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Optimizing Production Planning through APS Software at Barausse Srl

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Abstract

This thesis is based on an internship at the IT consulting and software provider Sanmarco Informatica SpA. The project was the implementation of Advanced Planning & Scheduling (APS) software at Barausse S.r.l., a medium-sized Italian manufacturing company, to improve production planning and better align resources and capacities. The thesis analyzes the stages of the software implementation and highlight the tailored configurations to meet the firm's operational needs.

The study also assesses how the potential benefits of this software, as are outlined in the literature, have truly materialized in the practical situation, and also reports the new challenges that arose during the implementation process. The provided insights emphasize the real potential of digital transformation to enhance production planning and resource management, offering valuable support for similar cases.

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Introduction

This thesis reports the results achieved during a project conducted in the context of an internship carried out at Sanmarco Informatica S.p.A., an Italian IT consulting firm specializing in software solutions across various sectors. Over a four-month period, the project aimed at a digital transformation involving the implementation of Advance Planning & Scheduling (APS) software at Barausse S.r.l., a mid-sized interior door manufacturer located in Veneto, Italy. The APS software, developed by Sanmarco Informatica, was integrated with Barausse's existing ERP system, Jgalileo, to optimize production processes, enhance planning efficiency and improve resource management.

The objective of this thesis is to show the practical benefits of implementing an APS system in manufacturing, focusing on how it can refine production planning and resource allocation to meet dynamic market demands. In addition, this study provides real-world insights into the complexities and challenges faced during the implementation, including the integration with existing systems and the problem of employees' resistance to change.

During the internship, the activities mostly focused on learning the structure and functioning of the APS tool, the required technologies, and the production processes at Barausse, for supporting the configuration activities in collaboration with the project team and tailoring the software to the company's needs to ensure effective integration into the workflow. This journey made it possible to get a deep exploration into the technical aspects of software configuration while also providing insights into the broader strategic decisions required for a successful implementation.

The thesis is structured to provide an overview of the project's steps and outcomes, from the analysis of Barausse's AS-IS processes to the configuration of the APS system. Chapter 1 introduces the APS systems and their place in modern manufacturing. It describes the evolution of production planning tools and the core principles of the APS software, and discusses the potential benefits and challenges of its adoption as are described in the literature. Chapter 2 focuses on Sanmarco

Informatica, the software provider, detailing its background, range of solutions and the specific APS tool used in the project. It covers the key functionalities, user interface and foundational principles related to production planning. Chapter 3 shifts to Barausse S.r.l., offering an overview of the company's history, market position and the challenges in its production processes before the APS implementation. It also outlines the APS project's objectives and analyzes the initial AS-IS business processes to identify areas for improvement. Chapter 4 delves into the software configuration in practice, starting from the integration with the existing ERP system (Jgalileo) and illustrates the steps taken to customize the software to fit Barausse's specific needs. Finally, Chapter 5 analyzes the project's outcomes, comparing benefits and criticalities with the expectations and identifies new challenges and also unexpected benefits that emerged during the APS integration.

1. Digital Transformation through the implementation of a Production Scheduler

This chapter introduces the concept of "Digital Transformation" by means of APS software, describing how it can be implemented in manufacturing. It then looks at how the integration of advanced planning and scheduling systems can support a company's production processes, what data is needed, and how it has to be managed. It then concludes describing possible future developments for APS systems.

1.1 Digital Transformation

Nowadays, digital transformation significantly impacts various industries. Companies must understand the benefits of digital technology to effectively interact with these tools and enhance their efficiency (Ebert & Duarte, 2018).

Digital transformation integrates digital technology into all business areas, fundamentally changing operations and delivering value to customers (Morakanyane, Grace & O'Reilly, 2017). Its impacts can be categorized into customer-focused and organization-focused effects.

By integrating advanced software technologies like data analytics, cloud computing, and artificial intelligence into traditional business frameworks, digital transformation enhances operational efficiency and customer experiences, driven by high-quality data and value chain integration. It also leverages revolutionary technologies to boost productivity, generate value, and improve societal welfare. Digital Transformation is recognized as essential by governments and organizations because it shapes policies that foster innovation and cooperation (Bresciani et al., 2021).

However there are several implementation challenges that include unsuitable organizational structures, unclear return on investment, and external barriers such as a shortage of skilled workers and regulatory issues (Ebert & Duarte, 2018).

1.2 Production scheduling

The evolution of scheduling methodologies has played a crucial role in the development of project management and production planning. The concept of scheduling is ancient, with evidence of its use in constructing the pyramids over 3000 years ago and in Sun Tzu's military strategies 2500 years ago. However, formal scheduling methods began to take shape in the 18th century with the advent of industrialization (Herroelen, 2009).

This section focuses on the history of scheduling, which originated first in project management and later for companies' production processes.

Early tools of project management included models and basic charts to visualize project timelines and tasks. In the late 18th century, Joseph Priestley created the first known bar charts, plotting lifetimes and historical events graphically. This method evolved with William Playfair's development of statistical charts, including line, bar, and pie charts, which laid the foundation for modern project scheduling tools (Weaver, 2006).

The 1950s marked significant advancements with the development of CPM (critical path method, by Kelley and Walker) and PERT by the U.S. Navy for the Polaris missile project. These methodologies introduced systematic approaches to project scheduling, focusing on task sequencing, time estimation, and resource allocation. CPM aimed at optimizing costs and resources, while PERT emphasized managing uncertainties in project durations (Weaver, 2006).

The integration of computers in the 1950s and 60s revolutionized scheduling. Initially, complex mainframe systems handled scheduling tasks, making it feasible to manage large-scale projects with many interdependent activities. These early systems evolved with the advent of mini-computers in the 1970s and personal computers in the 1980s, democratizing access to sophisticated scheduling tools. Developed by Dr. John Fondahl in the 1960s, PDM offered a manual, non-computer alternative to CPM. This method used graphical diagrams to represent project tasks and dependencies, simplifying the scheduling process and making it more accessible to project managers without computer resources (Kenley & Seppänen, 2009).

The advent of Advanced Planning and Scheduling (APS) systems in recent decades represents a significant progress in scheduling technology for the manufacturing sector (Stadtler, 2005).

APS systems integrate advanced algorithms and real-time data processing to optimize production planning and scheduling. These systems are considered a powerful tool for modern industries, allowing detailed resource allocation, scenario simulation, and real-time adjustments, enhancing the efficiency and responsiveness of modern manufacturing and supply chain operations in order to meet the complex demand of today's global markets (Kenley & Seppänen, 2009).

1.3 Overview of Advanced Planning and Scheduling Systems

Advanced Planning and Scheduling (APS) systems represent a sophisticated approach to manage production within an organization. The subsequent paragraphs will explore the topic further, detailing the key participants involved and explaining how APS is implemented within production environments.

1.3.1 Introduction to APS

According to Brun et al. (2006), APS systems represent one of the most significant innovations in manufacturing software since the introduction of MRP systems in the 1970s.

Advanced Planning and Scheduling (APS) systems serve as essential tools in the realm of manufacturing and supply chain management, significantly enhancing the optimization of production planning and scheduling activities (Mourtzis, Doukas & Psarommatis, 2014).

These sophisticated systems integrate complex algorithms, optimization techniques, and data integration capabilities, which are vital in refining decision-making processes. The implementation of APS results in elevated efficiency, cost reductions, and improved fulfillment of customer demands, effectively tackling the inherent complexities of production processes (Hvolby & Steger-Jensen, 2010).

Historically, APS systems evolved from simpler planning systems such as Material Requirements Planning (MRP) and Manufacturing Resource Planning (MRP II), which laid the groundwork for the intricate capabilities of current APS tools (Kenley & Seppänen, 2009).

These predecessors primarily managed inventory and capacity planning but lacked the robustness required for intricate planning and real-time decision-making that modern APS systems provide. Unlike traditional Enterprise Resource Planning (ERP) systems that handle broader business processes (Table 1.1), APS specializes in detailed planning and scheduling, including real-time simulation and scenario testing, which are crucial for dynamic and complex production environments (Reklaitis, 2000) (Stadtler, 2005).

Areas	ERP system	APS system
Planning philosophy	• Planning without considering the limited availability of key resources required for executing the plans. • Goal: Feasible plans • Push • Sequential and top-down	• Planning provides feasible and reasonable plans based on the limited availability of key resources • Goal: Optimal plans • Pull • Integrated and simultaneous
Business driver	Manufacturing coordination	Satisfaction of customer demand
Industry scope	Primarily discrete manufacturing	All industries
Major business area supported	Transaction: Finance, Controlling, Manufacturing	Planning: Demand, Manufacturing, Logistics, Supply chain
Information flow	Top down	Bi-directional
Simulation capabilities	Low	High
Ability to optimize cost, price, profit	Not available	Available
Manufacturing lead times	Fixed	Flexible
Incremental planning	Not available	Available
Speed of replanning	Low	High
Data storage and calculations	Database	Memory-resident

Table 1.1 - A comparison of APS systems and ERP systems (Entrup, 2005)

A core function of APS systems is their ability to determine the optimal selection of resources for various manufacturing activities. This includes assigning operations, sequencing production, and adjusting for variables such as plant capacities and workload imbalances while adhering to priority constraints. These systems not only suggest feasible production schedules but also allow manufacturers to simulate different scenarios before finalizing plans, thus ensuring that the most effective strategies are employed to meet demand and optimize resource use (Meyr, Wagner & Rohde, 2015).

Moreover, APS systems enhance supply chain integration by connecting with suppliers and customers, enabling a more synchronized and optimized planning process.

The main constituent modules of the APS systems in the three levels of supply chains are shown in Figure 1.1.

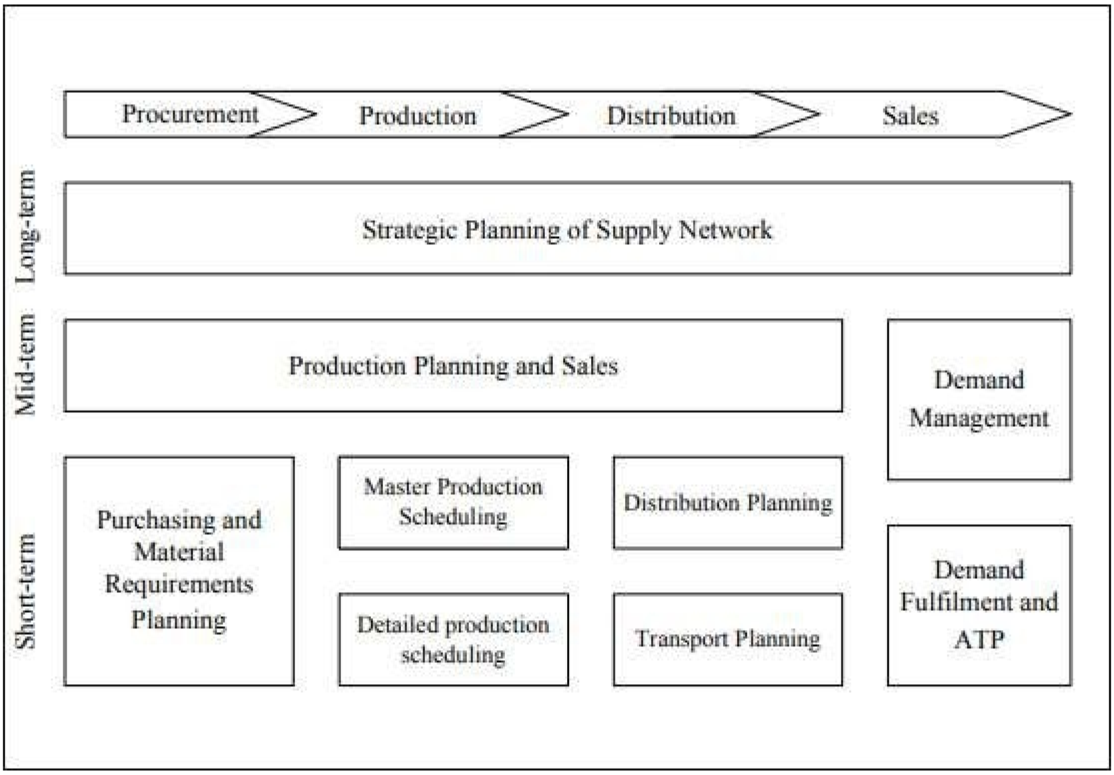

Figure 1.1 - APS systems structure (Meyr, Wagner & Rohde, 2005)

As these systems continue to evolve, they will play a critical role in addressing the increasing complexity of manufacturing operations and the growing demands of global supply chains (de Sousa, Camparotti & Guerrini, 2014). The future of APS is closely linked with advancements in Industry 4.0 technologies such as RFID and cloud computing, which promise to enhance the capabilities of these systems further. Despite these advancements, challenges such as dependency on human input and the popular use of spreadsheets remain prevalent, highlighting areas for future improvement and innovation (Stadtler & Kilger, 2008).

The primary objectives of Advanced Planning and Scheduling (APS) systems can be summarized as follows (Hvolby & Steger-Jensen, 2010):

- **Optimization of Resources:** efficiently allocating and utilizing resources to maximize productivity (Gruat-La-Forme et al., 2009).
- **Improved Lead Times:** reducing the time required to manufacture products and deliver them to customers (Mourtzis et al., 2014).
- **Enhanced Customer Satisfaction:** ensuring timely delivery and meeting customer demand more effectively (Stadtler & Kilger, 2008).
- **Increased Flexibility and Responsiveness:** enabling the firm to quickly adapt to changes in demand, supply chain disruptions, and other unforeseen events (Kenley & Seppänen, 2009).
- **Cost Reduction:** minimizing production and operational costs through optimized planning and scheduling (Gruat-La-Forme et al., 2009).

1.3.2 Actors Involved in APS Implementation

Several key stakeholders are generally involved in the implementation and utilization of APS systems (Stadtler & Kilger, 2008; Gruat-La-Forme et al., 2009; Mourtzis et al., 2014):

1. **Production Managers:** oversee the planning and execution of production schedules, ensuring alignment with APS recommendations.
2. **Supply Chain Managers:** manage the flow of materials and information across the supply chain to optimize inventory and logistics.
3. **IT Specialists:** ensure the integration of APS systems with existing ERP and other management systems, maintaining data integrity and system performance.

4. **Operations Analysts:** analyze production data and APS outputs to identify opportunities for further optimization and improvement.
5. **Executives and Decision Makers:** set strategic goals and approve investments in APS technology, aligning APS objectives with overall business strategy.

