plastic molds. If there is stock of plastic capsules, they are transported to the Quality area for testing. Otherwise, the molds may be purchased from an external mold supplier. Following that, the raw material is requested to an external supplier and initial tests are performed at their facilities by the Gluing area responsible. Once the product arrives at the Client company facilities, the Quality area tests the sample before moving to gluing;
- Special Project heads: Special Projects may include either a pre-approved head, in which case the procedure is identical to that of wooden and plastic heads, or a non-approved capsule. In this second case, the process will be presented in the sub-process B2.

Once the shanks and heads are brought to the Gluing area, the samples are glued and submitted to the Quality area. Then, the Quality area performs tests according to the customer's instructions. If satisfactory results are obtained, the Preconization area is informed and the temporary preconization is confirmed. Afterwards, the temporary preconization is sent to the commercial team and the Sample Shipping process begins (B3).

B2. Special Projects

Special projects refer to new heads that are developed according to customer request and have a focus on sustainability regarding the materials that are used. The process begins when a customer submits a specific request to the commercial team. On a weekly basis, the development manager analyses the feasibility of the project requests given by the commercial team. If a project is considered non feasible, the chief of projects notifies the commercial team as soon as possible. If the project is found to be feasible, the development manager informs the commercial team to contact the customer and request the necessary materials. Upon material delivery, the Quality area thoroughly inspects the material's conditions, which determines whether the Development area will produce and prototype samples, or whether new materials must be requested.

At this point, the procedure consists of three parallel branches. First, the development manager estimates the production cost, which is subsequently sent to management control through email. The management control determines the cost price based on this information and presents it to the commercial team. Meanwhile, a tiny sample containing 4 or 5 heads is prepared and shipped to the customer via the Sample Shipping (B3) process. In the third branch, the sample is tested, which includes food contact tests performed in France by the Legislations and Regulations area and physical tests performed in Portugal by the Quality area. Once the heads have been validated, the status of the heads is updated in an Excel file created based on a template used for tracking Special Projects.

Following, a small sample is delivered, and if required, a pre-series is ordered. If no pre-series is required and the head is approved, the following procedure is the usual process for Special Projects, which follows the standard process for Special Projects (a path inside the A1 process). If the head is not verified, the situation must be analysed to decide the best line of action. If a pre-series is requested, the development team notifies the commercial team that further material from the customer is required. When the material arrives, it is subjected to

quality testing by the Quality area and once approved it is molded into heads by the development team. Following testing, the items go through a 48-hour stabilization period.

Afterwards, the Development area starts head production, which includes performing the operations of sizing, drilling, laser marking (optional), and surface treatment or painting. After each step, Quality area tests the output and if necessary, communicates to the Development area the corrective measures to be applied. Once the Development area has glued the heads and stoppers together, they are transported to the quality department for physical testing. If the test findings meet the specified requirements, the samples are ready for Sample Shipping (B3).

B3. Sample shipping

The sample shipping process is a small process triggered by a request to dispatch small product quantities. It can be either intra-community or extra-community, the case in which case a proforma and a dispatch must be created by the Supply Chain area before scheduling transportation. Following this step, the Quality area sends a notice to the customer via email and ships the physical product. In the event of sample rejection, a thorough analysis is conducted, and numerous solutions are explored based on the customer's needs and requirements.

If the sample is accepted, the final preconization is forwarded to the commercial team by the Chief of Products, and a request is made to the Methods area for item creation in System A. Once the customer approves the preconization, the product becomes approved Special Project, and, in the case an order for production is requested, the correspondent process for standard Special Projects can be followed within the A1 process.

4.3 Identification of constraints

The constraints were identified based on a comprehensive evaluation of the mapped processes, quantitative data analysis, as well as inputs obtained from the teams during interviews, workshops, and shop floor visits. This thorough plan ensured an in-depth understanding of the different aspects influencing the organization's functioning. Overall, 20 constraints were identified in the four mapped processes.

The constraints were classified based on their most prevalent association with the processes that facilitate organisation and analysis. This categorization took into consideration the fact that some limitations are related to multiple processes. The Standard Process has a total of 13 constraints, while the New Projects has 5 constraints, and the Special Projects has 2. No constraints were identified in relation to the Sample Shipping. These constraints were further categorized into three distinct types. These categories are not mutually exclusive so, each constraint may fit in more than one type.

- Processes: these constraints are caused by inefficiencies, inconsistencies, redundancies, or failures in the processes. It is assumed that the people and information systems involved are appropriate and are operating correctly. Examples include the absence of well-defined or properly embedded processes;
- Systems: these constraints are caused by inefficiencies, inconsistencies, redundancies, or breakdowns in information systems. It is assumed that the people and processes involved are suitable and functioning correctly. Examples include the absence of systems and/or gaps in functionality of a current system;

- People: these constraints originate from inefficiencies in the participants involved in the process. It is assumed that the procedures and information systems are appropriate and functional. Examples include the noncompliance with internal processes or best practices.

A comprehensive list of all the constraints that were identified during the analysis grouped by process is presented next. The constraints were categorized according to the constraint types presented before.

A1. Order to delivery

Constraints on processes

- **C1. Absence of indicators in several areas that support performance evaluation - key performance indicators (KPI):** The absence of well-defined KPIs in various areas limits performance analysis, error pattern identification, progress monitoring, and improvement opportunities. Examples of potential KPIs include theoretical versus actual production quantity comparison, productivity levels measurement, and preconization success rate;
- **C2. Absence of functional descriptions that define each function's responsibility:** Since the functional descriptions are not clearly specified, and there are now employees with accumulated functions, it is unclear which duties fall within the scope of action of the different functions. Multiple duties are performed by the same person in roles such as Quality, Chief of Projects, and Preconization or Sales and Planning;
- **C3. Manual creation of manufacturing orders and incomplete information for their creation:** Manually creating manufacturing orders based on the information from System A by the Planning area creates difficulties in defining packaging details. In particular, for orders received through email that do not have corresponding Bill of Materials (BOMs) the insertion of this information has to be done manually and based on previous experiences. This may result in inaccuracies and inconsistencies that lead to efficiency losses and rework during packing;
- **C4. Absence of defined procedures to follow when performing a particular activity:** The lack of defined and formalized procedures makes it harder to understand how to approach certain tasks. This situation may lead to overlooked steps, inconsistencies, and varying outcomes. This can result in inconsistencies and variability in outcomes, which can impact quality control and even regulatory compliance;
- **C5. Non-existence of weight control when shipping products:** Before the product is shipped to the customer, there is no control regarding the weight of the package, leading to lack of confirmation and potential discrepancies in quantities shipped to customers;

Constraints on systems

- **C6. Absence of permanent stock control:** Lack of real-time stock records in the information system hampers the assessment of production capacity and needs for purchasing raw materials. This leads to time-consuming processes and to the reliance on monthly stock counts for projections, which are registered manually;

- **C7. Manual data update, in different information systems (System A, System B, System C and Excel) which lack integration among them:** Usage of multiple information systems with lower integration than the business needs. As a result, there is a need for manual updates and the emergence risks, such as lack of standardization, information management difficulties, resource waste, information loss or inconsistencies, and reduced productivity. As an example, whenever the Client headquarters or the Portugal division need to change the shipping date, this must be done manually in three different information systems;
- **C8. Manual creation of customer and item information, in two different systems and by different areas:** To create an order, the customer and item information must exist in the system. This registration is carried out manually in two different systems, by four different areas leading to inefficiencies, the allocation of different resources to the same task, and potential errors or inconsistencies in data;
- **C9. Dependence on multiple Excel files, that are used by different stakeholders and require manual transposition of information:** The different areas are dependent on several Excel files with duplicate and redundant information which needs to be manually transferred. This lowers efficiency and increases the risk of errors. The Planning area alone uses five separate Excel files, resulting in time-consuming and error-prone processes for consulting and validating information. These files cover various aspects such as new orders, bodies' orders, capsules' orders, completed orders, and transportation management;
- **C10. Lack of formalization of a detailed production plan:** The absence of a production plan database or system causes lack of visibility and control. Despite Planning and Gluing areas meet twice a week for planning meetings, important information is not recorded, leading to constraints such as limited visibility on machine availability, uncertain production sequencing, potential loss of information, and challenges in production control and deviation analysis;
- **C11. Lack of visibility into real-time production data:** Real-time data on production lines, including production per hour, equipment productivity, interruptions, and rejections, cannot be accessed currently. The data is manually recorded in Excel by workers during production shifts;
- **C12. Unavailability of the option to make partial deliveries on the tool used for consignment note issuing:** Tool for consignment note issuance lacks partial delivery option, requiring manual creation in Microsoft Word and causing delays in delivering the official consignment note to the invoicing team (since they need to receive the official consignment note);

Constraints on people

- **C13. Misalignment regarding System A usage, both at training level and access level:** Despite System A’s non-implementation in the Portuguese division, employees from areas such as Quality require information from it. Lack of training and lack of access to software might result in its inefficient use and the dependence on co-workers for data extraction may cause delays for both teams. Example: the preconization team needs to ask other teams that have access to the system for them to alter item status while they are under quality testing (status: approved or under testing);

B1. Product preconization

Constraints on processes

- **C14. Lack of clarity on who should cover the costs related with the development of new projects and potential samples:** Internal misalignment and uncertainty over who supports the expense of new projects. Currently, the company supports project development costs, which might result in sunk costs if initiatives are not pursued;
- **C15. Lack of visibility from the customer's side over the status of a new project:** Although the Preconization area records the development of new projects, the customer does not have visibility over this information. This leads to unrealistic expectations and frequent requests for updates. This situation is time-consuming and may negatively impact customer satisfaction;
- **C16. Inability to estimate new projects' costs:** The company is not able to accurately estimate the costs incurred while developing a new project, namely in the research and development phase which makes monitoring and price estimation more difficult;
- **C17. Inexistence of a structured method for collecting customer data for new projects:** Upon the reception of a customer contact, there lacks a standardized method for collecting initial customer information. This leads to time-consuming interactions between multiple teams and causes project delays;

Constraints on systems

- **C18. Multitude of internal control codes referring to the same customer order:** The communication between the Client company and its headquarters is based on a diversity of internal control codes, which requires establishing a conversion line between them. As a consequence, to understand the order in hand, it is necessary to refer to an additional Excel file with the code conversion;

B2. Special Projects

Constraints on processes

- **C19. Non-existence of manufacturing orders for Special Projects area:** The sequencing of the development and production for Special Projects items is not formalized and no manufacturing orders are created which can result in the loss of traceability and lack of recording of production information (the start and end dates of production or machines used for each order);

Constraints on systems

- **C20. Multiplicity of Excel files for controlling ongoing Special Projects, instead of a consolidated file with data from the different projects:** Special Projects production management is performed through several Excel files, each corresponding to a singular project. The communication between project areas is based on these files, which are dependent on manual updates. This may lead to inefficient communication and management of ongoing projects. Moreover, comparison analysis between projects is harder.

The identification of these constraints was a fundamental starting point for identifying recommendations that will allow for the construction of an improved process. The "as is" model serves as a foundation for process improvement and innovation. Understanding the existing situation enables the identification of opportunities for digital technology deployment, resulting in process improvements and cost savings. This understanding informs the selection of the most appropriate digital tools and systems that are aligned with the intended transformation goals and drive innovation. In the "as is" paradigm, data analysis gives insights for informed decision-making and process optimisation.

In the next chapter, we will delve into the recommendations that answer the identified constraints and present the resulting process that aims to enhance the efficiency and effectiveness of the company. By implementing these recommendations, the organization can provide innovative solutions for the identified constraints and design an optimized operational model.

5 Design of the improved operating model

An operational model is the basis upon which corporate processes, systems, and resources are constructed to fulfill strategic goals effectively and efficiently. An organization can boost efficiency and achieve better coordination between day-to-day operations and organizational goals by reevaluating and enhancing its current operating model (Mergel, Edelmann, and Haug 2019).

The identification of constraints, particularly those related to processes and information systems, has supported the idea that our organization's project for process improvement aligns with the scope of a Digital Transformation project. The creation of the future model takes into consideration the specified constraints, carefully customizing them to the unique needs and objectives of our organization. The recommendations presented in this chapter serve as a roadmap for transforming and optimizing existing processes, aligning them with the company's strategic goals and enhancing overall operational efficiency.

This chapter starts by introducing the proposed recommendations, which are organized into categories based on criteria established on the previous chapter. Following that, the chapter provides a brief description of the main improvements applied into the four subprocesses (A1, B1, B2, and B3), which were built using the most suitable and pertinent recommendations. This gives insight into how the suggested upgrades will affect the considered process. Finally, the chapter concludes with an overview of the company's expected results both in short and long term, presenting the projected consequences of the proposed changes.

5.1 Development of recommendations

The recommendations presented in this chapter have been develped to directly respond to the constraints identified in the previous chapter. The process of formulating these recommendations involved analyzing knowledge from past projects and conducting a thorough research into the latest evolutions in the industry. For the considered project, the Client company specified that the reccomendations used for designing the to-be model should be of easily incorporated in the day-to-day operations of the company. By leveraging the experience and exploring innovative technological solutions, it was possible to achieve a set of solutions tailored to the Client's specific needs.

5.1.1 Recommendations

The recommendations were numbered in order to match the code established for constraints. As a result, for example, recommendation R1 is a direct response to the constraint C1. Appendix D represents the correspondence between constraints and respective recommendations.

Order to delivery (A1)

Recommendations to constraints on processes

- **R1. Definition and implementation of KPIs across the different functional areas:** Define a management information model with clear KPIs, formulas, and goals for each functional area. The sequence of recommended steps is: set objectives for each specific area, define clear KPIs and respective calculation formulas, identify data sources, define a clear goal for each KPI, and analyze and discuss the KPIs in periodic meetings. KPIs definition should be reviewed periodically to ensure their relevance;
- **R2. Creation of Functional Descriptions Manual:** Create a descriptive document defining each function's duties, tasks, and activities to promote accountability and workload management. This document should be available for consultation to all the workers at any time, and should be revised/updated on an annual basis;
- **R3. Create an internal and formally written rule which requires the clarification of packaging specifications with the customer, whenever they are not available (on email orders):** Create and communicate an internal rule requiring the validation of packing requirements for orders received through email. Following confirmation, a BOM is created in the system for accurate inclusion in the manufacturing order;
- **R4. Creation of a procedures manual with a detailed explanation of how the activities should be performed:** Create a procedures manual to improve consistency and efficiency. It should describe in detail the steps required to complete specific activities in each of the different processes. Make it accessible to all workers and update it annually (or as needed) for relevance and accuracy;
- **R5. Creation of a weighing control to ensure the correct quantities when shipping products:** Implement a weighing control in the warehouse to accurately measure the package weight before each shipment. This recommendation requires the availability of scales in the warehouse, and the inclusion of this step on the process review. The function responsible for this activity and the system where the information would be recorded should also be included and adequate training to the identified function should be provided;

Recommendations to constraints on systems

- **R6. Implement a warehouse management tool for the record of quantities and stock location based on a scanning mechanism (e.g through barcode readers or other devices):** Implement scanning operations throughout stock transportation to collect live inventory data at critical points such as raw material delivery, storage, and the start or closure of production. Use existing barcodes on storage shelves to update stock in a centralized database automatically. Assuming that the delivery note has a barcode associated with information about the items and quantities;
- **R7. Integration of the information systems to enable data-sharing and enhance overall performance and functionality:** For this recommendation, a specialized IT team must perform an analysis of the requirements and potentialities of each system in use in order to establish an architecture for data integration. As a result, task duplication can be avoided and automatic updates across platforms achieved. It is suggested the use of an Application Programming Interface (API) (Imieliński,

Virmani, and Abdulghani 1999) for seamless communication between systems. This allows users in one system to access and use data from another one;

- **R8. Integration of the information systems to enable data-sharing and enhance overall performance and functionality [recommendation for constraint 7] and functions adjustment and re-definition:** Two solutions were considered for this constraint. The main one is the same recommended to address constraint 7. As an alternative solution, it was recommended to consolidate duplicate activities under a single role to minimize errors and inconsistencies. Therefore, the responsibility of creating items and customers in the different systems would be assigned to one role to ensure data consistency. The systems's access would have to be aligned with job functions;
- **R9. Implementation of an Enterprise Resource Planning (ERP) software to manage data from different functional areas:** Implement ERP software to replace Excel files, serving as a centralized source for accurate and efficient decision-making and data management. The Client company intends to implement a new ERP soon, as discussed in interviews and workshops;
- **R10. Acquisition or development of a tool for detailed production planning of manufacturing orders:** The main recommendation provided was the acquisition of a detailed planning tool to sequence production items on production lines. It would collect information available in the existing data sources in one single place. As a result, the information would be automatically updated in the existing files and creating a sequencing of the production orders and corresponding machines to operate would be easier. An alternative solution would be to develop a low-code application (e.g. Microsoft Power Apps) as a template for registering information during meetings between Planning and Production areas. The application would have, in one single place, all the necessary information regarding the manufacturing orders. Similarly to the main recommendation, the template could allow for production scheduling and planning;
- **R11. Set up a Manufacturing Execution System (MES) to have an automated real-time collection of production information:** A MES is a system that monitors the manufacturing process from the raw materials to the finished goods. It can automatically collect data from the machines and other systems with the aim to centralize the information for real-time decision-makers to optimize and improve the efficiency of production at floor level. It may be necessary to incorporate sensors for data collection steps which are not digitalized yet;
- **R12. Reconfiguration of the consignment note issuance tool to allow partial deliveries:** Analyze the feasibility of configuring the existing tool to enable issuing and sending consignment note directly on the platform, eliminating the need for Microsoft Word;

Recommendations to constraints on people

- **R13. Development of training sessions on System A for key users, and review of accesses:** Prepare internally developed training sessions, either by expert users inside the team or by users on the parent company's side. They should focus on explaining how to navigate and efficiently access information in System A. This would result in a

reduction of the time taken to perform these consultations and data extractions. In addition, regular access reviews are recommended for improved efficiency;

Product preconization (B1)

Recommendations to constraints on processes

- **R14. Clarification of the target cost model for new projects:** Discuss and define target cost model for new projects by considering a shared cost model where the customer pays for project development costs, which can be deducted from the final project price if an order is placed;
- **R15. Creation of predefined answer templates, that automatically inform the customer on new project status:** Implement predefined response templates to automate communication with customers regarding project request status. These templates lead to the development of a semi-automatic email response that confirms successful submission and provides an estimated response time frame based on the recommended form for constraint 17. Calculating the response time should take into consideration various factors. Once the email response is validated, it should be promptly forwarded to the customer. The company should also ensure that project progression is regularly updated in Excel files and that automatic emails are generated using pre-defined templates with specific phase results. By implementing these measures, the company can enhance visibility, improve communication, and ensure that customers have accurate expectations for project development;
- **R16. Collection and recording of information about project development costs in a centralized database:** Record expenses data in a centralized database for accurate project development cost estimation. Use a platform such as Microsoft Power Apps or an equivalent solution for integration with the company's databases. Connect invoices to new project files for precise cost calculation. Estimate variable costs and quickly assess new project costs using chosen variables and past project data. Include estimated project price in the confirmation email for customer billing if applicable. Note that the information on these variables can be collected from the form for data collection proposed on a recommendation for constraint 17, which are then analyzed;
- **R17. Creation of template/form for data collection:** Create a comprehensive template/form for customer project initiation. The form should include predefined fields, ensuring a clear and complete request for information. An additional proposed function is to implement mandatory fields to prevent missing data. It is relevant to note that the form can be easily integrated in low code solutions to get the data automatically recorded and distributed throughout the existing systems;

Recommendations to constraints on systems

- **R18. Development of a searching and consulting application (through the order codes) information on customer orders:** Develop a user-friendly application using a low code platform such as Microsoft Power Apps to efficiently manage and access customer order data. The application can be developed with the aim of allowing the user to search for the information on a certain order based on either the order code from the parent company or the order code used by the company in Portugal. The interface design should include a search engine and a list of matching orders with

relevant information. This implementation would save time, since there is no need to open and search for the conversion in the existing files and the process is automatized in one single window;

Special Projects (B2)

Recommendations to constraints on processes

- **R19. Inclusion of a step for manufacturing orders' creation on the Special Projects process:** During the ongoing review of the Special Projects process, it is essential to include the step for creating manufacturing orders to enhance traceability, similar to other projects. This will provide greater visibility into production, including times, quantities, materials used, and potentially information on the machines used for each order. To enable this, proper configuration of the information system is necessary;

Recommendations to constraints on systems

- **R.20 Development of an application to centralize the information on Special Projects:** Develop an application to manage Special Projects. Through the application (developed using Microsoft Power Apps or an equivalent solution) all the information would be centralized to make it easier to get status on projects and search for previous projects. Moreover, the application would also help monitor KPIs related with these projects.

5.1.2 Classification of recommendations

A classification system was used in this project to guarantee a structured approach and efficiently prioritize the proposed solutions. The goal was to help the Client understand which reccomendations are more relevant for short term impementation. Each recommendation was given a final score based on four essential criteria: implementation time, people effort, financial cost, and impact on efficiency. It is important to note that the classification according to the proposed criteria was carried out at a high level, based on experience in similar projects and based on the input from the Client company representatives.

The four criteria used for classification were as follows:

- Implementation Time: recommendations were categorized as short term, medium term, or long term based on the estimated duration of the proposed actions. Short-term actions were expected to be completed in less than a month, medium-term actions within a period of 1 to 6 months, and long-term actions requiring more than 6 months;
- People Effort: the level of employee involvement necessary to execute the actions were classified as low, medium, or high, depending on the participation required from the workforce. A low effort indicated the involvement of less than 5 employees, medium effort involved 6 to 10 employees, and a high effort required the participation of more than 10 employees;
- Financial Cost: the financial implications of implementing each recommendation were considered and categorized as null, low, medium, or high. The specific cost range for each category was defined by the Client company;

- Impact on Efficiency: the anticipated impact on process efficiency was assessed, taking into account factors such as error rate reduction and the optimization of human and material resources. Recommendations were classified as slightly reducing, reducing, or significantly reducing the error rate and/or the resources required to execute the process.

Quick-wins are distinguished by their short-term execution, low people effort, and no or low money expenses. Furthermore, they are predicted to increase process efficiency lowering the error rate and/or the resources required for execution. Table 2 summarizes the classification of the five quick-win recommendations.

Table 2 – Quick-wins recommendations

		Recommendation criteria			
ID Rec.	Recommendation	Implem. time	Financial cost	People effort	Impact on efficiency
R3.	Create an internal and formally written rule which requires the clarification of packaging specifications with the customer, whenever they are not available (on email orders)	Short term	Null	Low	Low
R14.	Clarification of the target cost model for new projects	Short term	Null	Low	Medium
R17.	Creation of template/form for data collection	Short term	Low	Low	Low
R18.	Development of a searching and consulting application (through the order codes) information on customer orders	Short term	Low	Low	Low
R19.	Inclusion of a step for manufacturing orders' creation on the Special Projects process	Short term	Null	Low	Low

5.2 Design of the to-be model

In the definition of the project scope, some recommendations were identified as value-adding to the company since they would directly respond to the needs of the company. Therefore, besides mapping of the improved processes, the functional descriptions manual and the commercial brochures about the Special Projects were predetermined as deliveries.

5.2.1 Process map of the to-be model

This section provides a summarized representation of the developed improved process map. This model was built from the recommendations previously presented in order to generate a realistic process that the Client company could easily adopt in a short period of time. The decision to focus on solutions that could be rapidly implemented was reached by mutual agreement between the PwC team and the Client, aiming at having an impact in day-to-day operations and as soon as possible.

Priority was given to "quick wins," changes that require little effort and a small investment and result in positive outcomes for the organization. In addition, the process mapping addressed the correction of missing stages as well as clarified the functional roles responsible for each task. These enhancements were included into the process map that was created. Long-term improvements were not neglected and were clearly marked as important annotations on the process map. The goal of these annotations was to offer a clear and detailed explanation of how implementing these long term recommendations would benefit the process.

In the finalized process map, activity times were included which facilitates task performance duration estimations and allows for the prediction of response times to both customers and suppliers.

In the next part, a number of relevant improvements are presented as a contrast to the existing process to illustrate the influence of the proposed improvement project on the process.

A. Standard Process

A1. Order to delivery

In terms of the order to delivery process, several significant improvements have been identified.

- The Sales assistant is in charge of printing new orders. When an order arrives, it is checked to see if it contains a Bill of Materials (BOM). In circumstances when the BOM is missing, the Sales assistant emails the commercial team to check the customer's packaging needs (Recommendation 3);
- Regarding the registration of items and customers into systems, two solutions have been proposed. In the short term, it is advised to assess system access and delegate the duty of creating these items to a single function (Recommendation 9). In the long term, systems integration allows for the manual insertion of customer/item data in the primary platform to trigger the automatic creation of the same information across all other platforms (Recommendation 7);
- The planning technician's responsibilities include monitoring System B for new orders and transferring the information to System E. Long-term, the deployment of an Enterprise Resource Planning (ERP) system and system integration will reduce the requirement for extracting and transferring data from one system to another because all essential data will be shared through a single source.
- In the case of internal manufacture of heads, short-term improvements include logging all production operations, quality tests, and results in Excel files, while the long-term improvement consists of adopting Manufacturing Execution Systems (MES) for real-time automated data collecting (Recommendation 17);
- In this case, the planning technician is in charge of stock analysis. The adoption of an ERP system enables a direct creation of purchase orders within the system for externally produced heads (Recommendation 9). When materials arrive at the warehouse, the recommended scanning system can instantly enter the information into the ERP system (Recommendation 6);
- Documentation accompanying the cargo is typically delivered during meetings between the planning and gluing teams. Quality tests are performed on samples, and if they are approved, the purchase order can be closed in the ERP system (Recommendation 9). Invoices and transportation paperwork must be sent to the accounting staff before the end of the month;
- Meanwhile, in the production and planning meetings that are held twice a week, the detailed production plan is documented in Excel for production schedule control (in the short term). In the long term, the acquisition/development of a tool for detailed production planning of manufacturing orders would facilitate data control. An activity regarding registration of a detailed production plan was added. A new activity has

been introduced for the registration of a detailed production plan (Recommendation 10);

- When heads are designated as stock items, warehouse operators are responsible for updating stock movements in the system;
- After gluing, the product is stored and ready for delivery. Warehouse personnel should photograph the transported products for future reference. In the long run, altering the consignment note issuance tool would allow for direct partial deliveries within the system. When the goods are ready to ship, warehouse personnel can use a scanning tool, in addition to the ERP system, to complete stock outbound operations in the system (Recommendation 9);
- A new step for price validation has been introduced, assigned to the sales assistant before issuing the invoice. The manufacturing order can be closed within the ERP system as well.