1.3.3 How APS Works in Production

APS systems generally operate by integrating with existing Enterprise Resource Planning (ERP) systems and other production management tools to collect and analyze data. The main components of APS systems include demand planning, production planning, production scheduling, and distribution planning (Ovacik, 2011).

These elements work together to ensure that production schedules are in line with demand forecasts, resource availability, and various constraints. Consequently, APS systems assist firms in: optimizing resource utilization and allocation, reducing lead times and inventory levels, improving on-time delivery performance, enhancing overall operational efficiency (Fleischmann et al., 2004).

In detail, APS systems collaborate with and enhance a firm's production by optimizing various activities, (Hagazi & Guo, 2013) including:

- **Data Integration and Analysis.** APS systems integrate data from various sources such as ERP systems, Manufacturing Execution Systems (MES), and other data repositories. This integration allows APS to analyze historical data, real-time production data, and demand forecasts to create a comprehensive view of the production landscape (Hvolby & Steger-Jensen, 2010).
- **Capacity Planning.** APS systems help firms to assess their production capacity accurately. By evaluating the availability of resources such as

machinery, labor, and materials, APS ensures that production plans are feasible. It highlights potential bottlenecks and provides solutions to optimize resource utilization, thus enhancing production efficiency (Hvolby & Steger-Jensen, 2010).

- **Production Scheduling.** One of the core functionalities of APS is production scheduling. APS creates detailed production schedules that specify what needs to be produced, when, and on which resources. This scheduling is based on constraints like machine availability, labor shifts, and material supply, ensuring that production runs smoothly without interruptions (Kenley & Seppänen, 2009).
- **Real-time Adjustments.** APS systems are capable of making real-time adjustments to production schedules based on unforeseen changes in the production environment, such as machine breakdowns or sudden changes in demand. This flexibility ensures that the production process can adapt quickly, maintaining efficiency and minimizing downtime (Vieira et al., 2021).
- **Optimization and Simulation.** APS uses optimization techniques to find the best possible production plan. By simulating various scenarios, APS can evaluate the impact of different production strategies and choose the optimal one. This optimization leads to substantial cost savings through better planning and lower inventory levels, effectively reducing production and operational expenses. Furthermore, APS systems improve delivery performance by enabling precise scheduling and better coordination across the supply chain, resulting in higher on-time delivery rates (Chen & Ji, 2007).
- **Detailed Tracking and Reporting.** APS systems provide detailed tracking of production activities. They monitor the status of each production order, track the progress of work-in-progress items, and report any deviations from the plan. This detailed reporting allows managers to

stay informed and make data-driven decisions to correct issues promptly (Kenley & Seppänen, 2009).

- **Collaboration and Communication.** APS systems enhance collaboration and communication across different departments within the firm. By providing a centralized platform where all stakeholders can access up-to-date information, APS ensures that everyone is on the same page, reducing misunderstandings and improving coordination (Vieira et al., 2021).
- **Scalability and Flexibility.** Modern APS systems are designed to scale with the business. They offer flexibility in terms of features and capacities, allowing firms to start with basic functionalities and add more complex ones as their operations grow. This scalability makes APS suitable for both small and large manufacturing firms. (Jonsson & Holmström, 2016)

- **Demand Forecasting.** APS systems utilize advanced algorithms to forecast demand more accurately. By analyzing past sales data and market trends, APS can predict future demand, helping firms to plan their production schedules accordingly. This reduces the risk of overproduction or underproduction, aligning supply with anticipated demand. The real-time data and insights provided by APS systems facilitate better decision-making, empowering managers to make informed choices and proactively manage operations. (Steger-Jensen et al., 2011).

1.4 Benefits and criticalities

It is well known that Advanced Planning and Scheduling (APS) systems offer significant benefits, particularly in enhancing efficiency, reducing costs, and increasing flexibility. However, there is considerable debate surrounding the challenges of implementing these systems and the medium-high initial costs (Jonsson & Holmström, 2016).

Genin et al. (2007) emphasize the great potential of integrating APS systems with Enterprise Resource Planning (ERP) for optimizing production processes.

On the other hand, skeptics point out several challenges and drawbacks associated with APS systems. They emphasize the high initial costs involved in adopting APS technology and the complexity of implementing these systems, which can be time-consuming and require significant changes to existing processes. Additionally, they note the challenges of integrating APS with existing ERP and other management systems, which can be difficult and resource-intensive. Skeptics also raise concerns about the heavy reliance of APS systems on accurate and timely data, as inaccuracies can lead to poor decision-making and suboptimal plans. Furthermore, they highlight the potential resistance to change within organizations, which can slow down the implementation process and reduce effectiveness (Meyr et al., 2002).

Many firms, especially those in industries with complex production processes and supply chains, have adopted APS systems to varying extents. The trend towards digital transformation has accelerated the adoption of APS systems, as firms seek to leverage advanced technologies for competitive advantage (Jonsson et al., 2007).

Researchers are exploring ways to mitigate the criticalities associated with APS implementation, such as developing more user-friendly interfaces and improving integration capabilities. There is also a focus on enhancing the algorithms and optimization techniques used in APS systems to further improve their effectiveness and efficiency (Ivert & Jonsson, 2010).

The common belief among researchers is that despite some difficulties, the advantages of APS systems are significantly greater than their drawbacks. Continuous advancements in technology and process improvements are expected to address many of the current limitations. Studies suggest that firms successfully implementing APS systems experience significant improvements in their operational performance and competitiveness. Future research aims to explore the integration of APS systems with emerging technologies like artificial intelligence (AI) and machine learning (ML) to further enhance their capabilities (Ivert & Jonsson, 2010).

Despite some criticalities related to implementation complexity and initial costs, the overall consensus among researchers is positive. Continuous advancements in APS technologies and their integration with other systems are likely to overcome current challenges, making APS an essential component of modern manufacturing and supply chain strategies. (Steger-Jensen et al., 2011).

The following two tables (1.2 and 1.3) summarize the major benefits and criticalities found in literature with their description, impact and comparison with traditional methods.

Benefit	Description	Impact	Comparison	References
Enhanced efficiency	APS systems streamline production planning and scheduling, reducing waste and improving productivity	Increases operational efficiency and reduces costs	Traditional methods often rely on manual processes, which are less efficient	(Gruat-La-Forme et al., 2009)
Cost reduction	Optimizes resource utilization, leading to lower production costs	Decreases overhead and operational expenses	Traditional methods may not fully optimize resource use, leading to higher costs	(Mourtzis et al., 2014)
Improved Lead Times	Reduces the time required to complete production processes and fulfill customer orders	Enhances customer satisfaction through timely delivery	Traditional methods may result in longer lead times due to inefficiences	(Stadler & Kilger, 2008)
Increased flexibility	APS allows for real-time adjustments to production schedules	Improves the ability to respond to market dynamics	Traditional methods are often rigid and slow to adapt to changes	(Kenley & Seppänen, 2009)
Better decision-making	Provides advanced analytics and simulations to support informed decision-making	Leads to more strategic and effective planning	Traditional methods may lack the analytical depth of the APS systems	(Hvolby & Steger-Jensen, 2010)

Table 1.2 - Major benefits of APS systems in literature

Criticality	Description	Impact	Comparison	References
High initial costs	The adoption of APS requires significant upfront investment	Can be a barrier for small to mid-sized enterprises	Traditional methods typically have lower initial costs but may incur higher long-term costs	(Jonsson & Holmström, 2016)
Implementation complexity	The complexity of integrating APS with existing systems can be time consuming and challenging	May delay the implementation and reduce initial effectiveness	Traditional methods are generally simpler to implement	(Meyr et al., 2002)
Data dependency	APS systems rely heavily on accurate and timely data for effective planning	Inaccurate data can lead to poor decision-making and suboptimal results	Traditional methods may not be as data intensive but are less precise	(Ivert & Jonsson, 2010)
Resistance to change	Organizational resistance to adopting new systems can compromise the successful implementation of APS	Slows down the adoption process and may reduce overall effectiveness	Traditional methods are more familiar to employees, leading to less resistance	(Mourtzis et al., 2014)
Integration challenges	Integrating APS with ERP and other management systems can be resource-intensive	May require additional technical support and increase costs	Traditional methods may not offer the same level of integration but are easier to manage	(Stadler & Kilger, 2008)

Table 1.3 - Major criticalities of APS systems in literature

1.5 Implementation strategy

Using Advanced Planning and Scheduling (APS) software can make a big difference and help a company to be more productive and effective in its manufacturing activities (Gruat-La-Forme et al., 2009). A robust implementation strategy is crucial to ensure seamless integration with companies existing systems, alignment with business processes, and measurable, repeatable improvements in key performance indicators. Some of the most important points to have in mind when designing an APS software implementation are the current IT infrastructure of the company, the scarce or excessive customization, the restraints regarding quality assurance or user acceptance testing, data integration, performance metrics, technical problems and user training (Meyr et al., 2002). Here, a description of the sequence of main points or activities to consider for a proper implementation approach is provided.

1. Current IT Infrastructure

- Evaluation: conduct a comprehensive evaluation of the existing IT infrastructure to assess its compatibility with the new APS software (Levykin & Iuriev, 2019).
- Incorporation: verify that the APS software can smoothly integrate with the current ERP, MES, and other pertinent systems (Fichman & Moses, 1999).
- Scalability: assess the scalability of the present infrastructure to accommodate the new software without the need for significant upgrades (Tvedt et al., 2004).

2. Customization aligned with business processes and specific requirements

- Business Process Assessment: evaluate and document existing business processes to highlight areas that require customization (Ngoh, 2020).
- Tailored Customization: collaborate with software providers to tailor the APS software to align with specific business needs (David, 2006).
- Industry-Specific Adaptations: tailor the APS software to align with industry-specific requisites, including compliance with regulatory standards (Zhang, 2003).

- User Engagement: engage end-users in the customization process to ensure software adequacy and productivity enhancement (Mazzoleni & Srivastava, 2008).
- User Input: solicit user feedback to highlight additional customization prospects that amplify functionality (Zhang & Wong, 2016).
- Adaptability: ensure the software's flexibility to accommodate evolving business needs and market dynamics (Qiao & Lv, 2011).

3. Testing and Continuous Improvement

- Initial Testing: perform thorough testing to verify proper functioning of the software and alignment with business requirements (Shahin, 2017).
- User Acceptance Testing: engage key users in this phase to confirm the software's functionality and user-friendliness (Stolberg, 2009).
- Continuous Improvement: set up a system for continual feedback and enhancement to tackle any issues and improve the software progressively over time (Sandberg & Mathiassen, 2004).

4. Data Integration and System Configuration

- Data Integration: strategize and carry out the fusion of data from current systems into the APS software for consistent and precise data management (Freire, 2022).
- System Configuration: adjust the APS software settings to adhere to organizational protocols and guidelines (Duh, 2006).
- Data Migration: ensure a seamless data migration process with minimal impact on ongoing operations.

5. Assessing Business Performance Impact

- Key Performance Indicators (KPIs): define pertinent KPIs to measure the influence of APS software on business performance (Ramamurthy, 1995).

- Baseline Metrics: set up baseline metrics before deployment for post-implementation performance comparison (Ramasubbu, 2014).
- Routine Evaluations: conduct regular performance assessments to evaluate the efficiency of the APS software and pinpoint areas for enhancement (Small & Yasin, 1997).

6. Addressing Technical Challenges and Solutions

- Typical Obstacles: recognize prevailing technical hurdles like integration challenges, data precision issues, and system outages (Ahmad & Cuenca, 2013).
- Resolutions: formulate tactics to combat these obstacles, including stringent data validation procedures, routine system upkeep, and extensive user education (Gottschalk, 1999).
- Vendor Assistance: ensure consistent assistance from software vendors for timely resolution of technical complications (Kristianto, 2011).

7. User Training Program

- Comprehensive Training: develop an all-encompassing training program that encompasses all facets of the APS software, from basic functionalities to advanced features (Subramanian, 2007).
- Role-Based Training: customize training programs according to various user roles to ensure pertinence and efficacy (Chaffey, 1996).
- Ongoing Support: furnish continuous support and training materials to aid users in acclimating to the new software and optimizing its advantages (Fichman & Moses, 1999).

To successfully implement APS software, organizations need to meticulously plan and execute the above mentioned process to ensure alignment with business processes, integration with existing systems, and delivery of measurable performance improvements. By focusing on essential elements like IT infrastructure, customization, testing, data integration, performance evaluation, addressing technical hurdles, and providing user training, businesses can effectively deploy APS software and reach their operational objectives (Gruat-La-Forme et al., 2009).

1.6 Future Development

Advanced Planning and Scheduling (APS) systems are set to play an increasingly pivotal role in the landscape of modern manufacturing. As we look ahead, these systems are anticipated to integrate deeper with emerging technologies, creating smarter, more adaptive planning tools that anticipate market changes and react in real time. The evolution of APS promises to not only refine production processes but also revolutionize the integration of supply chain management across global networks, ushering in a new era of manufacturing intelligence and operational excellence (Kjellsdotter & Jonsson, 2012).

Literature suggests some key future perspectives and trends for APS systems that are summarized as follows:

1. Integration with Emerging Technologies: APS systems are increasingly integrating with advanced technologies such as the Internet of Things (IoT), Artificial Intelligence (AI), and Machine Learning (ML). These technologies enhance the ability of APS systems to process vast amounts of data in real time, providing more accurate and dynamic scheduling and planning. For example, IoT sensors can monitor equipment status and production conditions, feeding real-time data into APS systems to optimize production schedules and anticipate maintenance needs (Freire, 2022).

2. Cloud-Based Deployment: the shift to cloud-based APS solutions offers numerous benefits, including scalability, flexibility, and reduced IT infrastructure costs. Cloud deployment allows manufacturers to access APS capabilities as a service, making it easier to update and scale as needed. This model supports smaller manufacturers who might not have the resources for extensive on-premises solutions (Duh, 2006).
3. Enhanced Collaboration: future APS systems will facilitate greater collaboration both within organizations and with external stakeholders such as suppliers and customers. By integrating data from multiple sources and providing a unified view of the supply chain, APS systems can help synchronize activities across different departments and partners, improving overall supply chain efficiency.
4. Real-Time Adjustments and Scenario Planning: one of the significant advancements in APS technology is the ability to make real-time adjustments. APS systems can adapt to changes in demand, supply, or production conditions instantaneously, ensuring that plans remain optimal. This capability is critical for handling disruptions and fluctuations, providing manufacturers with the agility needed in today's fast-paced market. Additionally, APS systems offer advanced what-if analysis tools, allowing manufacturers to simulate various scenarios and prepare for potential contingencies.
5. Automation and No-Touch Transactions: the future of APS includes more automation and the use of no-touch transactions, where orders are placed and processed autonomously with minimal human intervention. This trend reduces the potential for human error and speeds up the decision-making process, allowing manufacturers to operate more efficiently and respond swiftly to market changes (Fichman & Moses, 1999).
6. Sustainability and Efficiency: APS systems will also play a crucial role in supporting sustainable manufacturing practices. By optimizing resource use and minimizing waste, APS can help manufacturers reduce their

environmental impact. Advanced algorithms can plan production schedules that balance efficiency with sustainability goals, such as reducing energy consumption and managing resources more effectively (Sharma et al., 2023).

In conclusion, the future of APS in modern manufacturing is promising, with advancements in technology driving greater efficiency, collaboration, and adaptability. By embracing these trends, manufacturers can better meet the challenges of a dynamic market environment and maintain a competitive edge (Jonsson et al., 2007).

2. Description of Sanmarco Informatica and APS Software

The next chapter introduces Sanmarco Informatica, the company where the project has been developed, and its scheduling software (APS). The reader will go through a brief introduction of the company's history, followed by an exploration of the Sanmarco APS system. The presentation will detail the software's fundamental concepts, its main users, the implementation approach, the data integration and the user interface.

2.1 Company's History

Founded in 1985 and headquartered in Vicenza, Italy, Sanmarco Informatica Spa stands out as a leading provider in the Italian software development industry. Renowned for its commitment to innovation, reliability, and excellence, the company specializes in developing and implementing software solutions tailored to enhance business processes, increase efficiency, and reduce costs. Sanmarco Informatica's products are tailored to meet different requirements of clients across various industries, including finance, healthcare, wine, clothing and manufacturing.

To date, Sanmarco Informatica has successfully completed over 2500 projects, supported by a robust team of more than 700 employees. The company is dedicated to continuous growth and innovation, allocating approximately 20% of its yearly revenue to research and development. With its expanding influence Sanmarco Informatica maintains a significant presence throughout Italy, with additional offices in major cities such as Milan, Udine, Reggio Emilia, Bologna and Barletta.

Sanmarco Informatica is organized into ten specialized business units, among which the "Factory" Business Unit is responsible for developing the APS software (Figure 2.1).

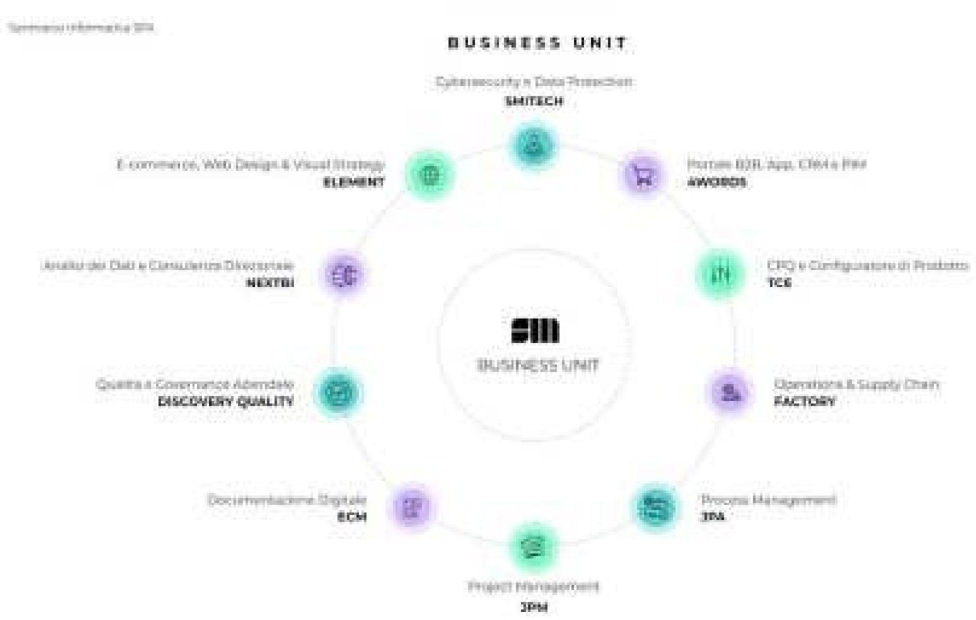

Figure 2.1 - Business units of Sanmarco Informatica (Source: Sanmarco Informatica SpA, 2023)

The Factory Business Unit specializes in consulting and software development services aimed at digitizing factory operations. Its primary software include production planning through Advanced Planning & Scheduling (APS), managing factory operations with a Manufacturing Execution System (MES), and enhancing supply chain efficiency with Supply Chain Collaboration (SCC).

In addition to the Factory Business Unit, Sanmarco Informatica Spa is organized into several other specialized business units:

- **Cybersecurity and Data Protection:** develops advanced technological solutions for Cybersecurity and Data protection tailored for businesses.
- **B2B portal, Apps, CRM, PIM:** provides B2B solutions to foster company growth through dedicated digital tools, including customer relationship management and product information management systems.

- **CPQ and Product Configurator:** streamlines quotation and order processes using secure and efficient technologies to reduce manual effort.
- **Process Management:** offers software for creating, managing and automating business processes.
- **Project Management:** designs software to support companies in managing their projects, facilitating the achievement of goals.
- **Digital Documentation:** provides comprehensive and integrated solutions to fully manage the entire lifecycle of electronic content.
- **Quality and Governance:** focuses on managing activities that ensure the quality of processes, products and services.
- **Data Analysis and Directional Consulting:** delivers application solutions for Business Intelligence, Budget systems, and Corporate Performance Management.
- **E-commerce, Web Design & Visual Strategy:** crafts custom platforms and offers tailored shopping experience alongside detailed visual design.

2.2 Sanmarco APS

Sanmarco Informatica offers a comprehensive solution through its Advanced Planning & Scheduling (APS) software whose aim is to facilitate the creation of realistic and achievable production plans by calculating reliable delivery dates for customers and Call to Promise (CTP) simulations to predict potential delivery dates for new orders.

Sanmarco APS offers a highly configurable framework for designing planning and scheduling systems. The graphical and visual management tool (Figure 2.2) provides comprehensive control over a company’s production process. It is designed to allow accessibility from any platform and operating system so that seamless integration can become easier as well as its use across different environments. This solution is aimed to facilitate the optimization of production processes by customers, for enhanced efficiency and customer satisfaction. The scheduler optimizes production by synchronizing material procurement with actual needs, reducing material stock, and ensuring delivery dates are met through precise scheduling and swift management.

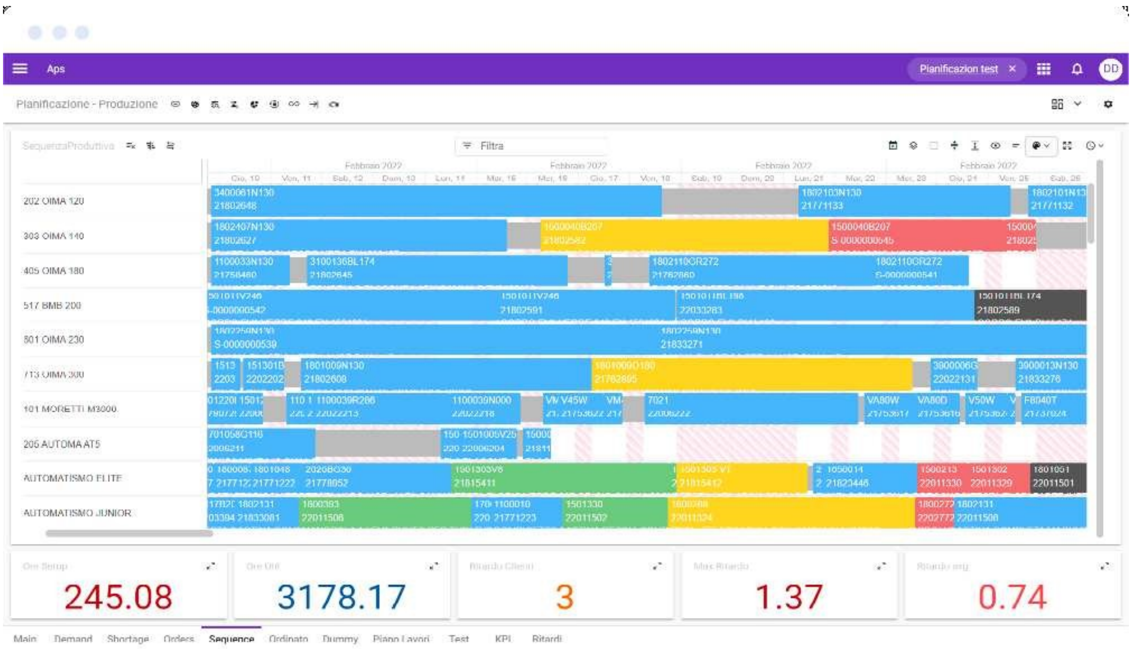

Figure 2.2 - Example of production planning interface (Source: Sanmarco Informatica SpA, 2023)

This software suite provides a set of features designed to enhance production planning and scheduling. These include:

- **Customer order tracking:** provides accurate order dates and tracks service levels for promised deliveries or requests not yet confirmed.
- **Finite capacity simulation:** creates realistic and feasible production plans by considering all production constraints.

- **Manage equipment and setup matrices:** enhances the production schedule by considering equipment availability and streamlining the utilization of facilities and the manufacturing process.
- **Material coordination:** monitors material shortages and sends notifications to suppliers based on the actual production schedule, ensuring timely material availability.
- **What-If Simulations:** allows users to handle multiple scenarios to conduct simulations, assess the impacts of strategic decisions and evaluate the feasibility of forecasted plans.
- **Human Resources Management:** identifies required human resources and skills for the production plan, schedules operators presence in the department based on the needed skills, and plans production according to the availability of scheduled staff.

APS software is designed to manage dynamic production schedules that can adapt to market fluctuations and unforeseen situations such as staff absences, supplier delays, equipment malfunctions, or urgent orders (Figure 2.3). It also ensures supply chain synchronization, enabling timely purchases that minimize inventory levels.

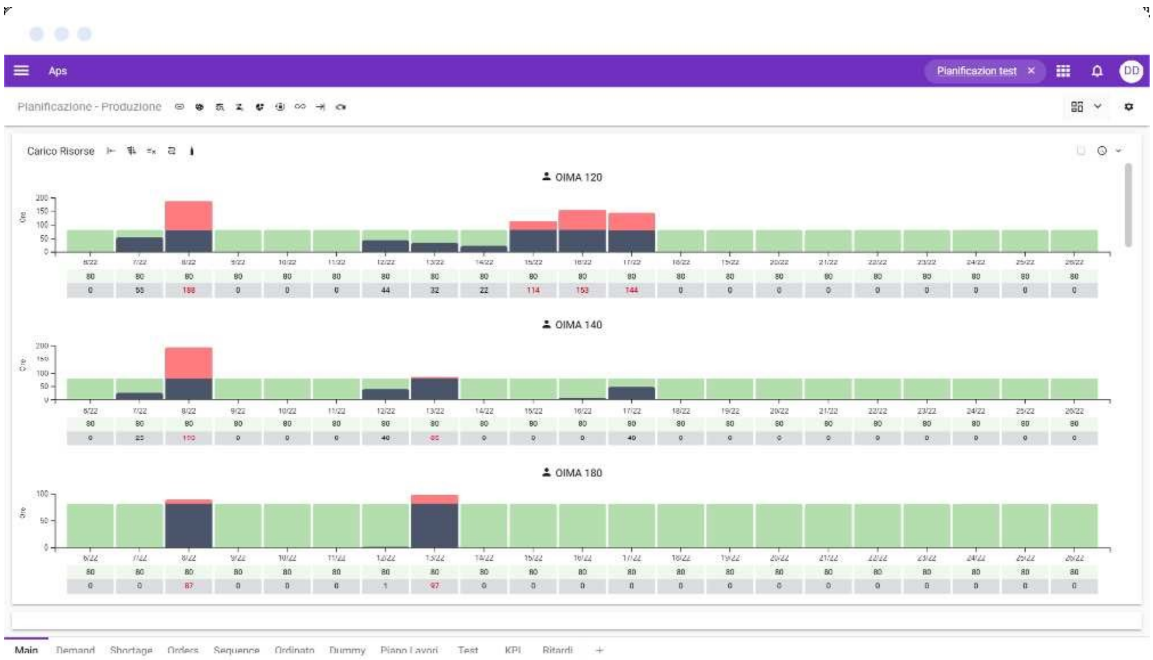

Figure 2.3 - Example of resource loading screen (Source: Sanmarco Informatica SpA,2023)

2.2.1 Main Users

APS software is generally used by various users, each distinguished by their specific roles within the production and supply chain management process. These roles include:

- Production planners: responsible for managing and generating production plans based on different variables such as machinery availability, raw materials and labor capacity. They use simulations and optimization capabilities to predict future outcomes and modify plans in real time.
- Operations managers: monitoring day-to-day operational efficiency and compliance with established plans, they analyze dashboards provided by APS to make strategic decisions and improvements.
- Supply Chain Manager: they manage the flow of goods and materials from acquisition to final delivery, ensuring that materials are available for

production on time and that finished goods are distributed to customers efficiently. They use APS to synchronize the supply chain, optimize inventory levels and plan based on production needs.

- IT staff: they manage the integration of the APS system with other business software and solve technical problems that may arise, ensuring the correct configuration of APS software without interruptions.
- Corporate Management: members of the executive management review advanced analytics and reports produced by APS to assess business performance and guide future strategic decisions.

In summary APS software is employed across various organizational levels, providing specialized tools that support operational, tactical and strategic decisions. This approach ensures the production process operates efficiently and aligns with the company's overall objectives.

2.2.2 Configuration approach

The User Interface (Figure 2.4) opens with a portal screen that authenticates user access permissions, providing secure entry to the APS platform. This initial step ensures that only authorized personnel can access the system, for a high level of security and data integrity.