B. New projects

B1. Product preconization

Regarding the product preconization process, some of the suggested improvements were:

- As a first step in preparing for the improvement of the process, a template/form should be provided to the commercial team for presentation to customers (Recomendation 17). This stage guarantees that all required information is gathered and included into the project launch process. Once the form is received, the project manager has access to all of the information needed to begin the project;
- Specific stages for cost price analysis have been expressly added in the process following the development of temporary preconization in the Stoppers with Heads path. This innovation is intended to improve cost management and decision-making during the manufacturing of Stoppers with Heads (Recommendation 16);
- Throughout the project, effective communication lines between diverse departments have been emphasized. For example, in plastic head manufacturing, the preconization technician contacts the gluing manager for samples because the latter has experience in plastic head production;
- Furthermore, test findings on Stoppers with Heads after gluing are reported to the preconization technician as soon as possible, guaranteeing a seamless flow of information between relevant parties.

B2. Special Projects development

Special project development presents a few improvements in its process, some of them being:

- A special project arising from an internal request has been included as a triggering component in this procedure. The project manager is identified as the person in charge of coordinating all communication between the commercial team and other parties participating in the project;
- Following the feasibility investigation, the collected data is recorded in Excel for historical purposes;

- Preconization of the stopper and of the head are now recognised as different pathways;
- Regarding heads preconization, the tests performed on the heads upon the receipt of raw materials have been represented in the process map. Furthermore, timelines for providing input throughout the preconization process have been set in the process map. When heads are validated, the resultant data is updated in an internal Excel file of authorized heads. Moreover, the test findings obtained after head validation are carefully documented in the system;
- When a consumer chooses not to do a pre-series, an extra step is added to alert the Methods area to generate the item in the system. If a pre-series is requested, the chief of projects is in charge of asking for additional resources from the commercial team. In the short term, when the molding step is performed the information about manufacturing activities and quality outcomes is recorded in Excel. In the long run, the use of Manufacturing Execution Systems (MES) would help to automate this procedure (Recommendation 11);
- The process path for the construction of a preconization for the stopper stays similar with the current process. This approach involves the analysis of the bottle, the request for samples, and the cost price analysis.

B3. Sample shipping

Sample shipping is the process that had the least transformation. Some of the suggested improvements are:

- The responsibility for scheduling transportation lies with the Sales assistant. Subsequently, the warehouse operator performs the task of physically delivering the product to the customer while the Sales assistant is responsible for sending an email to the customer containing the tracking information;
- In the event that the customer rejects the sample or the preconization, the Chief of projects assumes the role of analyzing the situation.

When the process mapping was concluded, a second workshop was performed in order make the necessary corrections to the improved process map. The aim of this workshop was to systematically review the entire process, from start to end, and obtain valuable feedback regarding the proposed changes. Considering that the mapping was built based on improvements that could be quickly implemented, the workshop participants were made aware that long-term changes were acknowledged and recorded within the map through clearly identifiable notes.

5.2.2 Functional descriptions manual

The functional descriptions manual serves as a valuable tool in addressing the identified constraint related to the lack of clear roles and responsibilities within the organization. It is associated to the Recommendation 2.

This document aims to record and clarify the duties and responsibilities attributed to each function within the considered business unit. It is a tool that can be used as a foundation for defining performance evaluation metrics for the recorded functions. Additionally, this document enhances internal alignment, accountability, and efficiency by clarifying responsibilities and reducing duplicated activities. As complementary attachments, an

organogram and a RACI Matrix were developed to better clarify the hierarchy lines inside the business unit and the roles each function plays for each activity.

An organogram is a graphic depiction of the structure of an organization that shows relationships and positions. It depicts a hierarchical structure, reporting lines, and duties. A detailed organogram was supplied in the functional descriptions manual, reflecting the revised business unit organization and offering more clarity on separating functions from the duties of the individuals performing them. Some of the main adjustments compared to the as-is model functions definitions are:

- When defining the activities responsibilities, it was made clear the difference between the manager (which had a more strategic role inside the area) and the technician (responsible for most of the operational work). For example: Gluing manager and Gluing operators and warehouse operators;
- The sales area and planning area had their functions clearly outlined and therefore were presented as two sub-areas included in the Supply chain area. As a result, the roles of sales assistant and planning technician (which included the responsibilities of planning of manufacturing orders) were redefined.

A RACI matrix is a tool used to define and clarify roles and responsibilities within a project or process. It helps identify who is Responsible, Accountable, Consulted, and Informed for each activity or task. In this case, the RACI matrix was constructed by gathering all the activities represented within the project or process. The attribution of roles followed the presented rationale:

- Responsible: is the person or group that has to complete the activity. Based on the information assembled on the mapped process, the responsible function for a specific activity would be the one to which the execution of that activity is assigned to. There can be multiple R's per activity;
- Accountable: is the person or group that must ensure that the activity is completed successfully and that the desired results are achieved. A is to whom the R is accountable. In order to identify the accountable role in an activity, an analysis over the organogram of the company is necessary to understand the person in charge of their responsibilities that fall under a certain area of the company. There can only be one A per activity;
- Consulted: those who need to be consulted or provide input. When analysing the process, it can be identified as those who may need to be asked for input regarding a certain activity since they may have some experience or extra knowledge on those type of activities. They must be consulted before the decision is reached since it will affect areas under their control. There can be multiple C's per activities and it represents a two-way communication;
- Informed: represents those who need to be kept informed about the progress or decisions related to the activity. In the process, whenever the flow changed lane, the transmission of knowledge would be represented by having the person who would continue the activity informed of the execution of the said activity. There can be multiple I's per activities and it represents a one-way communication.

An illustrative example can be provided to exemplify the allocation of roles within the decision-making process. In the context of analyzing findings before verifying the temporary

preconization, the quality technician is responsible for conducting the analysis. Meanwhile, the quality manager has the ultimate responsibility for this, being the one accountable for it. With their specialized experience, the gluing manager is consulted to provide insights into various corrective measures that may be performed. Finally, the preconization technician, who will ultimately confirm the temporary preconization, is informed about the decision made

The templates used for the Functional descriptions manual and RACI matrix are provided in Appendix E and Appendix F.

5.2.3 Special Projects commercial brochures

The Future Special Projects Process Brochures are documents that outline two distinct processes, in Brochure 1 and Brochure 2, created for commercial purposes. Brochure 1 focuses on standard projects (pre-existing heads) within the Special Projects, while Brochure 2 focuses on new projects (new heads) within the same domain.

These brochures serve as informative tools that illustrate the many stages of the future process and indicate their completion status. Each phase is accompanied by a concise description and a standard estimated duration. Additionally, the brochures feature a time monitoring bar, providing customers with a visual representation of their order's development progress.

The major goal of these brochures is to allow successful communication with commercials and customers by providing them with relevant information on the state of their project, the various development phases, and time and expectation management. Moreover, they serve as a means to promote the potential of Special Projects during Client company sales interactions. The benefits of its use include the synthesis of relevant information into a single document. This not only improves communication with customers but also provides the commercial team with a comprehensive perspective of the Special Projects area process. Lastly, the brochures can be used for internal time control, serving as reference for a comparison between theoretical and actual timeframes.

5.3 Expected results

In the short term, it is anticipated that the company will successfully implement the described process improvements.

This entails ensuring that tasks and functions align with the definitions outlined in the functional descriptions manual. The expected outcomes of these improvements include the elimination of redundant tasks, more balanced workload distribution, improved collaboration, and enhanced communication among various departments within the company. The clear illustration of steps, inputs, outputs, and decision points facilitates communication and collaboration among team members and increases accountability and transparency, which is expected facilitate the identification and discussion of future improvements. This end-to-end detailed overview will also be helpful in the onboarding of new employees.

Furthermore, automation of processes and reduction of manual work are anticipated. Although the time required for quality testing cannot be reduced, the increased knowledge and improved management of customer, supplier, and interdepartmental expectations will facilitate smoother operations for the quality department. Additionally, the gluing department will be able to analyze KPIs such as on-time expedition, utilization rate, and OEE, enabling data-driven decision-making.

In the long term, the integration of platforms, systems, and APIs will enable automation across the value chain, reducing manual activities and freeing up resources for other tasks. The implemented systems also enhance data analysis capabilities, enabling the detection of inconsistencies and facilitating the adjustment of KPIs and strategic decisions.

The next chapter will discuss the main conclusions of this project and the future work, highlighting the remaining potential for improvement after the assessment and design phases of the transformation project.

6 Conclusions

This master dissertation, based on a consulting project developed for a client in the cork stoppers industry, focused on providing the Client company with an improved transformation of its current operating model. The project followed a framework developed by PwC that fits into the BPM lifecycle concept and was oriented into providing recommendations for improvements that fit within the Digital Transformation.

The Client company aimed for an improvement of the current processes through the identification of their main constraints. Additionally, being aware that currently there was a lack of understanding of the tasks associated to the different functions, it also wanted for a document that allowed the registration of the tasks attributed to each function. As a third goal, the company wanted to increase the visibility of its special projects area inside the Stoppers with Heads business unit.

From the beginning of the project, it was established a work plan that was composed of two phases and started with an assessment of the current operating model. In order to get familiar with the company and its processes, the project started with gathering knowledge regarding the processes flow inside the company. This was achieved through directly requesting for data files in a quantitative approach and by performing interviews, workshops and shop floor visits. With the quantitative data provided, it was possible to get some results regarding some KPIs such as the OEE, On-time Expedition and Utilization Rate of the company. A two-interface dashboard was developed as a way to present to the Client company the results of the analysis performed in an organized and visual way.

The three data collection methods allowed for a comprehensive analysis of the current processes which resulted in the current processes mapping of the Standard process (which consisted in the order-to-delivery activities) and New Projects processes (which included the subprocesses of Product Preconization, Special Projects and Sample Shipping). Additionally, and considering the conclusions built from the quantitative data analysis, it was possible to collect a list of 20 constraints related to processes, information systems, and people.

Based on the constraints identified it was possible to develop recommendations that directly responded to the needs of the company. Through the classification of the constraints in a pre-defined weighted criteria, it was possible to prioritize them according to implementation time, financial investment, people effort and impact on efficiency. Before advancing to the construction of the improved operating model, the list of constraints and recommendations was sent to the Client company for validation.

Following the classification of recommendations and focusing on implementing a solution that could be quickly set up and provide a short-term future reasonable operating model, a mapping of the improved to-be model was delivered. It included notes regarding long term

suggestions for more structural transformations namely regarding the acquisition/development of information systems or total systems integration solutions.

As a member of the project's operational team, the author was required to actively engage in project task execution and assure the effective delivery of project outcomes. However, it should be highlighted that each team member took part in all aspects of the project, ensuring a high degree of involvement and quality. The author's responsibilities included: taking notes during interviews and workshops for documentation; planning and organizing workshops; formulating relevant conclusions from quantitative data analysis; analysing existing processes to identify constraints in the as-is model; proposing recommendations based on identified constraints; building the future processes of the to-be model; constructing responsibilities within the functional descriptive manual; constructing the RACI matrix; and designing informative brochures for special projects.

6.1 Main results

The project team succeeded in delivering value to the Client company, by developing outputs directly associated with the needs.

The knowledge about the reality of the operating model of the company was achieved through the process map of the current processes, therefore providing a comprehensive representation of the organization's activities, systems, and responsibilities. In addition to the quantitative analysis dashboard, these deliverables were the foundation for the subsequent analysis and identification of improvement opportunities.

The project also resulted in the identification and categorization of constraints within the current processes. These constraints were carefully analysed, leading to the formulation of actionable recommendations that address the issues of the Client company in an effective way. The recommendations establish an orientation towards business transformation, including digital transformation.

As a result of the project, a short-term enhanced operating model was created. The developed model included the most relevant suggestions in terms of people effort, financial cost, implementation time, and impact on efficiency, making it an achievable improved scenario. Long term recommendations were also included as a note in the delivered process map in order to facilitate future implementation.

Another significant result of the project was the creation of a functional descriptions manual that outlined the organizational structure and functions within the company. This manual provided a comprehensive understanding of roles, responsibilities, and reporting relationships, promoting a shared understanding of the organizational structure.

Lastly, a commercial brochure was developed to showcase the Stoppers with Heads, specifically those made with special materials. The brochure aims to attract new customers to buy products in this particular product range.

6.2 Project limitations

Despite the valuable insights and contributions provided by this master dissertation project, several limitations should be addressed to provide a comprehensive understanding of the project's scope challenges.

To begin with, it is vital to highlight that this project only had two phases: assessment and design. The lack of an implementation phase limits our knowledge about how the recommendations will be implemented and their actual impact on the Client company. Therefore, deeper research is required to fully understand the impact of the proposed recommendations and evaluate their efficiency.