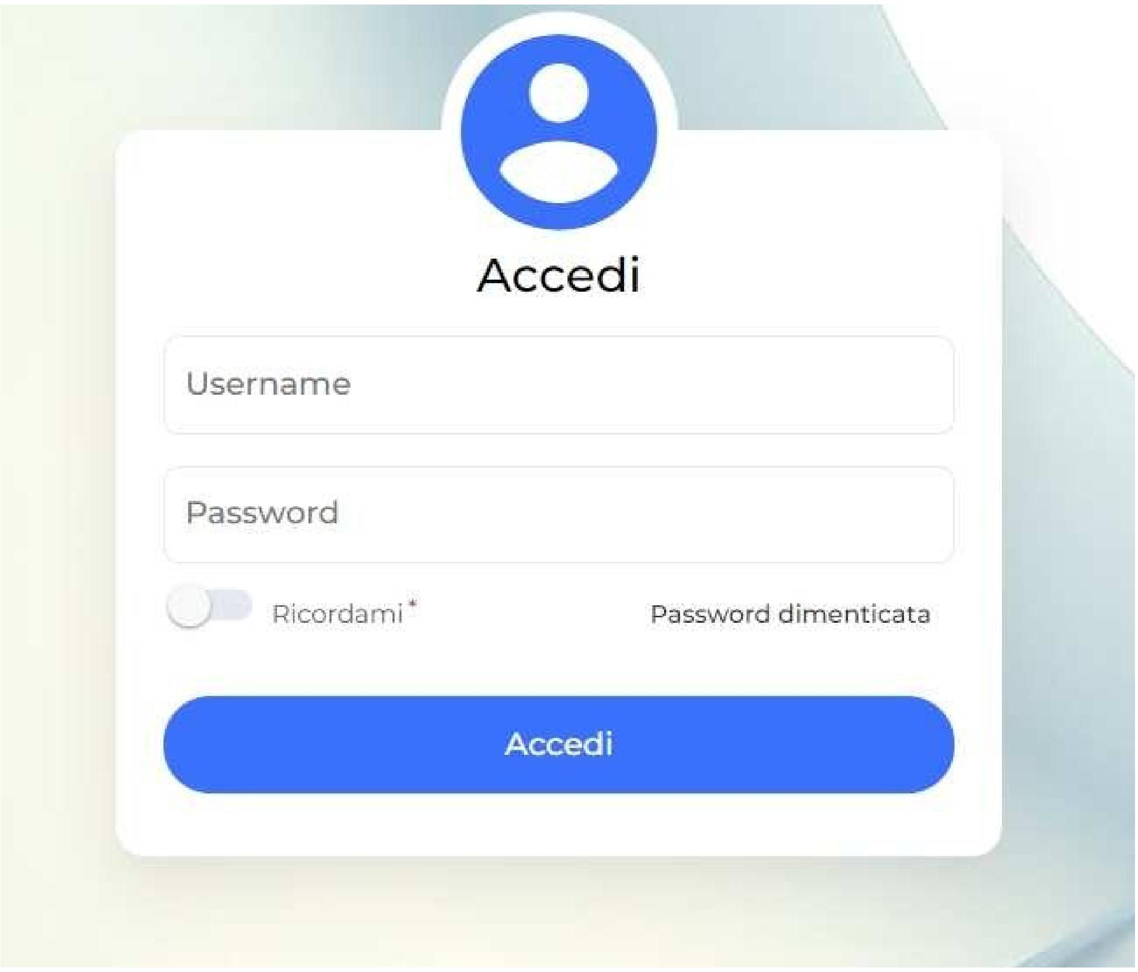

Figure 2.4 - User access interface (Source: Sanmarco Informatica SpA, 2023)

Once authenticated, users are granted access to a tailored dashboard, which is designed to streamline their workflow and enhance usability. The portal is designed to be intuitive and user-friendly, offering a seamless experience as users navigate through the various features and tools available within the platform.

The APS home page opens, structured as follows (Figure 2.5): on the left, there is a menu with entries that provide access to various configuration pages. There is also a quick search bar to facilitate navigation within the menu. Additionally, at the bottom left, the configured workspaces for the environment are displayed.

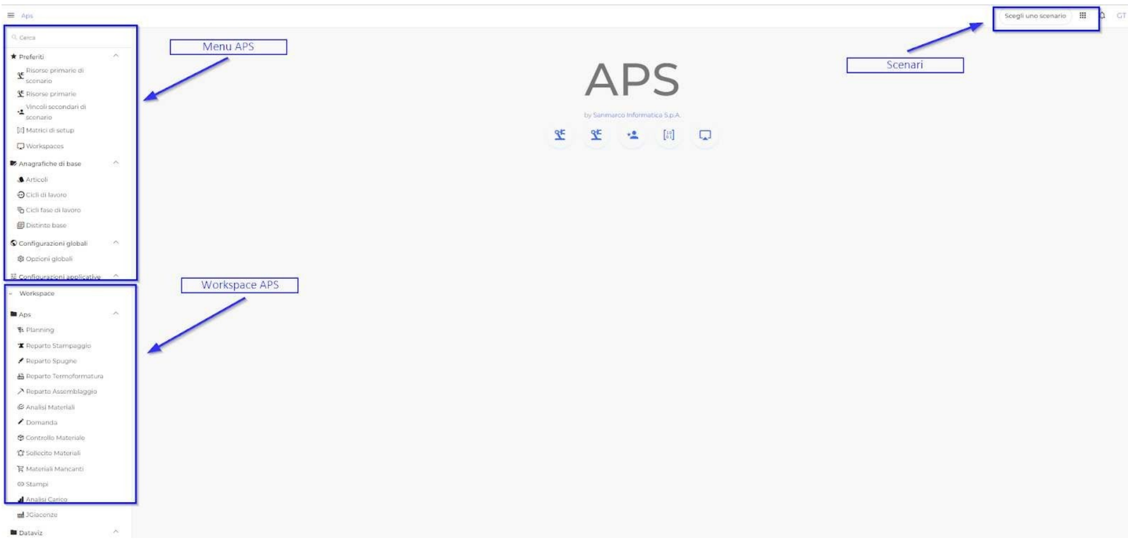

Figure 2.5 - Example of initial user interface (Source: Sanmarco Informatica SpA, 2023)

The next step involves the selection of "Scenario" as APS software allows the creation of various tailored scenarios for each specific user (Figure 2.6). Selecting the appropriate scenario grants users access to their designed workspace. Each user has access only to specific information and workspaces, defined by business needs and linked to their login credentials. For instance, some users, like planners, have broader visibility and can view all orders released by the company.

Figure 2.6 - Example of scenario selection

Sanmarco APS is designed around a Widget-Workspace approach allowing users to personalize the web portal to meet their specific requirements.

Widgets: all features that present information as visual objects are managed through configurable and implementable widgets. These widgets are designed to facilitate user interaction with the program and allow for the pre-selection of information streams (as shown in Figure 2.7, widgets of "Piano Lavoro" and "Carico Risorse"). Data can be displayed in various formats depending on the user9s needs, including grid representations and graphical formats such as pie charts, area charts, Gantt charts, gauges and diagrams. This flexibility enables users to query data for purposes such as statistical analysis.

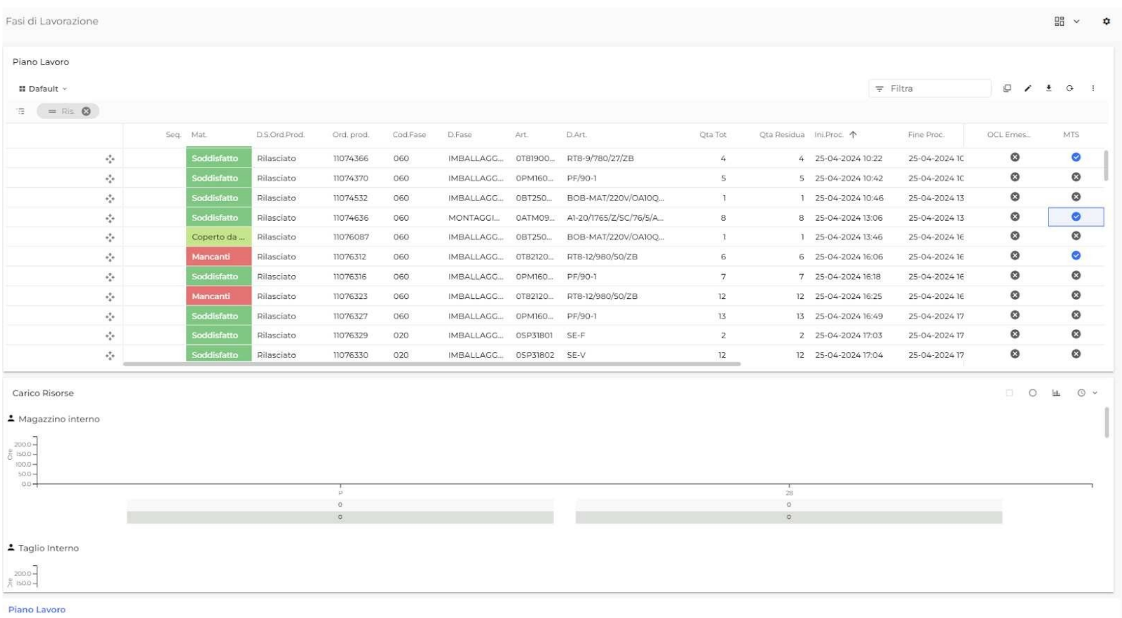

Figure 2.7 - Example of widgets containing processing phases and resource loading(Source: Sanmarco Informatica SpA, 2023)

Workspaces: are highly configurable areas designed to meet the specific needs of users through the use of widgets and buttons. Each workspace can be accessed by clicking on the list located at the bottom left of the home screen (Figure 2.8).

In general, workspaces consist of various widgets, buttons, and tabs. The buttons enable users to perform actions such as import, scheduling, and export. The tabs, visible at the bottom, represent different pages within the workspace.

Figure 2.8 - Example of workspace with three buttons added

Buttons: selecting the "+" button located at the top right corner of the workspace page, users see a configuration screen. This allows for the customization of all available buttons with a variety of predefined actions tailored to specific needs. In this particular instance (as illustrated in Figure 2.9) the user is configuring a data import and an ASAP (as soon as possible) scheduling.

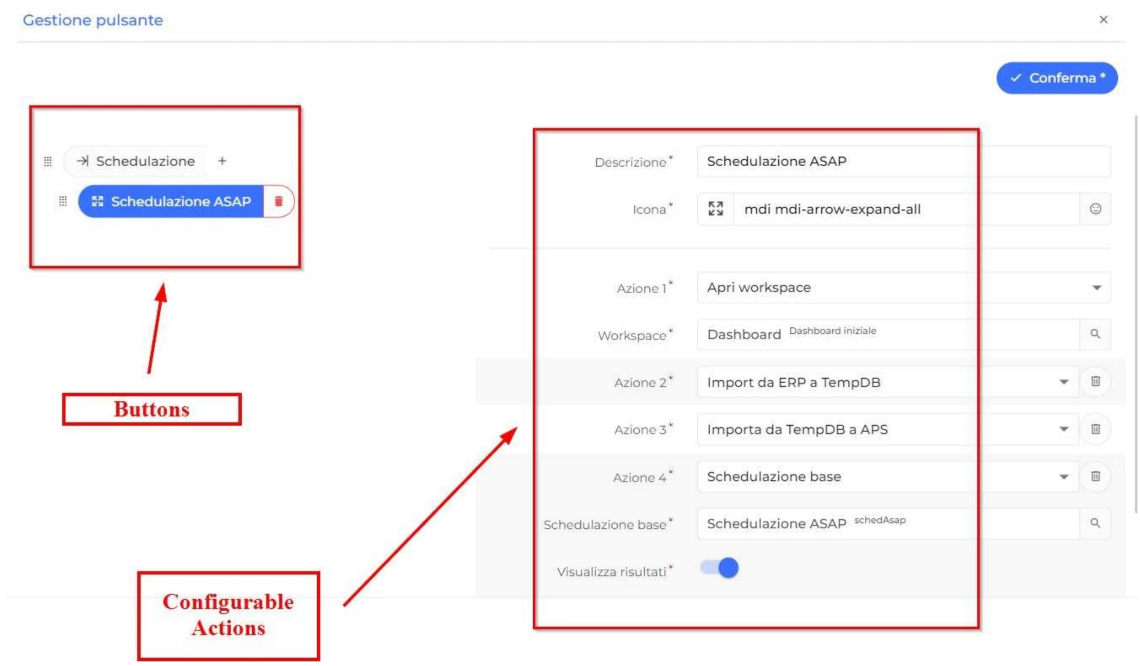

Figure 2.9 - Example of button configuration with a set of actions

An important configuration in APS during its implementation are the preferred sequences (Figure 2.10). The preferred sequences, which are considered during scheduling, are set in the resource master data and allow scheduling to account for factors such as demand date or rankings (priority, setup time, etc.). To view the preferred sequences, users should navigate to Primary Resources of Scenario from the APS menu, enter the resource of interest, and scroll down to the "Preferred Sequence" section.

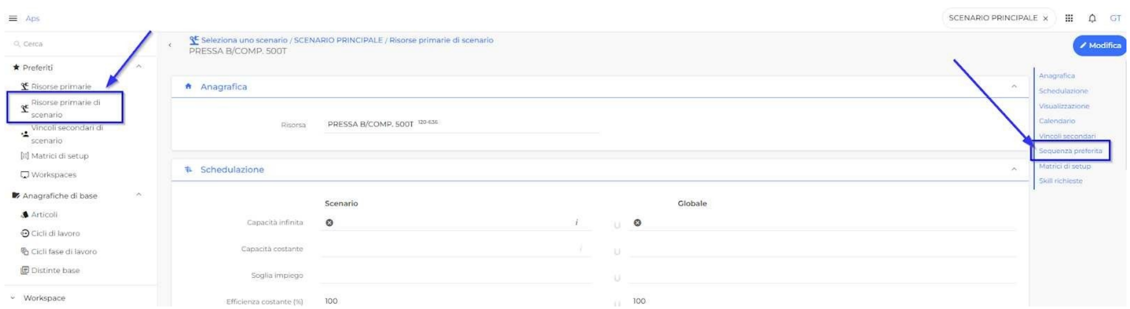

Figure 2.10 - Example of preferred sequence screen

Some examples (Figure 2.11) to use in the preferred sequences section are:

- **Phase Ranking:** refers to the priority imported from the ERP "Jgalileo", with orders scheduled in the following sequence: black first, followed by red, yellow, green, and blue (colors listed in decreasing order of importance).
- **Setup Time Ranking:** when priorities are equal, phases with shorter setup times are scheduled first, followed by phases with longer setup times. Setup time can be related to color changes or mold changes.
- **Original Priority Ranking:** under equal conditions, customer orders are prioritized over orders for restocking inventory.