The project was also limited by resource constraints and limitations related to the short term scope and impact requested by the Client. Some of the recommendations focused on quick implementation, which was influenced by the availability of resources within the Client company. This restricted the exploration of more comprehensive and long-term alternatives which could enable more efficient and sustainable process improvements.

Insufficient data registration and monitoring in the Client company created challenges in the quantitative analysis, limiting the quality, accuracy and depth of findings. It also restricted the ability to compare the evolution of the company in short-term, being harder to detect if the implemented suggestions are having a positive impact in the near future.

Lastly, confidentiality agreements limit the possibility to pursuit results that support some of the conclusions developed throughout this dissertation. This limitation restricts the full exploration of certain aspects, potentially leaving gaps in the understanding of the organizational context and analysis performed.

It is crucial to emphasize that these limitations do not undermine the value of the project's contributions. On the contrary, recognizing and understanding these constraints present avenues for future research and study. This acknowledgement allows the continuation of the research regarding the applicability of process management and digital transformation within the cork stopper sector and beyond.

6.3 Contributions and Future work

The project presented in this dissertation has generated valuable insights in the areas of business process management and digital transformation, providing also significant practical contributions to both the Client company and the consulting company. These insights reveal valuable insights that should be taken into consideration.

The successful application of business process management in the project, has proved itself to be an example of effective execution. The results of the study confirm the accuracy and usefulness of the BPM life cycles described in the literature.

However, it is important to note that, although the framework employed for project execution was similar in essence to the existing models in the literature, there were some differences associated with the nature of a consulting project. A framework for a consultancy project requires flexibility varying on the selected project scope and adaptability to the considered Client company. While the literature frequently emphasizes an iterative approach, consulting projects frequently have time constraints that allow for only one single iteration. Therefore, it demands from the consultant company to develop a transformation that can be later conducted by the Client, even without the consulting firm's continuous engagement. The adaptability and sustainability of the solutions are an implied request of the client companies.

Therefore, the BPM lifecycle inspired framework developed by PwC - Transform framework - presents itself as an adaptation of the presented life cycles to the consultancy projects. This modern framework recognises the necessity of linking the external view and additional

experience of the consultancy company with the internal team's knowledge on the processes and organizational structure. Mixing external ideas with inside expertise is a fundamental factor for the success of this initiatives.

In terms of digital transformation, businesses must keep updated with the changing client needs and embrace digital technologies to remain competitive. The suggested transformation has placed the Client company in a position to embrace the necessary digital improvements based on industry trends and preparing the company for future enhancements.

Additionally, the project is aligned with the critical success factors initially presented in the literature review. In this project, management support throughout the project phases ensured strategic alignment between the project development and the company's vision, which were ensured by the constant conversation and weekly status meetings throughout the project. Moreover, involving workers in interviews, workshops, and shop floor visits facilitated their understanding and preparedness for change, therefore bridging the people and the information systems to find an adequate solution. Finally, the analysis of innovations and technological advancements enabled the design of a competitive improved operating model that would enable for the company economic and technological development.

The project team is currently creating a presentation for the consulting company on the developed workshop. This will give significant insights on the preparation and contribution of workshop for as-is process mapping. Sharing the key lessons learned from the workshop will contribute to spread information and improve understanding of good workshop practises in similar consulting projects.

Regarding the Client company, four main areas for future work were identified. Firstly, it is recommended the exploration of the improvement phase. Building on the foundation established in the assessment and design phases of the consulting project, this is the expected evolution of the project in order to correctly employ the proposed recommendations. A systematic and structured approach should be followed to ensure the continuity of the project and to achieve the projected goals.

Regular revision of process mapping is crucial to ensure their accuracy and relevance. Adjustments should be performed on a regular basis to keep it current with any changes in processes or systems. It is critical to specify a defined revision time and appoint a responsible who will be accountable for organising the revision process and ensuring active involvement from all relevant parties.

The definition of key performance indicators is a topic that deserves further investigation. By developing KPIs, the company may efficiently track its success, make data-driven choices, and discover opportunities for future improvement. This is crucial not only for tracking the existing transformation process, but also for determining future directions for the improvement of the company's performance.

Finally, it is expected that the delivered dashboard for data analysis is further used in order to support data-driven decision-making. This dashboard should combine and display the KPI's to help monitor and evaluate the success of the implemented suggestions. This will enable for the identification of areas that require attention as well as the tracking of overall progress towards organisational goals.

These contributions lay the foundation for future research and exploration in the fields of process management, digital transformation, and consulting practices within the cork stopper industry and beyond.

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Appendix A: Interview template

Client company name
Process Transformation

Data: XX/XX/XXXX	Page 1 of 3

Interview - Value Chain

Schedule & Place:		
Start	**End**	**Place**

Participants	Company / Area	Participants attendance time

Meeting agenda:

The aim of this meeting is to understand the Client Company's value chain processes:

- In a first phase, the general context of the Client Company and its processes;
- In a second phase, the details of the activities contained in each process.

Questions:

General/Context:

- What are the different areas of the company (Supply Chain, Quality, Bonding, and what others?) and what processes are each area responsible for?
- How is your area organized? What teams are there under your supervision and how many employees work in the department? What are the main activities/responsibilities of each team? How do the different teams in your area interact with each other? Are there regular team meetings?
- How is communication established between your area and the different areas? E.g. Development? Quality?
- What are the main indicators used/measured by the different areas (operational)?
- What are the information systems used to support the different areas? What are the main shortcomings of the currently used information systems? What do they still do manually/outside the system and what do they consider it would be advantageous to include in the system/automate?

Strategy to Plan

1. **Develop and manage your area's planning, policies and strategies**

   1.1. How is the department's global strategy defined? How is compliance with the corporate strategy and strategic objectives monitored?

   1.2. What are the metrics they use to measure the performance of different areas? How often are they reviewed? How often are the different areas evaluated?

   1.3. How do analyzes and performance indicators contribute to the continuous improvement of the production process?

	Client company name Process Transformation	
	Data: XX/XX/XXXX	Page 2 of 3
	Interview - Value Chain	

1.4. Is there any kind of periodic reporting? What report and to whom? Is there anyone who analyzes the results obtained and defines improvement initiatives?

1.5. What systems / tools do you use to carry out your daily activities?

1.6. Are any process improvements planned in the near future?

2. **Budget**

2.1. What are the main steps included in this process?

2.2. Who (from your board) participates in the budgeting processes?

2.3. What criteria are used in building the budget?

2.4. What are the defined timings for budget presentation and approval? Who approves the budget?

2.5. How is the communication between your area and the financial area carried out? In what system?

2.6. Who is responsible for ensuring budget monitoring and compliance?

2.7. Are any process improvements planned in the near future?

3. **Make to Stock vs Make to Order**

3.1. Is production by batch?

3.2. What time is production done? Is this schedule fixed or does it vary depending on the time of year? Are there production peaks during the year? What factors are they related to?

3.3. How many production shifts are there? How many employees are part of the production process, at each stage of the process (from capsule molding to storage)?

3.4. How many production lines are there in the factory?

3.5. Who is responsible for drawing up production plans? Which areas are involved in drawing up production plans and needs? How are they prepared and what is the frequency of elaboration? How often are production plans reviewed? Who is responsible for validating the production plan?

3.6. Are deviations from planning monitored? In what system?

3.7. How many SKUs are produced? Do the specifics of each SKU require equipment changes? Are reference/setup changes made at certain times of the day or can they be made at any time? How many changes occur, on average, per day?

3.8. What are the factors that most limit the production process?

3.9. Are the warehouses managed in an integrated/joint way?

3.10. Who is responsible for coordinating industrial processes?

3.11. Are there minimum/safety stocks of final product?

3.12. Are any process improvements planned in the near future?

	Client company name Process Transformation
	Data: XX/XX/XXXX — Page 3 of 3
	Interview - Value Chain

Source to Pay

4. **Request new material and define requirements / Create requisition and purchase order**

   4.1. How is a purchase triggered and subsequently carried out in this area? Who is responsible for purchasing raw materials (subcontracting)? What is the interaction with the planning area?

   4.2. How are stocks associated with different products managed? Are there defined minimum stocks for purchased products?

   4.3. How is a purchase requisition made? Is production or purchasing responsible for making the order? Who contacts the suppliers?

- What are the **strengths** you identify in the different processes?
- What are the main **constraints** that you identify in the different processes?
- Do you identify **opportunities for improvement** that can be implemented?

Other relevant observations:

General Observations

Identified Strengths:

-

Identified Weaknesses/Constraints:

-

Identified Improvement Opportunities:

-

Follow up questions for other areas:	
Question	**Area**
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Requested Documents:		
Name/format	**Date**	**Responsibility**
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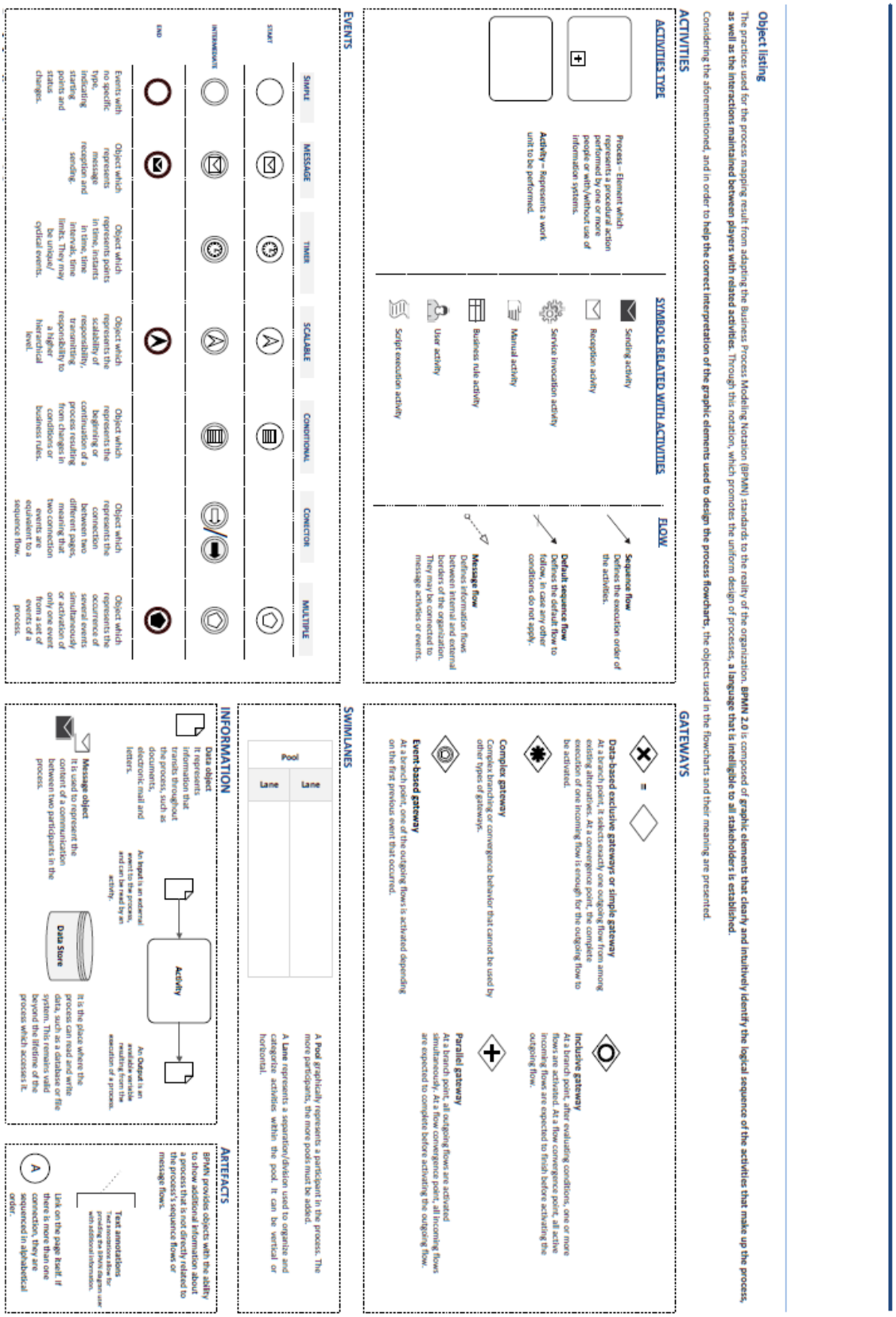
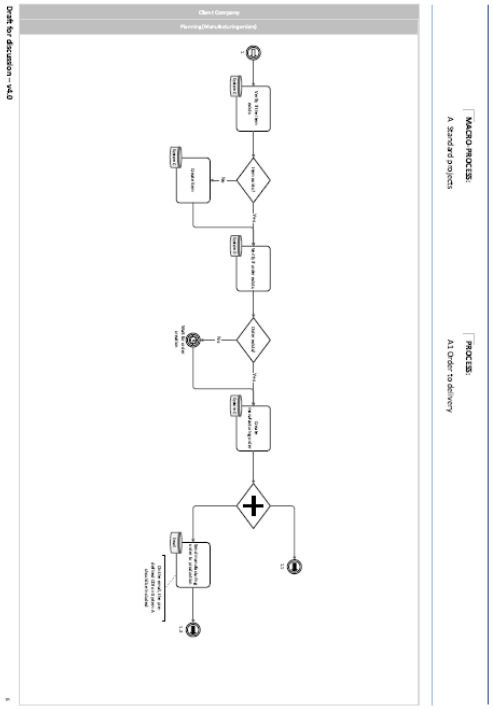
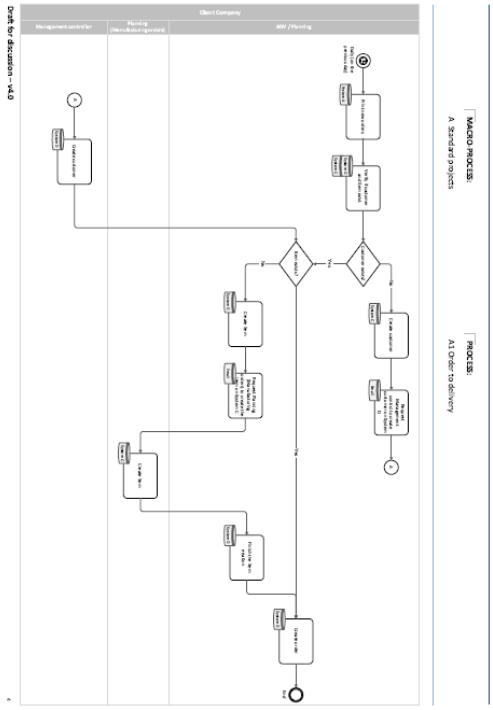
Appendix B: Business Process Modelling Notation 2.0 object listing used