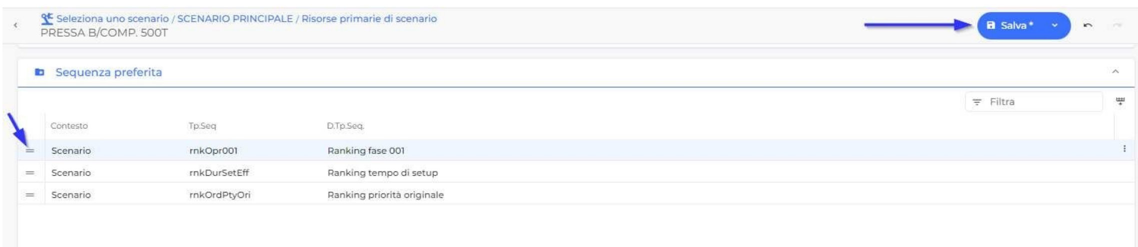

Figure 2.11 - Example of preferred sequence configuration (Source: Sanmarco Informatica SpA, 2023)

Sanmarco APS allows configuring additional settings such as machine calendars (as shown in Figure 2.12), including holidays and maintenance schedules, suppliers, groups, customers, orders, articles and matriculas. Users can also manage resources, which encompass all the machinery and equipment used in production, as well as the production cycles.

This ensures that the scheduling system accounts for machine availability, downtime and specific sequences of production processes, further optimizing the production flow. By setting these parameters, APS provides a comprehensive tool for precise and efficient planning, aligning production schedules with real-world constraints.

Figure 2.12 - Example of calendars with one shift (Source: Sanmarco Informatica SpA,2023)

As illustrated in Figure 2.13 and Figure 2.14, personalization also regards the widgets within the workspace that can be filtered by date, order number, customer number, article and more, using specific filters distributed throughout the interface. These filters enable users to refine the data displayed within an entire widget or just a portion of it. A way to apply filters is by accessing the menu under the grid title. By selecting "Data Filter" a window opens where you can insert filters by choosing the column and the text to filter. From this window, one can also set the sorting order for the results displayed in the table. In the example, the results are sorted by ascending resource code and ascending process start date, and filtered to show only entries with a delay time greater than 0. Furthermore, columns can be customized and rearranged according to user preferences, enabling customized data visualization.

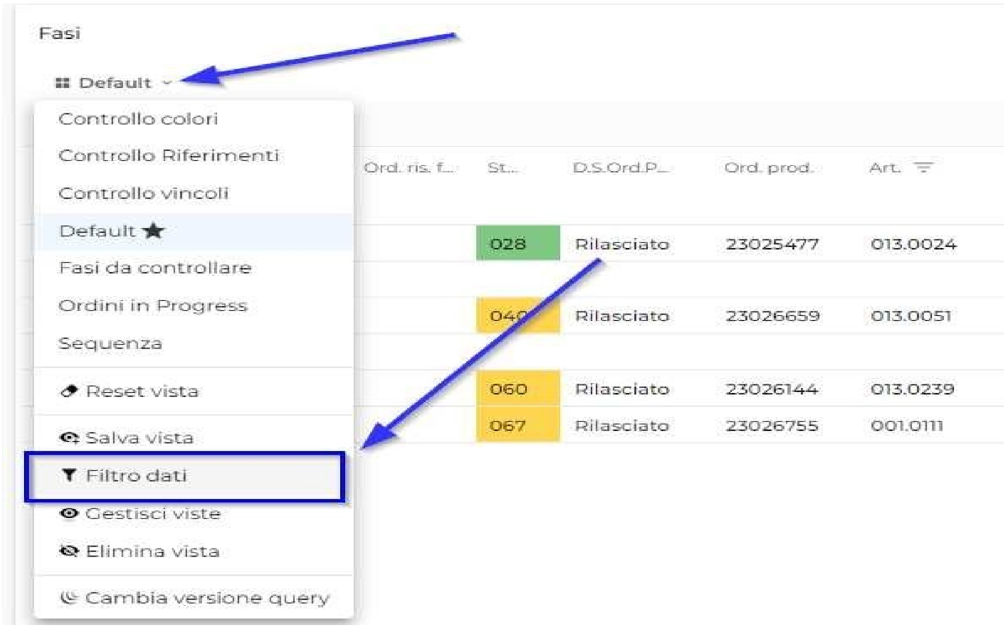

Figure 2.13 - Example of filters application

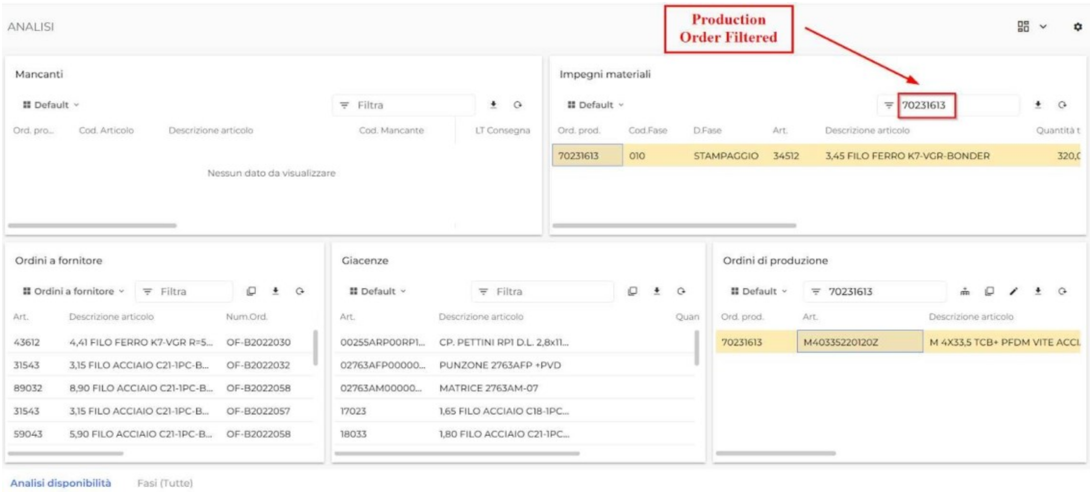

Figure 2.14 - Example of personalized widgets

2.2.3 Data Integration

Data integration is the process of synchronizing information from external sources into the APS platform. This can be performed through the ETL (Extract, Transform, Load) process, on demand based on a customer's request or scheduled to run automatically. The ETL process (Figure 2.15) associates the various documents and extracts information from the ERP database facilitating data sharing.

For this reason, the ERP also allows data sharing through a set of "staging tables" to act as a bridge system with the final aim of linking the ERP with the APS to any database, spreadsheet, printouts or whiteboards. The ETL process is coordinated with specific software that shows and configures the transformations from the ERP for each table. Each transformation involves multiple steps that modify the data in the ERP and transfer it to a temporary database, which subsequently feeds into the APS database.

Information flows from the ERP system to APS, but it can also come back from APS to the ERP. Updates to the ERP database follow some of the user actions in the APS, but there are indeed many other cases where changes are confined to the internal APS database.

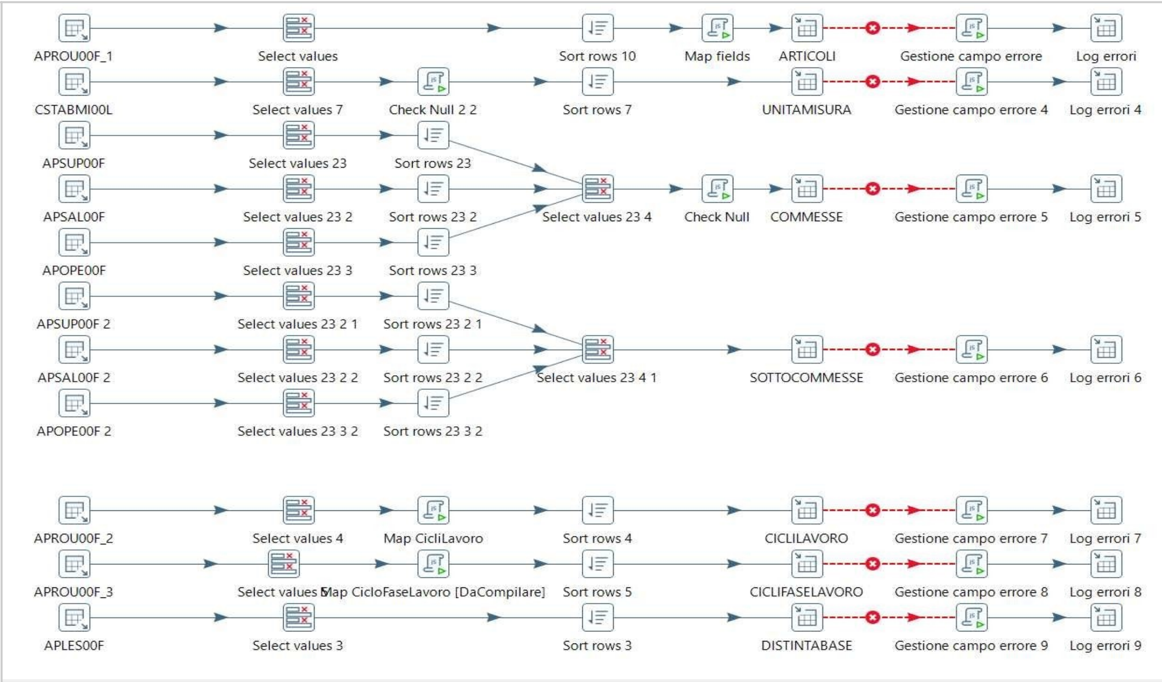

Figure 2.15 - Example of data flows in ETL

3. Customer Company: Barausse (AS-IS Situation)

This chapter provides an in-depth exploration of Barausse S.r.l., covering various aspects of the company's operations, history, and production processes. It begins with an overview of the company's background and market, followed by a detailed history of its growth and achievements. The chapter then delves into the production model, illustrating the step-by-step process from initial material preparation to the final product. Additionally, it discusses Barausse's approach to market demands through different production strategies. Then it concludes with an analysis of the current AS-IS business processes and the objectives of the APS implementation project, aimed at enhancing efficiency and customer satisfaction. This comprehensive overview sets the stage for understanding Barausse's operational framework and strategic initiatives.

3.1 The company

Barausse S.r.l. is a mid-sized company headquartered in Monticello Conte Otto (Vicenza) specialized in the production of interior doors, entirely designed and manufactured in Italy. Renowned for their high-quality craftsmanship and innovative design solutions, Barausse produces functionally and aesthetically pleasing products both for residential and public spaces, including hotels, restaurants, hospitals, wellness areas and offices.

In addition to interior doors Barausse designs and manufactures paneling and partitions, ensuring that its products meet the diverse needs of various environments. The company integrates artisanal expertise with industrial precision, ensuring top-tier products that meet stringent environmental and health standards.

Operating in a global market (Figure 3.1), the company follows a market diversification strategy with plans to expand into the American and Far East markets. Moreover, to its stores in Italy, the company has international branches, including Barausse Rus in Moscow, Barausse Polska in Warsaw, Casa Palladio in Accra, Ghana and Barausse Miami in the USA.

Figure 3.1 - Sales Network (Barausse Srl, 2024)

3.2 History

Founded in 1967 by the Barausse brothers, the company originated from a family artisan tradition and quickly evolved into an industrial enterprise in the 1970s by enhancing its distribution channels. Besides strengthening the domestic market, Barausse began penetrating international markets in the 1980s.

In 1980, Barausse promoted the “Superlegno” consortium, the first national body to monitor production processes and materials in the sector. By 1990, it became the first Italian door manufacturer to achieve ISO 9002 certification. The company also expanded its range of product certifications, including fire resistance, allowing it to enter the hotel market.

From the mid-1990s, Barausse focused on aesthetic innovation and product flexibility, leading to the registration of significant industrial patents. In the 2000s, the company implemented an advanced logistics system, enhanced its organizational structure, and launched its first collection of aluminum doors.

Since 2005, Barausse has been the preferred partner for renowned global projects, collaborating with famous architects such as Massimo Bellunato and Massimo Iosa Ghini. By 2010, the company expanded its commercial presence by opening branches in Italy and abroad.

Today, Barausse continues to expand its range of certifications for soundproofing and fire resistance, showing off 10 international certifications and 18 industrial patents. The company maintains its international market expansion, closing 2023 with a turnover of € 15.5 million (Report Aziende, 2024).

3.3. Production model

The production cycle begins with the preparation of the internal structure and the fillers of the door panel. The fillers, chosen based on the desired performance characteristics, include:

- Honeycomb Filler: lightweight and strong.
- Perforated Chipboard: enhances stability and durability.
- Pavafibres: a mineral fiber panel used in doors requiring soundproofing and fire certification.

After these initial steps, the materials proceed to the pressing phase, forming the first rough structure of the door panel. The panel then undergoes squaring and edging, which adjust its height and length through a double pass in the edge-squaring machine. For non-laminated doors, the panel moves to the painting phase. The edges are first painted in a dedicated booth using a spray gun, except for wood-finish doors, which already have finished edges. Then, both faces of the panel are painted on a specialized line. Following painting, the panel undergoes hardware fitting, involving drilling for hinges, locks, and other hardware as needed. If required, the panel may also be routed according to the door model. Finally, the panel is ready for packaging unless additional painting for special finishes or the application of frames, profiles, mirrors, or other customer-specific accessories is needed.

The diagram below (Figure 3.2) illustrates the production cycle described, with production departments highlighted in orange, subcontractors handling external processes in blue, and the final order palletization stage in green.

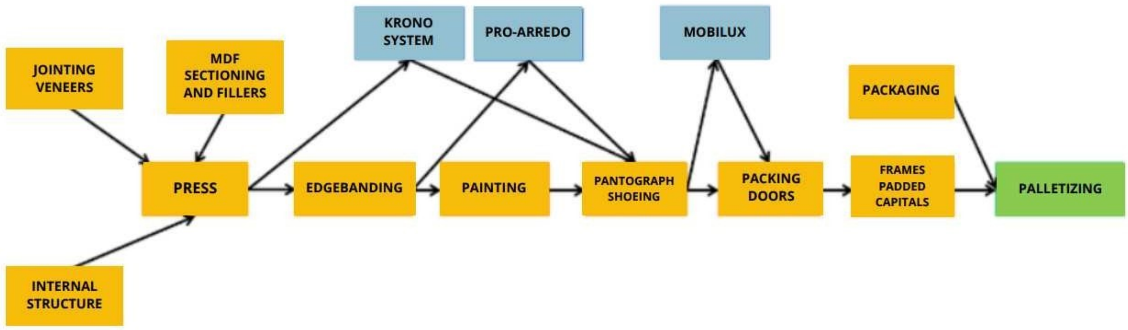

Figure 3.2 - Diagram of a door production cycle (Barausse Srl, 2024)

The facility is divided into various specialized departments, each dedicated to a specific phase of the production process. Below is the layout of the production plant (Figure 3.3), highlighting the different departments. As shown in the figures, the production plant is divided into two main areas (Figure 3.4).

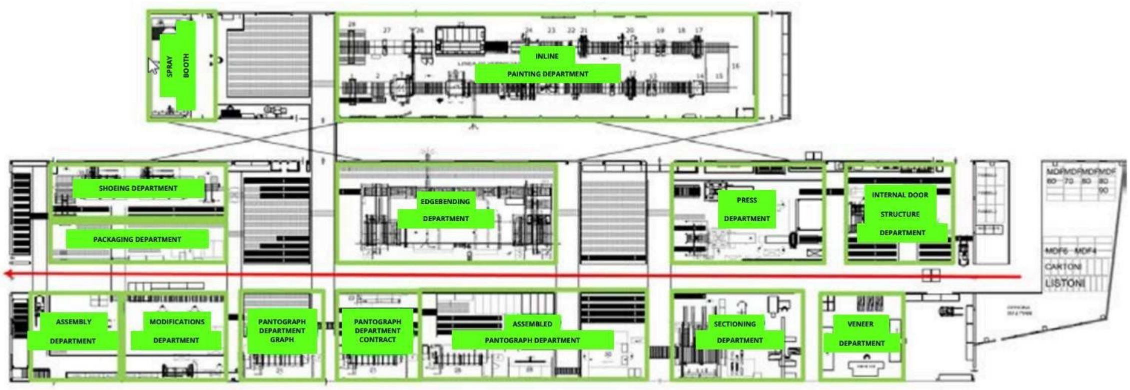

Figure 3.3 - Layout plant 1 di Barausse s.r.l (Barausse Srl, 2024)

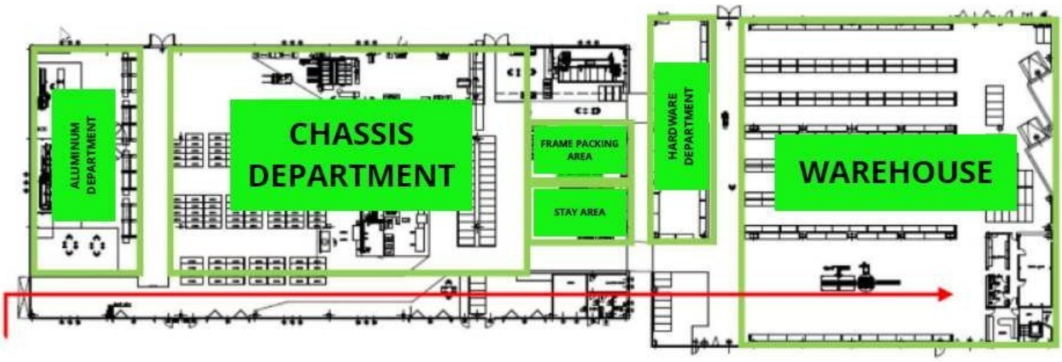

Figure 3.4 - Layout plant 2 di Barausse s.r.l (Barausse Srl, 2024)

The company adopts three primary production approaches on a global scale:

- **Engineer to Order (ETO):** custom designs and production based on specific customer orders.
- **Make to Order (MTO):** manufacturing starts once catalog orders are received.
- **Make to Stock (MTS):** Products are produced in advance based on demand forecasts.

Among these strategies, MTO is the least utilized, only for a small portion of the order portfolio. These products are produced using lean principles to minimize inventory levels, with various raw materials and semi-finished goods managed using a Kanban system.

3.4 APS project: the initial situation

APS projects typically require significant effort from the company to maintain data accuracy, ensuring that information within the defined IT model (such as bill of materials and production cycles) is complete and aligned with the company’s production model.

We examined Barausse’s current data management practices related to production, as the success of APS projects is closely linked to the accuracy of the input data. An initial analysis revealed several data-related issues that needed to be addressed and preliminarily resolved by the company to ensure optimal use of the APS software:

- Production orders without phases: corrective actions were taken from managing customized cycles to standardized cycles, ensuring all work phases are accurately coded.
- Cycle time accuracy: verified the accuracy of standard machine processing times, crucial for finite capacity scheduling.
- Lead times for external processing: updated the "external processing lead time" field to accurately reflect the time required by subcontractors.
- Confirmed purchase dates: verified confirmed delivery dates for materials required by production orders.
- Item Lead Times: updated lead times in the ERP item master to determine material availability dates, for materials that are lacking.
- Customer promised dates: ensured adherence to customer delivery dates, a key element for scheduling.
- Closing production orders linked to closed sales orders: settled production orders and phases associated with completed sales orders to optimize resource allocation and material usage.
- Balancing external processing orders: maintained a clear, updated view of ongoing external processing activities for accurate subsequent phase planning.
- Buffer times between phases: coded wait times at the machine level to reflect non-productive time preceding phase initiation.

- Attributes in cycle phases: added attributes (e.g., wood type, diameter, filler) to optimize production planning through appropriate grouping.
- Machine association with cycle phases: updated machine associations with production phases, removing obsolete machines and correcting inaccuracies.
- Uncommitted or unsettled production orders: managed these orders by either settling them or assigning distant expiry dates to avoid impacting capacity.
- Machine groups: are sets of machines that can be used interchangeably to perform various production phases (e.g., for routing), enhancing planning flexibility. If a machine belongs to a group, it is possible to manually adjust the sequence of operations and the specific machine on which a phase is executed. Machines from other groups are visible depending on a selected icon.

These adjustments were crucial for the system to function effectively and align with the company's production processes. By addressing these key areas, Barausse improved its data management practices, ensuring the effective operation of the APS scheduler.

3.5 Project objectives

Examining the current AS-IS business processes and customer requirements of a firm is fundamental for the APS software configuration. The main objective of the implementation project is thus to understand the present production and planning enviroment. This analysis was performed in cooperation between myself and a senior consultant from Sanmarco Informatica. It was initiated by the senior consultant in late February and we have further worked jointly, conducting interviews with the Supply Chain Manger, Operations Manager and IT Manager of Barausse to gather insights, compare and consolidate data in preparation for the APS software configuration.

The main objective of the APS software, in the case of Barausse, is to support the scheduling of production orders, which are currently not planned, as dates are directly set by the MRP (Material Requirements Planning) without considering the productive capacity of various resources. Additionally, improving the setup time in the pressing phase is a significant goal to enhance overall efficiency. By consolidating production orders with a specific rule, setup times can be optimized, addressing one of the major issues identified in the current process.

Sanmarco APS production scheduler is configured to achieve finite capacity scheduling, providing a graphical representation of machine workloads. This will enable the company to quickly assess machine capacity saturation during different periods and provide the sales department with more reliable dates to communicate to the customers.

The scheduling will involve confirmed production orders linked to closed sales orders rows and also the so-called "hidden" orders. These refers to items for which a precise bill of materials has not yet been defined but for which it is necessary to commit the productive capacity of the involved machines. These orders are managed by associating them with a generic cycle without creating material requirements.

To conclude, in the case of Barausse, the APS implementation project focuses on enhancing overall visibility and efficiency to ensure timely fulfillment of customer orders. This approach aims to improve production planning and scheduling, reduce delays, and optimize resource utilization, ultimately leading to better customer satisfaction and streamlined operations.

3.6 AS-IS business processes

This paragraph will provide an overview of the current processes in use at Barausse, detailing the AS-IS flow (Figure 3.5).

a. Request for finished product from the customer

The process begins with the customer's request for a finished product, facilitated by the sales department. A sales order, complete with detailed specifications, is generated in the ERP system. The sales order remains open until the bill of materials (BOM) is created, integrating crucial information such as prices, discounts, and commissions. Currently, the sales department sets the dates for sales order lines without considering the production workload.

b. Release of BOM and production cycle via product configurator

The technical department uses the product configurator software to release the BOM and the associated standard production cycle. This step is crucial for detailing the production process and preparing the necessary data for material planning.

c. Creation of production orders

After the sales orders are finalized, the MRP generates production orders. Currently, there are no specific sequences within the materials and cycle phases, as all materials are picked in the first phase of the production process. The MRP system is updated daily, with runs scheduled every morning to ensure updated and timely planning of production orders in response to customer demands.

d. Progress of phases and orders

The progress of work phases and production orders is tracked using RFID (Radio Frequency Identification) or manual entry in the management software. A web interface linked to the ERP system handles phase progress. By default, the system does not track the specific machine performing a work phase but reads the resource indicated in the production order phases within the management software.

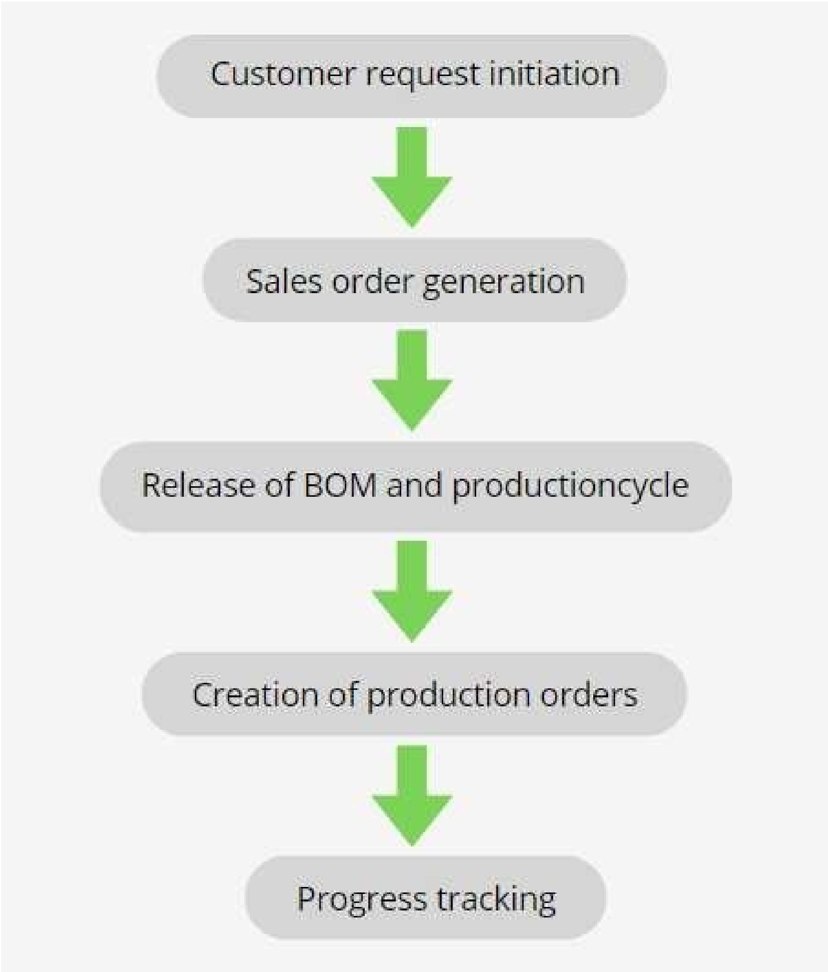

Figure 3.5 - Graphical representation of Barausse's AS-IS production process

4. Configuration and Implementation of APS Software (TO-BE Situation)

The following chapter details the implementation phase of the software, where various modules are configured to align with the company's requirements and enhance existing business processes. It will discuss the transfer of data from the company's ERP system and the generation of links. The implementation of ALAP (as late as possible) and ASAP (as soon as possible) scheduling will optimize project timelines. Dedicated workspaces for real-time production monitoring, along with comprehensive dashboards to visualize key metrics and streamline processing phases, will be explained. The operations performed by the scheduler are outlined in this section, concluding with the Data Export from APS to the ERP.

4.1 Data Import from ERP

The input data for APS was extracted from the ERP system (referred as "Jgalileo" by Sanmarco Informatica), specifically from the "BAR90DAT" library (production environment). The data alignment process between the ERP and APS was conducted through the appropriate configuration of ETL (Extract, Transform, Load) system connectors. Specifically, data related to production orders, customer orders, sales forecasts, inventory, supplier orders and equipment availability were synchronized.

The data import from the ERP to APS was managed (Figure 4.1) through a dedicated import command (button). Scenario-level information includes the date and time of the last import performed. From the ERP environment, technical information of the items was extracted, including products master data, production cycles, resource master data, item master data, bills of materials, machine groups and other relevant data.

In APS, a single scenario was configured (Figure 4.2) for the main production environment (MAIN-BARAUSSE), specifying which data was imported from Jgalileo (as indicated in Jgalileo's "scenario management"). If necessary in the future, a second scenario can be created.

Figure 4.1 - Example of data import command

Figure 4.2 - Example of scenario selection

It was necessary to make customizations of the ETL to interface appropriate fields not managed by APS by default but that the company wanted to import, such as the supplier code and description, purchase account, and information on the closure performed for sales order lines and linked cycle.

Based on this data, APS enabled the simulation of a feasible and realistic production plan, both in the short and medium/long term, developed based on the company's priorities for material allocation and scheduling. This simulation also required the prior setup of machine calendars and the holiday calendar, which included closure days for the Barausse company. Currently, two calendars have been configured: an 8-hour shift (8:00-12:00 / 13:00-17:00) and a 24-hour calendar for subcontractors (00:00-23:59).

4.2 Pegging Generation

After importing the data, the operation of creating links, known as pegging, was performed. Pegging connects commitments, such as customer orders, sales forecast and production orders, with the committed objects, such as warehouse stock, work-in-progress from production orders and purchase orders. This linking process provided clear traceability between the different entities and allowed for visualization of the origin and destination of commitments within the APS system.

Specific pegging rules (advanced links) were set up to connect inventory, production orders, or supplier orders to customer and production orders. The company's required logic for the links involved initially connecting commitments and committed materials by reference and job order. Subsequently, links were generated for requirements, with a temporal distribution primarily involving date-based allocation and secondarily supplies derived from purchase orders and production orders.

4.3 ALAP and ASAP Scheduling

Following the pegging operation, ALAP scheduling played a crucial role in providing an in-depth view of machine capacity. This simulation is performed considering infinite capacity. This phase also aimed to calculate the target end date for each stage, considering the earliest demand linked to the production order or a higher-level production order (such as a customer order). This date became essential for the subsequent ASAP scheduling process.

ASAP schedules at finite capacity. This process aims to create a short-term work plan, with the primary objective of establishing execution dates for production orders and processing stages, ensuring that customer commitments are met promptly. During this process, capacity constraints and the optimization logics configured in the production system are carefully considered. Special attention is given to customer-required dates, utilizing phases aggregation logics based on specific attributes, such as wood species thickness and type of filler. This aggregation mainly focuses on the press (B17-001) and previous machines (B13-001, B05-001, B10-001).