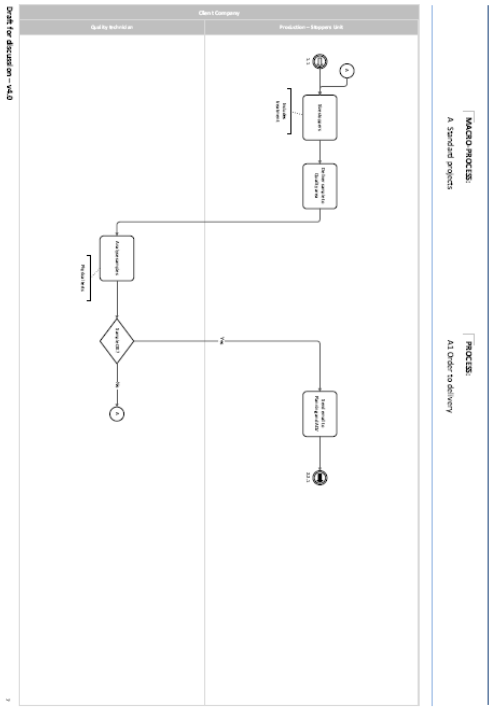


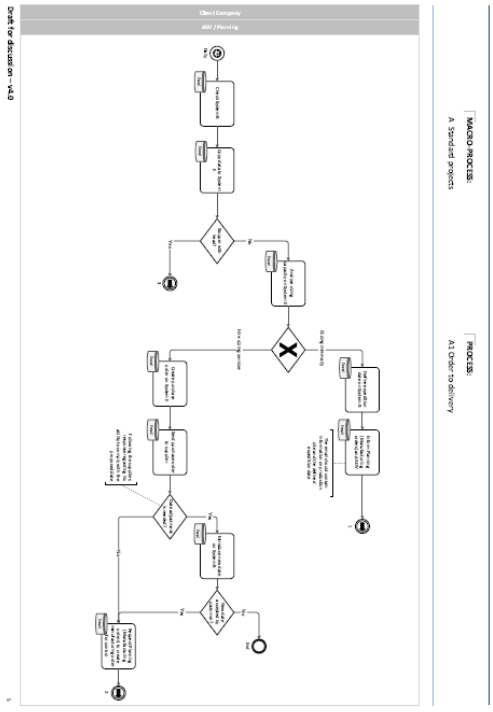
Appendix C: Process Mapping “as-is”

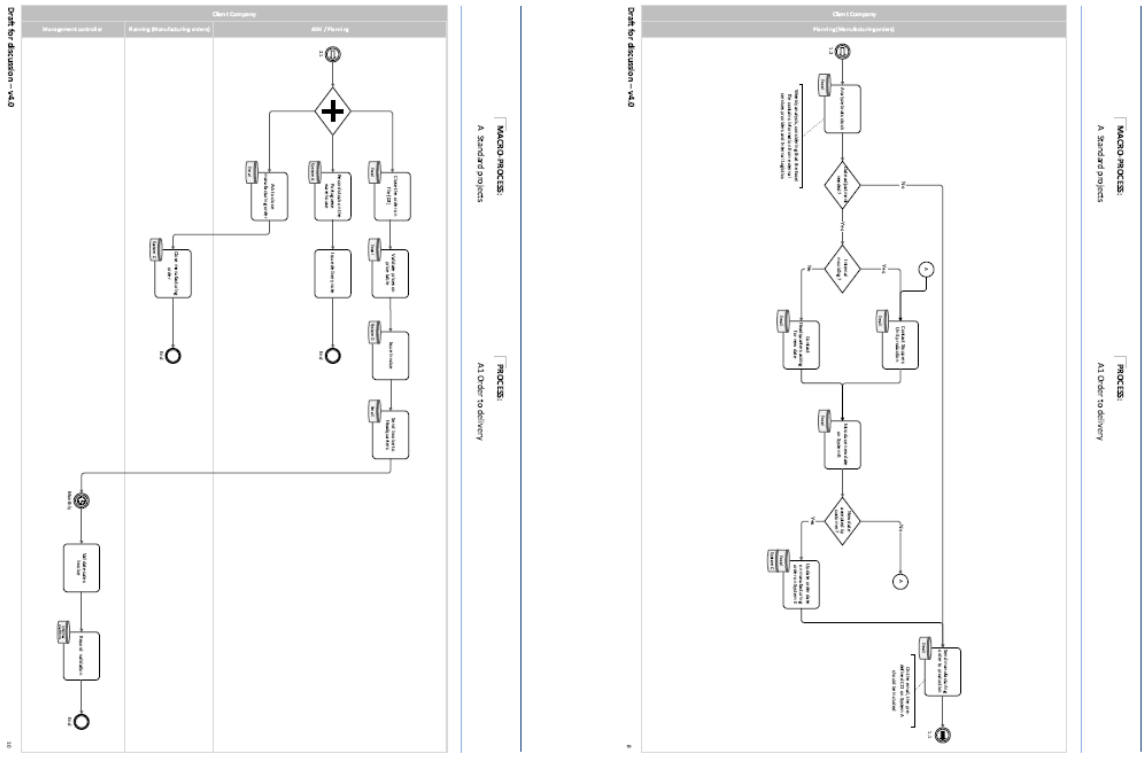
Order to delivery







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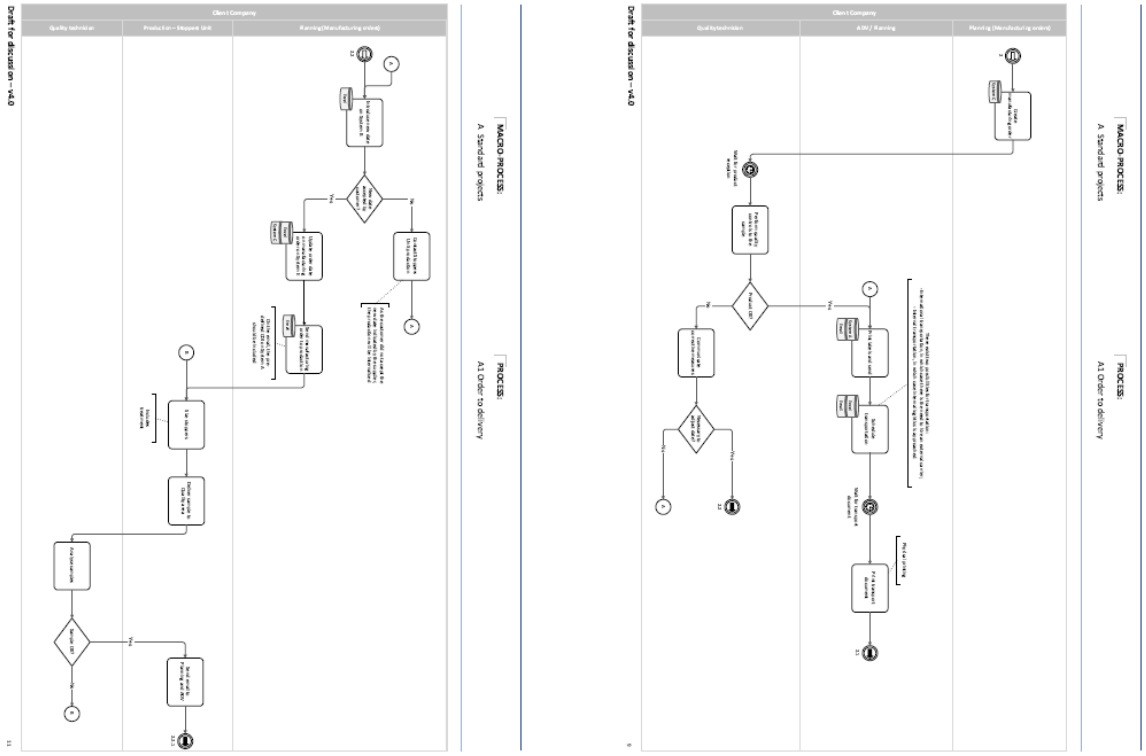
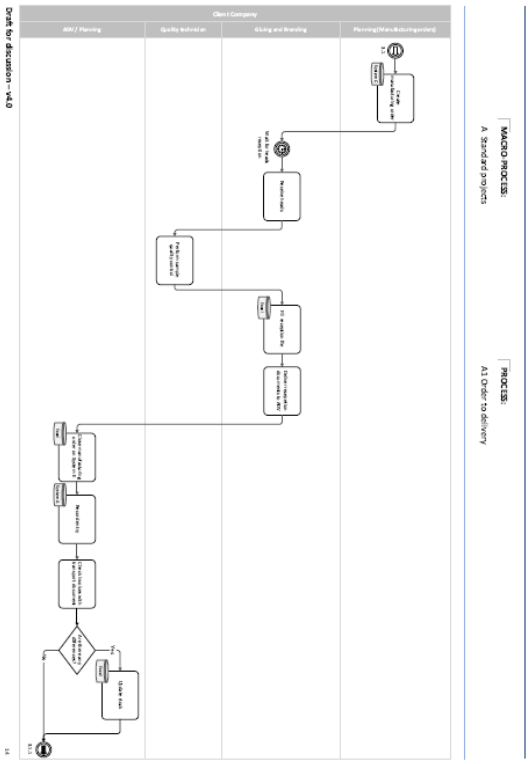
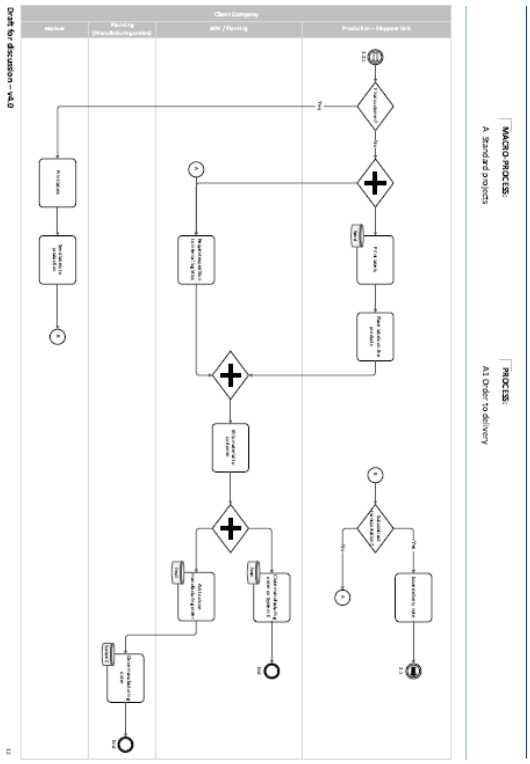
A Standard projects
PROCESS:
A1 Order to delivery
Client Company
Planning (Manufacturing orders)
Draft for discussion – v4.0


MACRO PROCESS:
A Standard projects
PROCESS:
A1 Order to delivery
Client Company
Quality technician
AOV / Planning
Planning (Manufacturing orders)
Draft for discussion – v4.0