The management of attribute-based aggregation involves creating appropriate setup matrices and modifying the preferred machine sequence. It is important to note that sequencing criteria are defined for each machine.

As previously mentioned, the ALAP and ASAP scheduling modes are typically executed in succession. Initially, an infinite capacity ALAP scheduling is performed, allowing each phase to store its target date in relation to the demand date. The demand date represents the deadline by which the processing phase should be completed, ensuring that the requested item is available by the indicated date, which may pertain to a customer order, a sales forecast or the replenishment of inventory.

After the ALAP scheduling, an ASAP scheduling is performed as soon as possible, following an ordering defined based on the rules agreed upon with the client. The company aims to manage a large number of internal production machines using a finite capacity approach. To achieve this objective, it's necessary to appropriately configure all the machines, through the association of correct work calendars, the desired sequencing logics and other relevant settings.

From the initial analysis, it became clear that there was a need to define an advance limit, known as the "minimum scheduling horizon", which represents the maximum period by which the end of a phase can be anticipated compared to its demand date (calculated in ALAP scheduling). Currently, the value set for this parameter is 14 days, according to the company's guidelines. This parameter can be established globally via a dedicated button or for individual machines. This setting allows for controlling the advance of phases, ensuring they are not scheduled too far in advance of their respective demand dates. The higher the minimum scheduling horizon set, the greater the capacity saturation of the machines, but also the higher WIP (Work In Progress). Conversely, with a lower minimum horizon, there will be less WIP but also less machine saturation.

In the pressing phase, it has been decided to consolidate production orders to optimize setup time, addressing the major issue identified. A minimum scheduling horizon of 10 days has been set, prioritizing the matching of items over demand dates to avoid setup changes with each item switch. Consequently, the input to the pressing machine must adhere to this logic, ensuring that the arrival dates of the materials in use are checked accordingly.

The operations on these machines will be sequenced based on customer order dates, also considering setup optimizations such as wood species, thickness, and type of filler. It is crucial to define maximum advance days, as previously mentioned, to avoid excessive phase aggregations due to setup optimization.

Regarding setup times between phases with different attributes, these will be managed through dedicated setup matrices. In this context, retrieving the attributes will not require ETL customizations, as standard Jgalileo fields will be used.

A flag named "MTS" (Make to Stock) has been implemented to indicate if a phase is not linked to any customer order, signaling that production is intended for stock.

For managing subcontractors with lead times, a customized procedure for handling work orders has been implemented, outlined as follows:

- The work phases associated with an external work order are set with an end date equal to the "Confirmed Delivery Date" from Jgalileo, if available, or alternatively the "Requested Delivery Date."

- The start date is calculated by subtracting the lead days present in the order phase. If these days are not indicated at the cycle level, it is suggested to add this information to ensure accurate calculation.
- If the dates read are in the past, the end date (goods arrival) is forced to today, making it equal to the start date.
- A flag named "OCL Issued" has been associated with each phase to identify if the phase is linked to an issued work order. This flag provides a clear indication of the relationship between the phase and the work order, simplifying the management and visualization of information.

This customized procedure aims to optimize the management of work orders and external processing phases, ensuring accurate date monitoring and clear identification of phases associated with issued work orders.

A view named "OCL with Work Order" has been created to provide a quick overview of all phases associated with a work order. However, it is important to consider that forcing the arrival of goods by subcontractors may introduce temporal inconsistencies with previous phases, especially when the arrival is backdated.

For external phases without a work order, a standard approach based on lead days has been adopted. An exception concerns the subcontractor, treated as an internal company resource. In this case, a finite capacity logic has been implemented, requiring a specific customization to obtain the duration time from the field "load hours" instead of the "Lead Days" field. Subcontractor phases are identified by analyzing the resource associated with the phase, specific to this subcontractor. This approach implies the need to define a dedicated holiday calendar and to encode appropriate cycles in Jgalileo, with differentiated times based on the article family.

If necessary, it is possible to download a file in Excel, CSV, or PDF format directly from APS (Figure 4.3). This file will provide an ordered list of processing phases, organized by their target start date, thus facilitating the consultation and analysis of planned activities.

Figure 4.3 - Example of export command

4.4 Workspaces implemented for production monitoring

This paragraph provides an overview of the key workspaces in APS. It begins with the "Dashboard" and "Processing Phases" workspaces, which offer detailed views of machine work plans and production phases, helping planners monitor and manage resources effectively.

The chapter then explores the "Machine Load" and "Gantt" workspaces, which focus on resource utilization and the sequencing of processing phases. “Materials” and “Inventory” management are also covered, with tools to ensure smooth production and efficient stock control.

Additionally, the management of “Supplier and Customer Orders” is discussed, highlighting APS's role in tracking order statuses and aligning schedules with commitments. The chapter also touches on “Manual adjustments to phase sequences”, allowing for fine-tuning of work plans. Finally, it concludes with the process of “Data Export” from APS back to Jgalileo, integrating key information into the ERP system while maintaining data integrity.

4.4.1 Dashboard and Processing phases

The “Dashboard” and “Processing Phases” workspaces offer a detailed view of the machine work plans, allowing for the examination of all processing phases in APS along with their related information. The ability to sort phases by scheduled start date and group them by machine facilitates the visualization of the resource plan proposed by APS.

Crucial information for each phase, such as the production order, the item and alerts regarding potential delays or materials shortages, is provided in a clear and accessible manner. This organization helps planners in quickly assessing the current state of production and making informed decisions to ensure smooth and efficient operations (Figure 4.4).

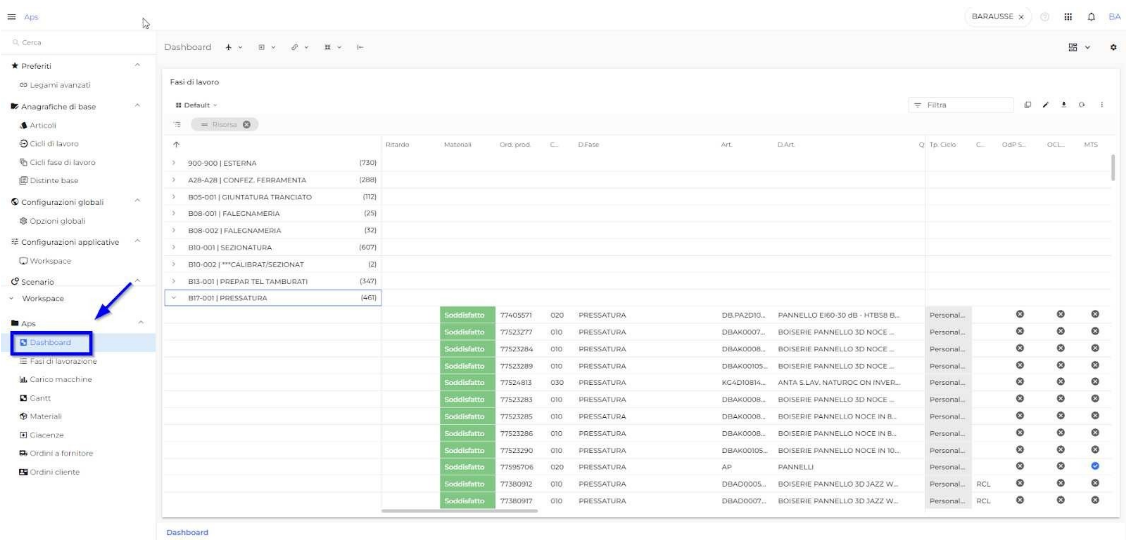

Figure 4.4 - Example of “Dashboard workspace”

In the work plan, it is possible to examine the links of each phase, providing a clear representation of connections with customer orders, production orders, inventory, purchase orders and any missing material. Currently, the interrogation of these links is conducted graphically (Figure 4.5), but a functionality is being developed to explore the links in a tabular and linear format.

This view will allow planners to evaluate which delayed components can be ignored or can be worked on later. Simultaneously, a delay might suggest relying on a subcontractor for external processing. This enhanced capability will help in making more informed decisions to maintain production efficiency and meet delivery deadlines.

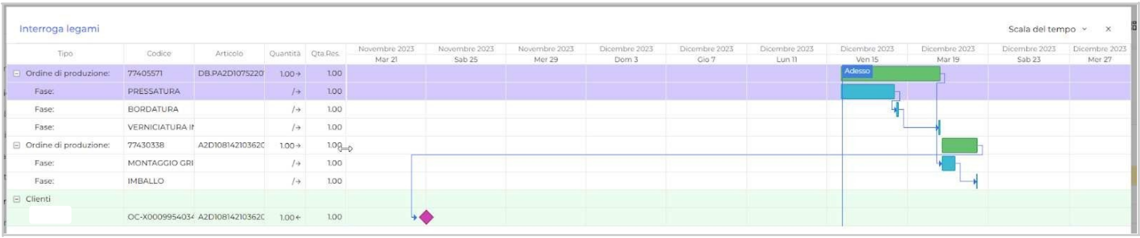

Figure 4.5 - Example of links interrogation

4.4.2 Machine Load

The “Machine Load” workspace provides a detailed visualization of the machine workload, offering a comprehensive analysis of resource utilization. The available capacity, calculated based on the calendar associated with the machine, is represented in light gray, while the actual load generated by the scheduling is highlighted in dark gray. This visual scheme (Figure 4.6) provides a clear indication of machine availability and their actual use in the production department.

Figure 4.6 - Example of machine load

4.4.3 Gantt

The graphical representation (Figure 4.7) of the sequence of processing phases associated with resources, filtered in the "Gantt" workspace, offers a clear visualization of the order of processing phases and the resources involved. This customizable visualization allows the inclusion of specific information within the bars, such as the item code and phase description, providing an immediate overview of ongoing activities and the resources employed in production.

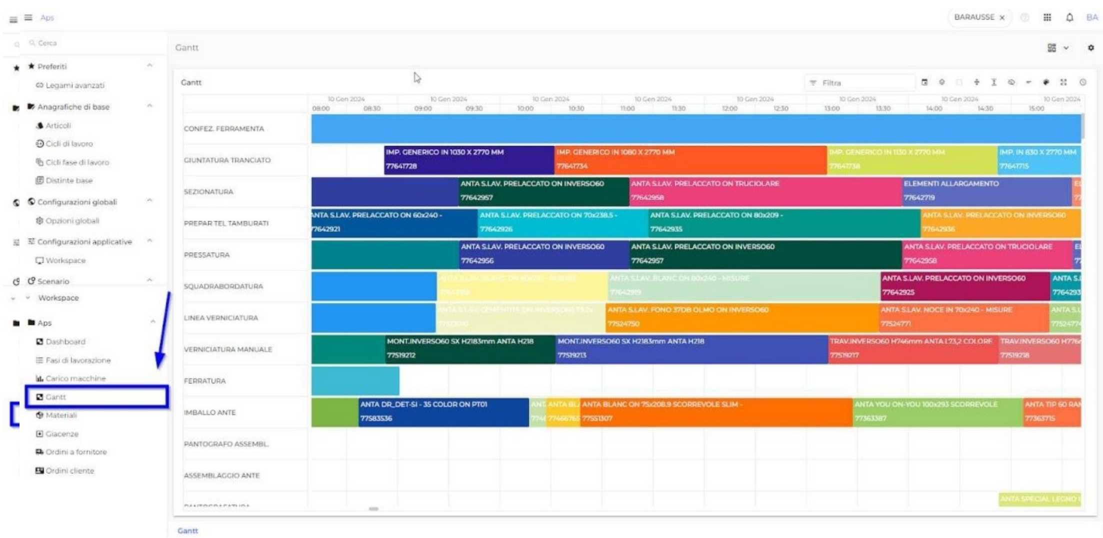

Figure 4.7 - Example of Gantt chart

4.4.4 Materials

The “Materials” workspace offers a detailed visualization (Figure 4.8) of the materials committed to various production orders, providing in-depth information on each material involved in the production process. This workspace helps planners monitor material usage, availability and potential shortages, ensuring that production runs smoothly and efficiently.

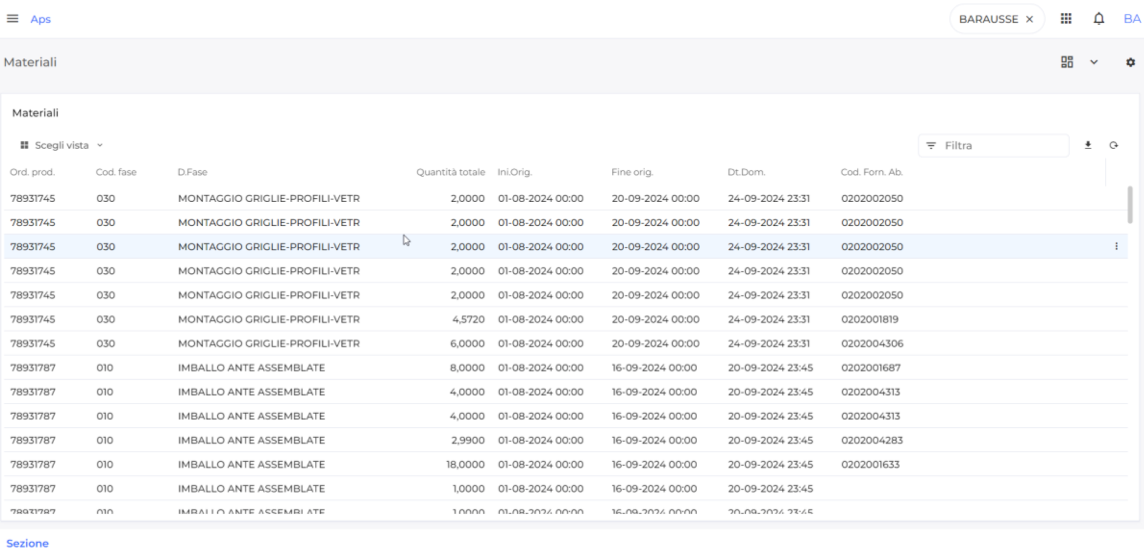

Figure 4.8 - Example of “Materials” workspace

4.4.5 Inventory

The “Inventory” workspace displays all items in the warehouse, including the available quantity and the date of the first commitment (Figure 4.9). This workspace allows planners to monitor stock levels, track inventory usage and identify potential shortages, ensuring that production requirements be met and inventory be managed efficiently.