MACRO PROCESS:
A Standard projects
PROCESS:
A1 Order to delivery
Client Company
Planning (Manufacturing orders)
AOV / Planning
Quality technician
Gluing and Branding
Draft for discussion – v4.0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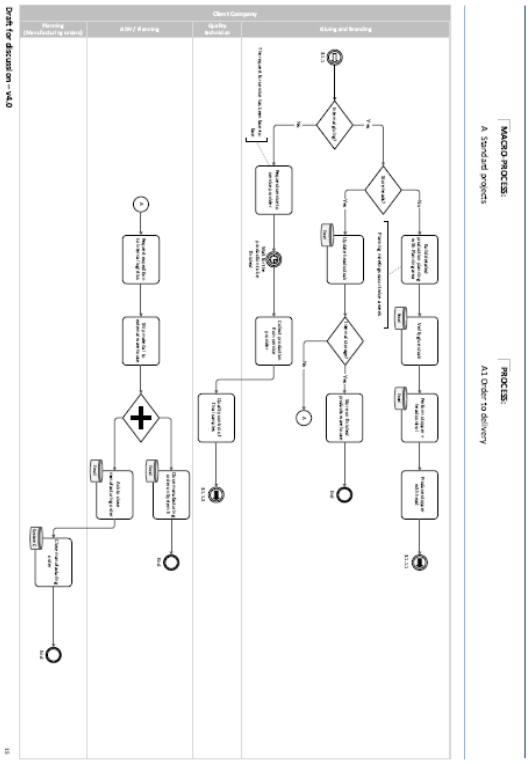
PROCESS:
A1 Order to delivery
Client Company
Method
Planning (Manufacturing orders)
AOV / Planning
Production – Stopper Unit
Draft for discussion – v4.0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PROCESS:
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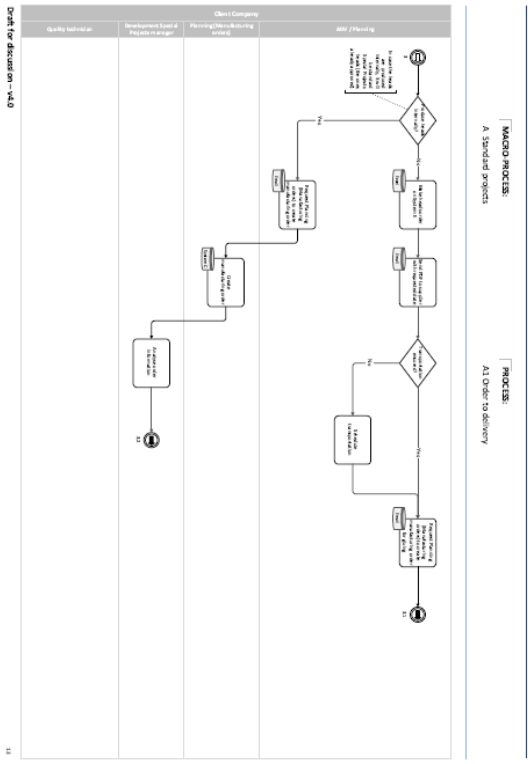
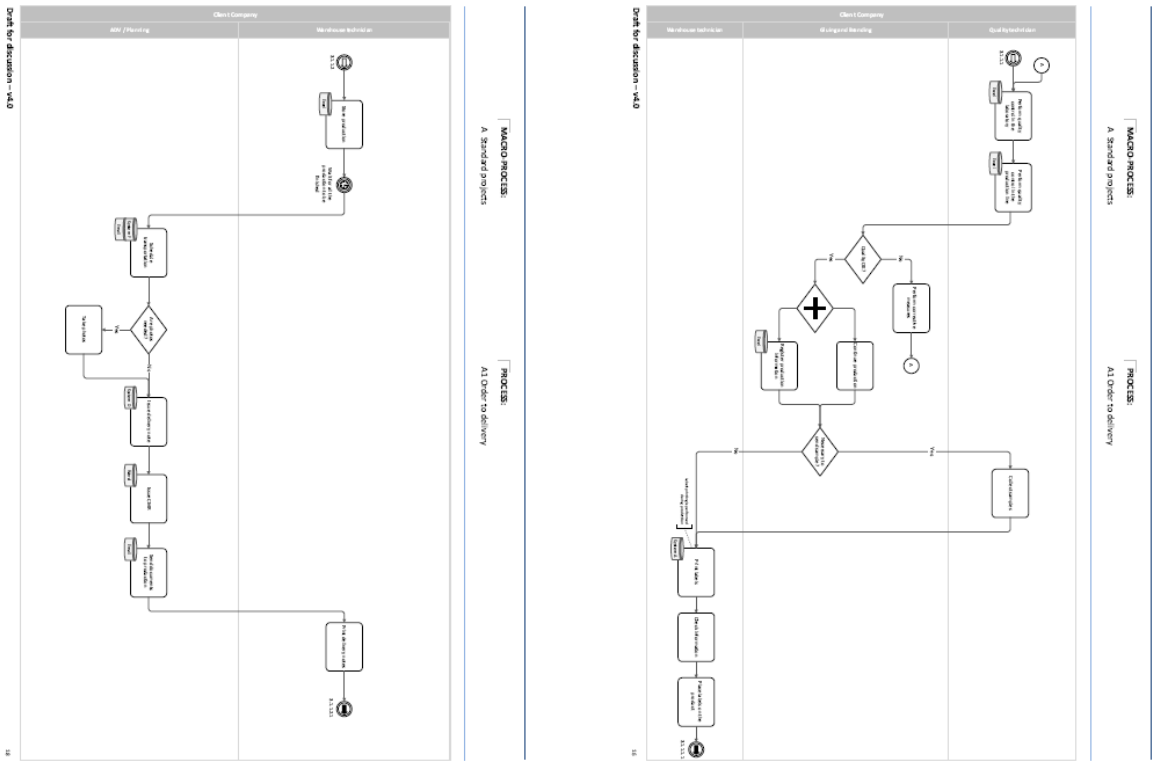
Client Company
Planning (Manufacturing orders)
AOV / Planning
Quality technician
Gluing and Branding
Draft for discussion – v4.0


MACRO PROCESS:
A Standard projects
PROCESS:
A1 Order to delivery
Client Company
Quality technician
Development Special Projects manager
Planning (Manufacturing orders)
AOV / Planning
Draft for discussion – v4.0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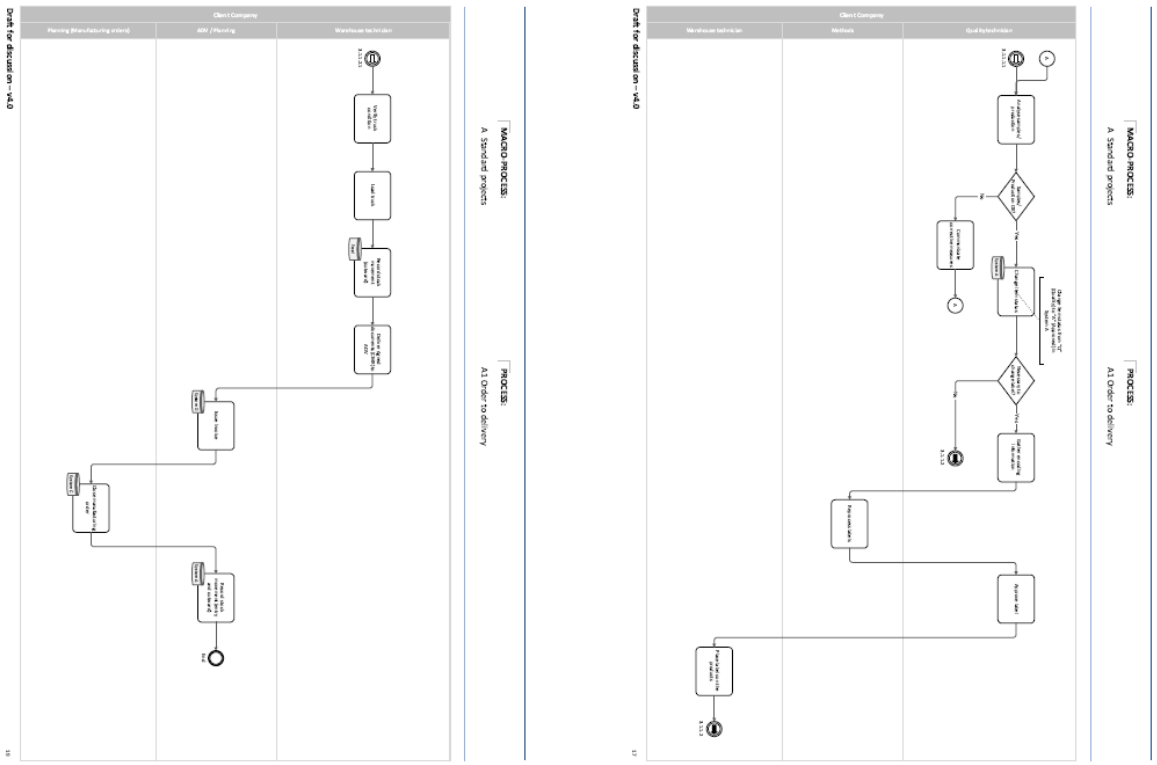
PROCESS:
A1 Order to delivery
Client Company
Warehouse technician
Gluing and Blending
Quality technician
Draft for discussion – v4.0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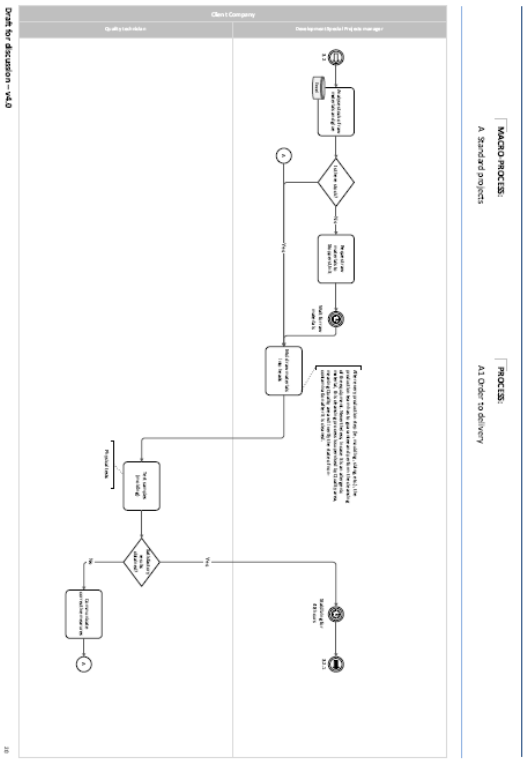
PROCESS:
A1 Order to delivery
Client Company
Warehouse technician
Methods
Quality technician
Draft for discussion – v4.0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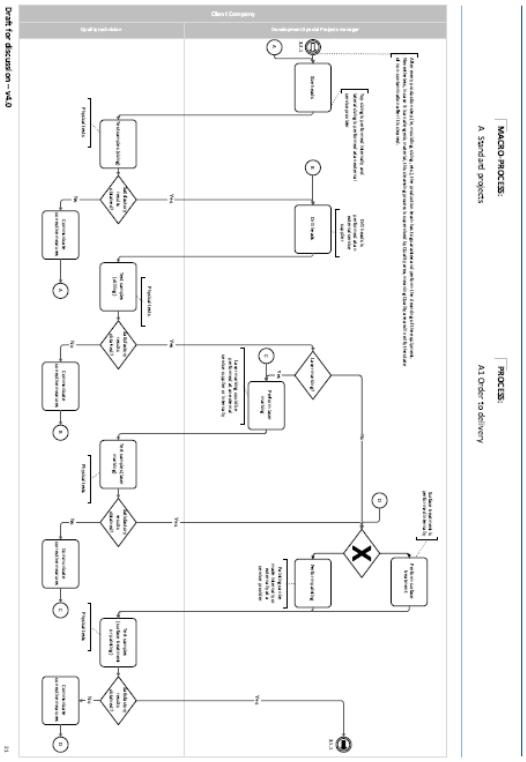
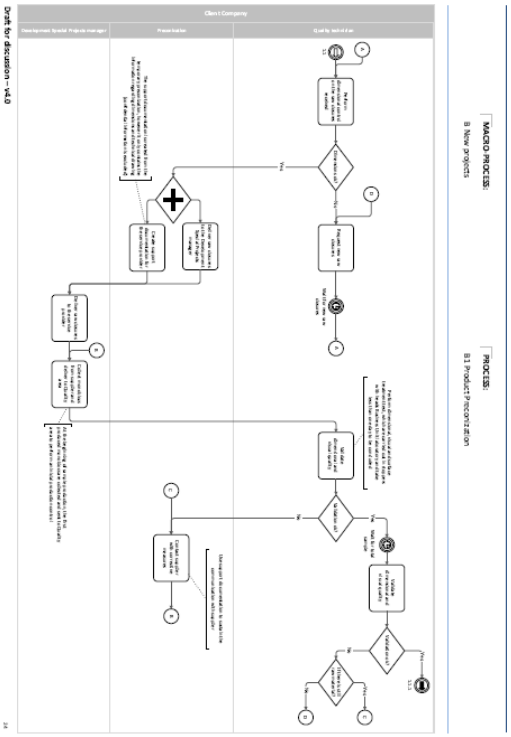
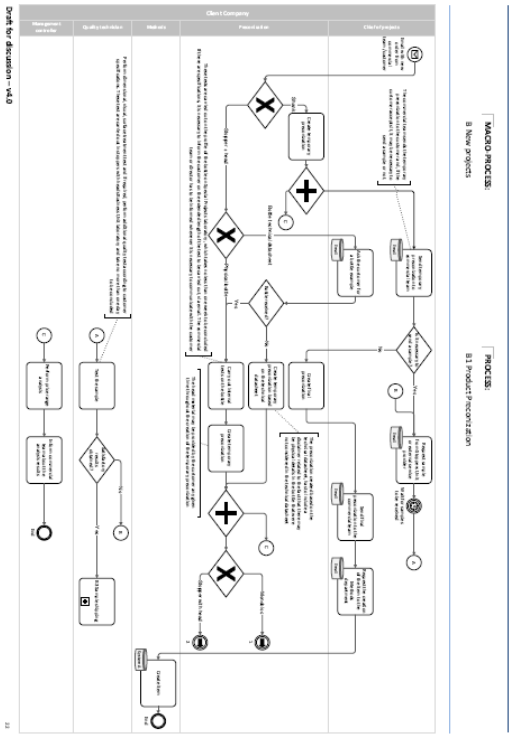
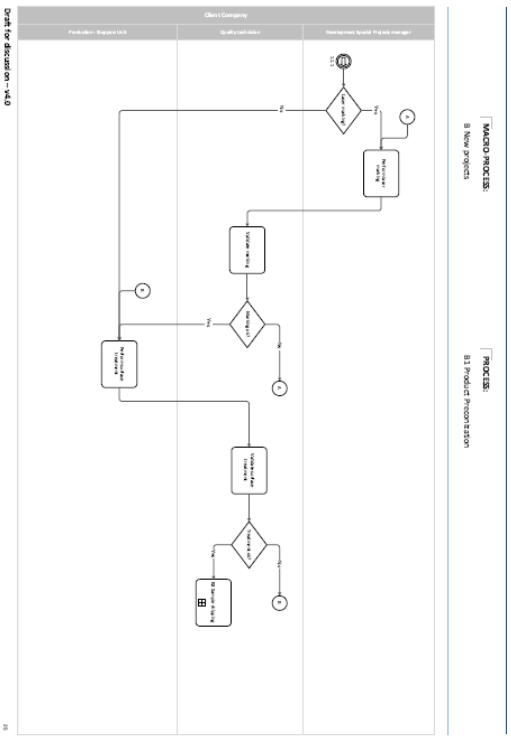
PROCESS:
A1 Order to delivery
Client Company
Draft for discussion – v4.0

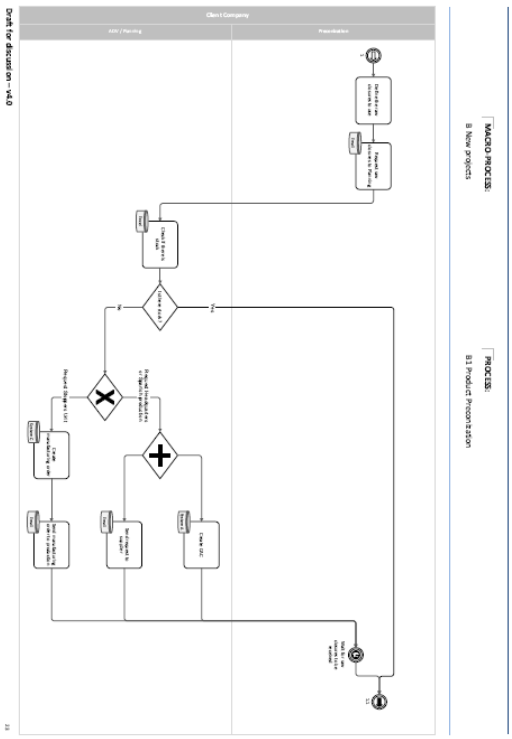

MACRO PROCESS:
A Standard projects
PROCESS:
A1 Order to delivery
Client Company
Draft for discussion – v4.0

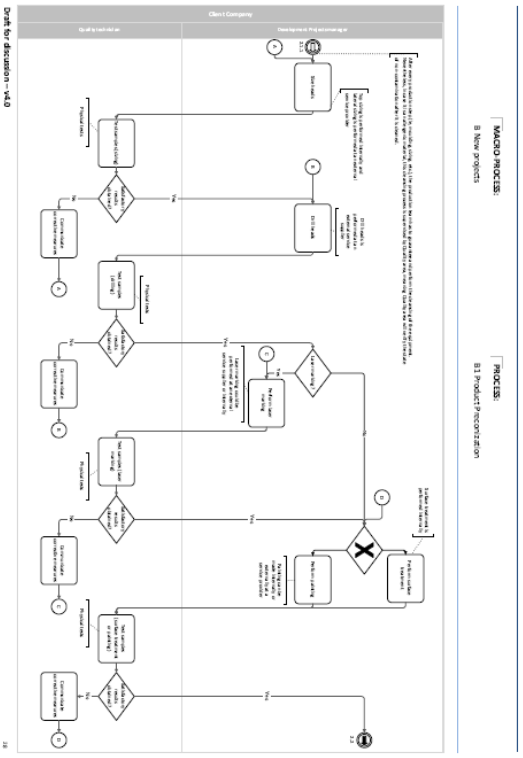
New projects

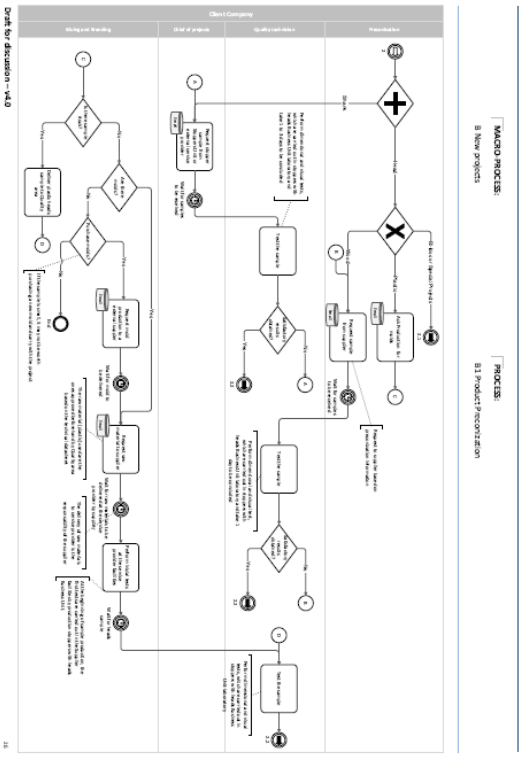


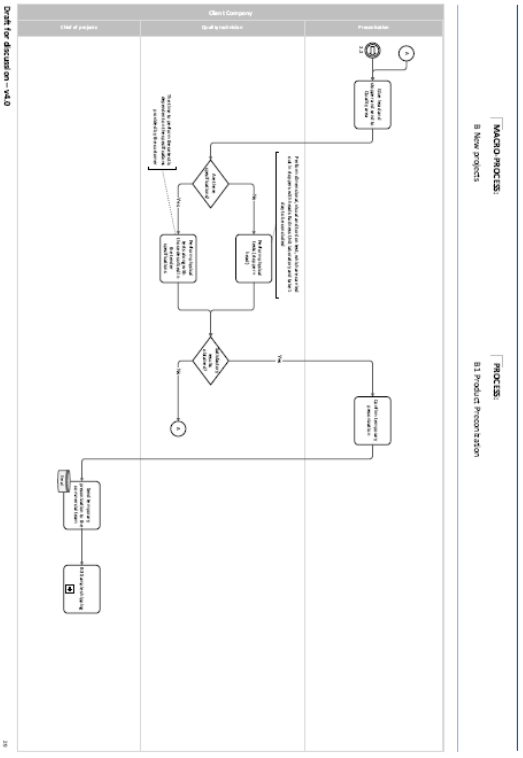







MACRO PROCESS:
B New projects
PROCESS:
B1 Product Preconfiguration
Draft for discussion – v4.0
Client Company
Development Project manager
Quality technician


MACRO PROCESS:
B New projects
PROCESS:
B1 Product Preconfiguration
Draft for discussion – v4.0
Client Company
Presentation
Quality technician
Chief of projects
Marketing and Branding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PROCESS:
B1 Product Preconfiguration
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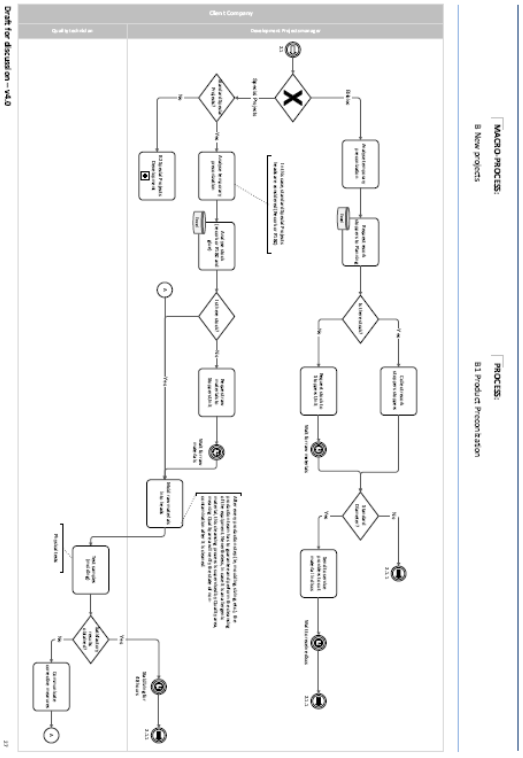
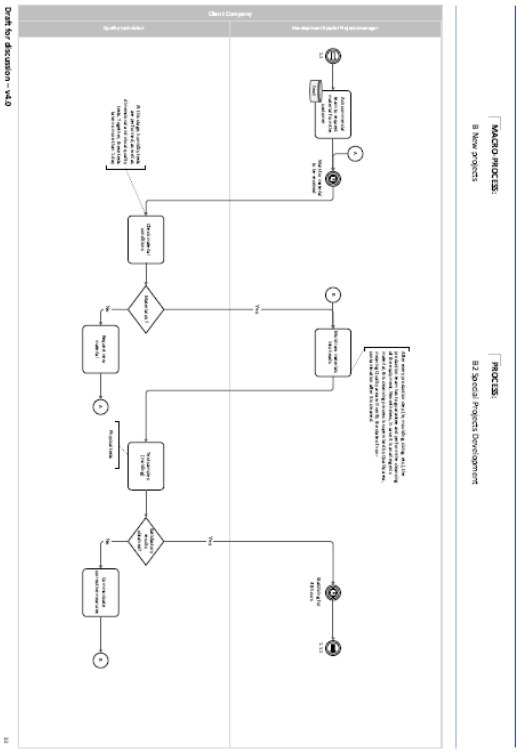
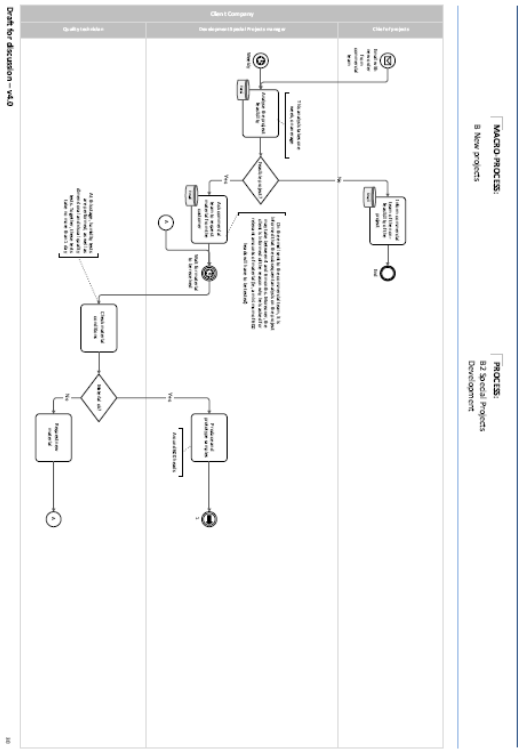
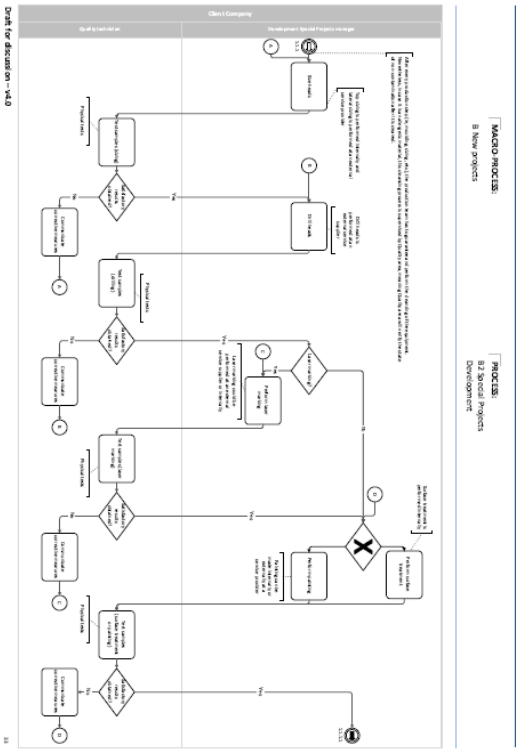
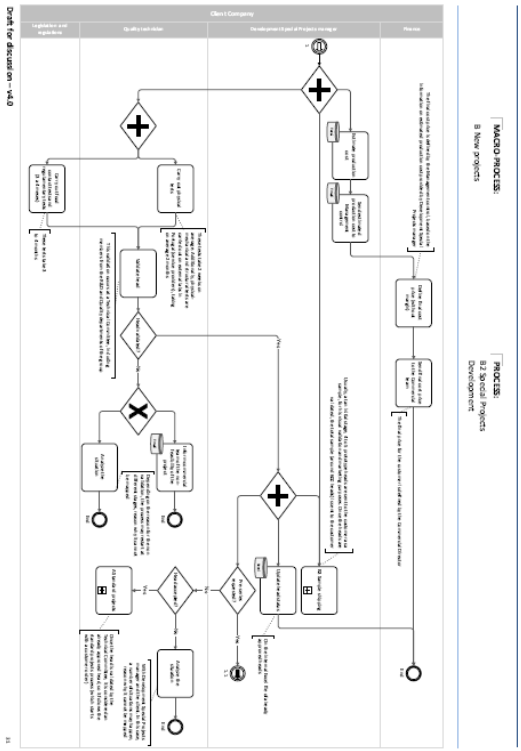
Client Company
Development Project manager
Quality technician

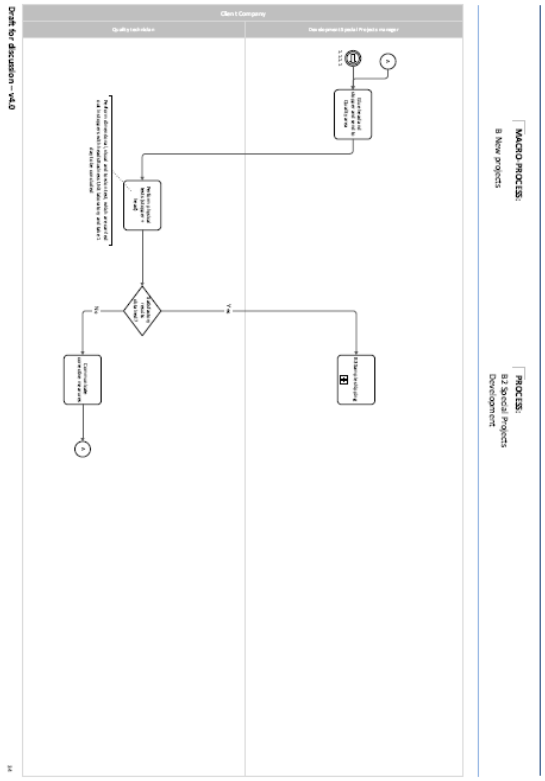

MACRO PROCESS:
B New projects
PROCESS:
B1 Product Preconfiguration
Draft for discussion – v4.0
Client Company
Presentation
Quality technician
Chief of projects

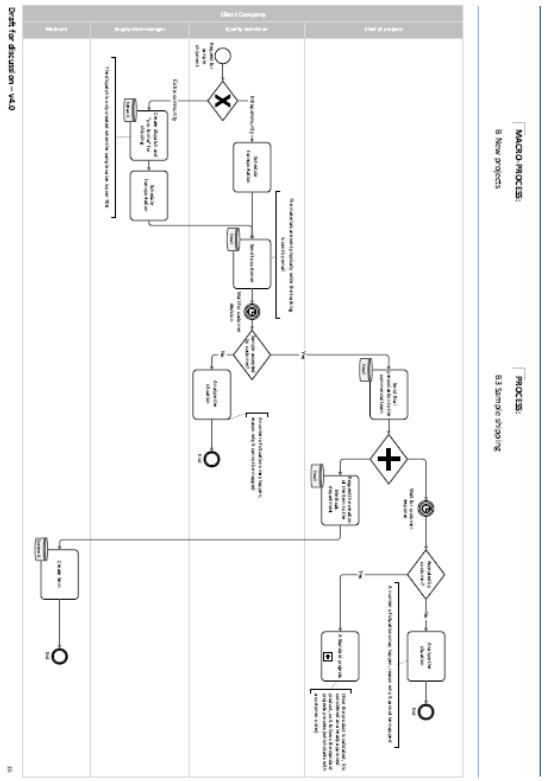









MACRO-PROCESS:
B New projects
PROCESS:
B2 Special projects development
Client Company
Quality technician
Development Director/ Project manager
Draft for discussion - v4.0


MACRO-PROCESS:
B New projects
PROCESS:
B3 Sample shipping
Client Company
Merchants
Supply chain manager
Quality technician
Chief of projects
Draft for discussion - v4.0

Appendix D: List of constraints and respective recommendations

Process	Subprocess	ID Con.	Constraint	Classification	ID Rec.	Recomendation
A	A1	C1	Absence of indicators in several areas that support performance evaluation - key performance indicators (KPI)	Processes	R1	Definition and implementation of KPIs across the different functional areas
A	A1	C2	Absence of functional descriptions that define each function's responsibility	Processes	R2	Creation of Functional Descriptions Manual
A	A1	C3	Manual creation of manufacturing orders and incomplete information for their creation	Processes	R3	Create an internal and formally written rule which requires the clarification of packaging specifications with the customer, whenever they are not available (on email orders)
A	A1	C4	Absence of defined procedures to follow when performing a particular activity	Processes	R4	Creation of a procedures manual with a detailed explanation of how the activities should be performed
A	A1	C5	Non-existence of weight control when shipping products	Processes	R5	Creation of a weighing control to ensure the correct quantities when shipping products
A	A1	C6	Absence of permanent stock control	Systems	R6	Implement a warehouse management tool for the record of quantities and stock location based on a scanning mechanism (e.g through barcode readers or other devices)
A	A1	C7	Manual data update, in different information systems (System A, System B, System C and Excel) which lack integration between them	Systems	R7	Integration of the information systems to enable data-sharing and enhance overall performance and functionality
A	A1	C8	Manual creation of customer and item information, in two different systems and by different areas	Systems	R8	Integration of the information systems to enable data-sharing and enhance overall performance and functionality [recommendation for constraint 7] and functions adjustment and re-definition
A	A1	C9	Dependence on multiple Excel files, that are used by different stakeholders and require manual transposition of information	Systems	R9	Implementation of an Enterprise Resource Planning (ERP) software to manage data from different functional areas
A	A1	C10	Lack of formalization of a detailed production plan	Systems	R10	Acquisition or development of a tool for detailed production planning of manufacturing orders
A	A1	C11	Lack of visibility into real-time production data	Systems	R11	Set up a Manufacturing Execution System (MES) to have an automated real-time collection of production information
A	A1	C12	Unavailability of the option to make partial deliveries on the tool used for consignment note issuing	Systems	R12	Reconfiguration of the consignment note issuance tool to allow partial deliveries
A	A1	C13	Misalignment regarding System A usage, both at training level and access level	People	R13	Development of training sessions on System A for key users, and review of accesses
B	B1	C14	Lack of clarity on who should cover the costs related with the development of new projects and potential samples	Processes	R14	Clarification of the target cost model for new projects
B	B1	C15	Lack of visibility from the customer's side over the status of a new project	Processes	R15	Creation of predefined answer templates, that automatically inform the customer on new project status
B	B1	C16	Inability to estimate new projects' costs	Processes	R16	Collection and recording of information about project development costs in a centralized database
B	B1	C17	Inexistence of a structured method for collecting customer data for new projects	Processes	R17	Creation of template/form for data collection
B	B1	C18	Multitude of internal control codes referring to the same customer order	Systems	R18	Development of a searching and consulting application (through the order codes) information on customer orders
B	B2	C19	Non-existence of manufacturing orders for Special Projects area	Processes	R19	Inclusion of a step for manufacturing orders' creation on the Special Projects process
B	B3	C20	Multiplicity of Excel files for controlling ongoing Special Projects, instead of a consolidated file with data from the different projects	Systems	R20	Development of an application to centralize the information on Special Projects

Appendix E: RACI Matrix Template

Client Company Name
Instructions and guidelines

Draft for discussion

Role types

Type	Role	Initial considerations
R	Responsible ("Doer")	There can be multiple "R"s
		The "R" conducts the actual work
		The "R" owns any process issues that arise
		The "R" is often referred to as the "process owner"
		The "R" has performance metrics that align to process performance
A	Accountable ("Approver")	There must be exactly one "A" specified for each task
		The "A" is ultimately accountable for the completion of the task
		The "A" approves changes / exceptions to the process
		The "A" is to whom the "R" is accountable
		The "A" enforces decisions
C	Consulted	There can be multiple "C"s
		The "C"s are those whose opinions are sought
		The "C"s have the capability, knowledge or resources to support the work or decision making
		The "C"s must be consulted prior to a decision being reached, because decision will affect areas under their control
		The "C"s represent two-way communication
I	Informed	There can be multiple "I"s
		The "I"s are those that are kept up-to-date on progress and results
		The "I"s must be notified after a decision is made
		The "I"s represent one-way communication

Frequency

The frequency defined is for activity's execution, therefore being associated with the "Responsible"

Analysing a RACI Matrix: Vertical analysis per roles

What is seen?	What it could mean?	Potential improvement opportunities
Lots of "A"s	Should this role have ultimate responsibility for so many tasks/steps?	The optimal number and types of accountabilities should be defined for each role to ensure that the tasks / steps are performed to upmost quality
Lots of "R"s	Can this role physically perform so many tasks/steps?	The optimal number and types of tasks / steps should be defined for each role to ensure that the tasks / steps are performed to upmost quality
No empty spaces	Does this role present a bottleneck?	An analysis of distribution of responsibilities across the roles should be conducted, to see whether, if appropriate, a reallocation could be undertaken
Empty role	Does this role need to exist? What is the impact of it being overlooked?	An analysis should be conducted to understand if this role can be excluded, by looking at distribution of responsibilities across the roles to see whether, if appropriate, a reallocation could be undertaken
No "A"s or "R"s	Does this role need to exist?	An analysis should be conducted to understand if this role should be excluded or its nature should be changed, in order to increase efficiency

Analysing a RACI Matrix: Horizontal analysis of work activities

What is seen?	What it could mean?	Potential improvement opportunities
No "A"s	Is anyone accountable for this activity?	It should be defined an accountable owner for every activity or the activity may not be performed properly
No "R"s	Is anyone responsible for this activity?	It should be defined a responsible for every activity or the activity will not be completed as no resource is allocated
Lots of "C"s	Do this many people need to be consulted on the task?	Optimal consultation levels should be defined and applied, in order to keep efficiency as high as possible
Lots of "I"s	Do this many people need to be informed of task?	Optimal numbers of people to be informed first hand should be defined and applied for each situation
Empty activity	Does this task need to exist? What is the impact of it being overlooked?	An analysis should be consucted to understand if this activity can be excluded

Client Company Name
RACI Matrix

Process ID	Page number (to-be processes)	Activity	System	Usual Frequency	Financial manager	Management controller	Methods assistant	Production manager	Supply chain manager	Sales assistant	Planning technician	Quality manager	Preconization technician	Quality technician	Gluing manager	Gluing operator	Warehouse technician	Development manager	Development operator	Chief of projects	Number of participants
A1	Order to																				
A1		Activity 1	System A	Daily					A	R											2
A1		Activity 2	Email	As needed					A	R											2
A1		Activity 3	System B	Daily					A	R											2
A1		Activity 4	System B	As needed					A	R											2
A1		Activity 5	Email	As needed			I		A	R											3
A1		(...)	(...)																		0
B1	Product																				
B1		Activity 1	System A	Daily					A	R											2
B1		Activity 2	Email	As needed					A	R											2
B1		Activity 3	System B	Daily					A	R											2
B1		Activity 4	System B	As needed					A	R											2
B1		Activity 5	Email	As needed			I		A	R											3
B1		(...)	(...)																		0
B2	Special Projects Development																				
B2		Activity 1	System A	Daily					A	R											2
B2		Activity 2	Email	As needed					A	R											2
B2		Activity 3	System B	Daily					A	R											2
B2		Activity 4	System B	As needed					A	R											2
B2		Activity 5	Email	As needed			I		A	R											3
B2		(...)	(...)																		0
B3	Sample shipping																				
B3	41	Activity 1	System A	Daily					A	R											2
B3	41	Activity 2	Email	As needed					A	R											2
B3	41	Activity 3	System B	Daily					A	R											2
B3	41	Activity 4	System B	As needed					A	R											2
B3	41	Activity 5	Email	As needed			I		A	R											3
B3	41	(...)	(...)																		0

Total																
Number of Activities in which the function participates (any role)	0	0	4	0	20	20	0	0	0	0	0	0	0	0	0	0
Number of Activities in which the function participates as **Responsible**	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0
Number of Activities in which the function participates as **Accountable**	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Number of Activities in which the function participates as **Consulted**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Number of Activities in which the function participates as **Informed**	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0

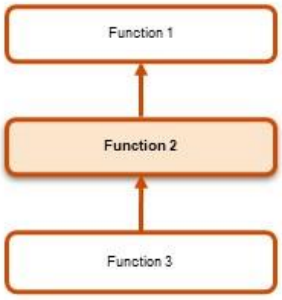
Appendix F: Functional Descriptions Manual Template

2.1 Function Name

Function's objective

Description…

Hierarchical reporting lines



Responsibilities

- **Responsibility 1**
- **Responsibility 2**
- **Responsibility 3**
- **Responsibility 4**
- **Responsibility 5**

Client Company

Draft for discussion

1

2.1 Function Name

Required qualifications and skills

[To be filled by Client Company]