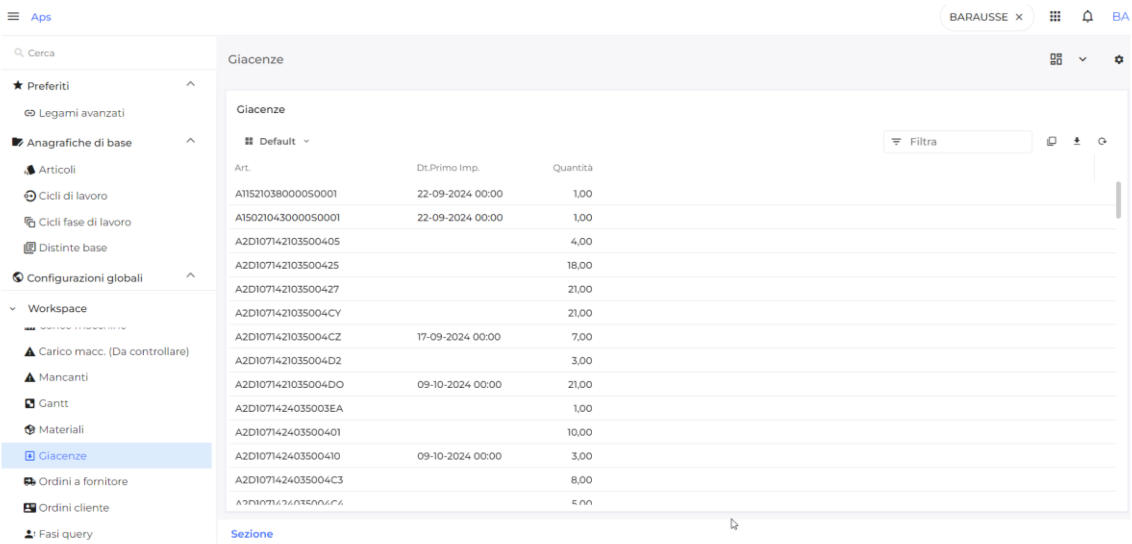

Figure 4.9 - Example of “Inventory” workspace

4.4.6 Supplier and Customer Orders

The “Supplier Orders” workspace is configured to highlight delays relative to the agreed date and the first commitment date, facilitating management and any necessary follow-ups. This workspace helps planners monitor supplier performance, track order statuses and ensure timely deliveries to support uninterrupted production.

The “Customer Orders” workspace (Figure 4.10) is designed to clearly display all customer orders and provides important details such as item codes and descriptions, quantities, delays, request and confirmation dates and order priorities. This visualization facilitates the monitoring and management of customer orders in relation to APS planning.

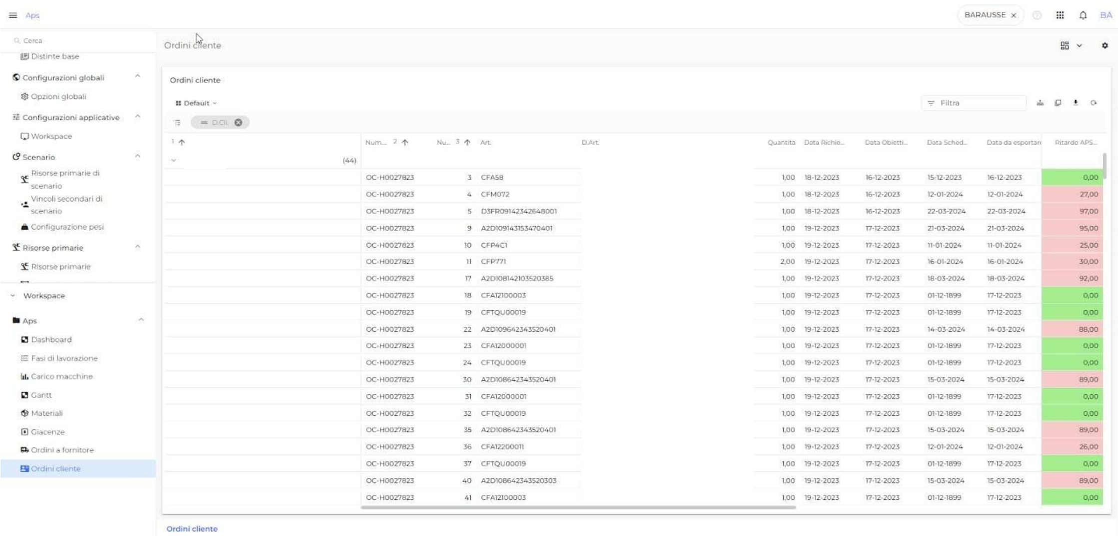

Figure 4.10 - Example 1 of “Customer Orders” workspace

A customized procedure for dating the sales order lines in the "Customer Orders" workspace has been implemented, outlined as follows.

After an ASAP scheduling of the work phases, the system proposes a scheduled date for each sales order row. This date corresponds to the end date of the production order for the item associated with that sales order.

The procedure scans all rows within each sales order and stores the "worst date" among them. The "Export Date" field for all rows is then set according to the following logic:

- For rows where "release kit rows" is not selected in Jgalileo, the worst stored date is used for all rows. This ensures that all rows have the same date, corresponding to the worst line and are shipped together.
- For rows where "release kit rows" is selected in Jgalileo, the "Export Date" field is set to the scheduled date from APS. These rows can be shipped indipendently.
- In both cases, the set export date differs from the requested date (or the confirmed date, if present) only if it is worse. This ensures consistent management of shipping dates, allowing for grouped shipments based on production and shipping needs.

The "Customer Orders" widget (Figure 4.11) displays scheduled dates that are later than the customer's requested date in red, while those meeting the deadline are highlighted in green. Additional calculated columns can be created upon the client's request to enhance the visualization of customer orders, incorporating further desired logic. Furthermore, specific views have been created to show only open or closed rows, ensuring a focused and clear presentation of information.

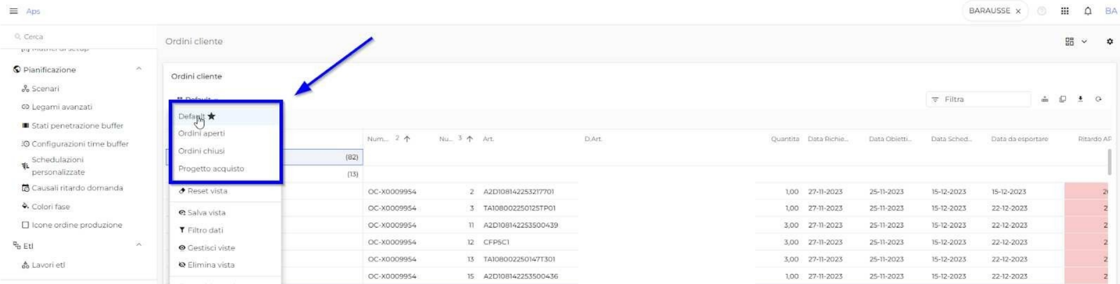

Figure 4.11 - Example 2 of "Customer Orders" workspace

In addition to importing extra fields, appropriate colour coding is applied to facilitate reading of the information. For example, (as shown in Figure 4.12), sales order rows that have not been closed are highlighted in red, consistent with Jgalileo's current practice.

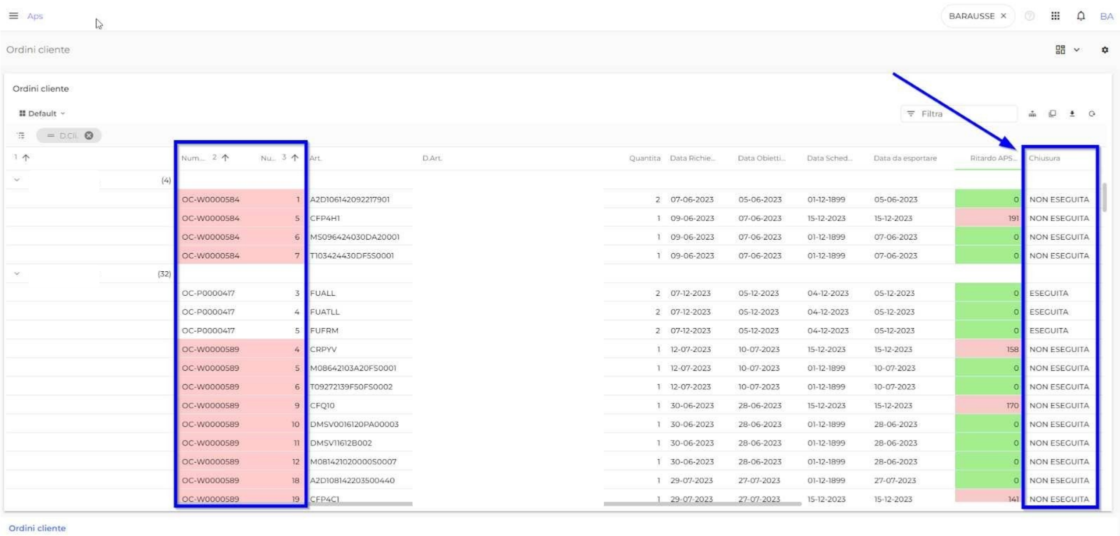

Figure 4.12 - Example of coloured rows

A procedure has been implemented to identify production orders linked to open sales orders, allowing the option to assign them different priority in scheduling compared to those linked to closed sales orders. Generally, users can customize the organization of these widgets in the various workspaces according to their preferences. APS, by offering a detailed overview of various aspects of the production processes, becomes a new control and decision support tool.

Additional workspaces have been created based on the client's specific needs to support data analysis, such as a view dedicated to missing materials, highlighting production orders with unavailable stock or without purchase/production orders covering them. Auxiliary materials, which are not considered standard when missing, do not present problems as they are not coded in the bill of materials.

The department head and other users with access to APS can view the machine workload, including the simulation of the work plan generated by the software. Additionally, the scheduling of phases in the coming weeks with missing work-in-progress or purchased materials is available, highlighted in yellow and red, respectively. The implementation also includes viewer users, with read-only permissions, ensuring secure and focused information management.

4.5 Manual adjustments of phase sequences

After a thorough analysis of the data, the planner has the ability to manually intervene in the proposed work plan, by making adjustments to the order of the phases. Using the Drag&Drop function, the desired position of a phase within the resource can be defined.

Once the desired modifications to the sequence of processing phases have been made, it is necessary to click the "Reschedule" button to allow APS to verify the feasibility of these changes. This step is crucial to ensure that the changes are coherent with the timings of the previous phases and any other system constraints.

If the modifications are feasible and comply with the planning constraints, the actual position of the phases is updated to reflect the desired order, ensuring that the scheduling remains consistent. Alternatively, a work phase can be moved to another resource using the work phase edit menu.

4.6 Data Export to Jgalileo

The last step in the APS implementation process involves exporting data from APS back to Jgalileo (Figure 4.13). The information flow returned to the ERP system includes the following:

- Production orders
- Processing phases
- Sales order rows

Along with the export, the scheduled start and end dates are updated and passed to the MES (Manufacturing Execution System) while the proposed date will be recorded in an extra field for each sales order row. However, the commitment dates for materials will not be updated. Similarly, the request and confirmation dates for sales orders rows will remain unchanged. Additionally, the actual dates, which influence the MRP (Material Requirements Planning) of purchases, are not updated. This means there is no impact on purchase proposals at this stage, though this could be considered for future development.

This approach maintains the integrity of the material commitment dates, the start and end dates of production orders, and the request and confirmation dates in sales orders. At the same time, the use of additional dates allows for more informed decision-making on both the production and commercial sides.

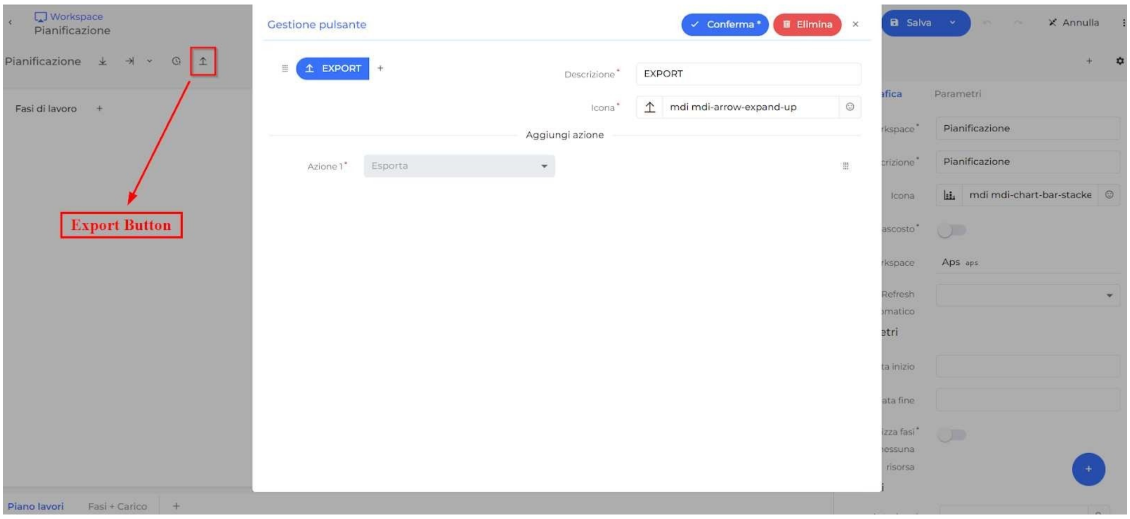

Figure 4.13 - Example of Export button

4.7 Project task monitoring

During the months of the project implementation, the various consultants involved diligently use this Excel file to monitor the progress of each task. This comprehensive tracking document is designed to ensure all activities are managed efficiently and completed on time.

Each row in the file records specific details about the tasks, including the activity description, the dates when the task was initiated and completed, and the person or team responsible for carrying out the task. The priority of each task is also clearly indicated, categorized as high, medium or low to help prioritize the workload effectively.

Moreover, the file specifies which area of the company, such as APS, ERP or General is responsible for taking ownership of the task. The current status of each task is meticulously tracked and updated, with various status options available including "To Do", "In Progress", "Done", "Approved", "Waiting for Offer" and any other relevant stages that reflect the ongoing activity.

Maintaining this detailed record is crucial for several reasons. Firstly, it allows the team to know exactly who to contact if any issues or questions arise related to a specific task, ensuring that problems can be addressed quickly and efficiently. Secondly, it provides a transparent and accurate record of the specific activities that have been requested by the client and resolved by the team. This documentation is essential for invoicing purposes, as it allows the company to provide the client with detailed information about the work that has been completed, ensuring that all tasks are billed accurately and in accordance with the client's requests.

This structured approach (Figure 4.14) not only facilitates clear communication among the team members but also provides a transparent overview of the project's status, ensuring that every task is accounted and any potential delays or issues are promptly addressed.

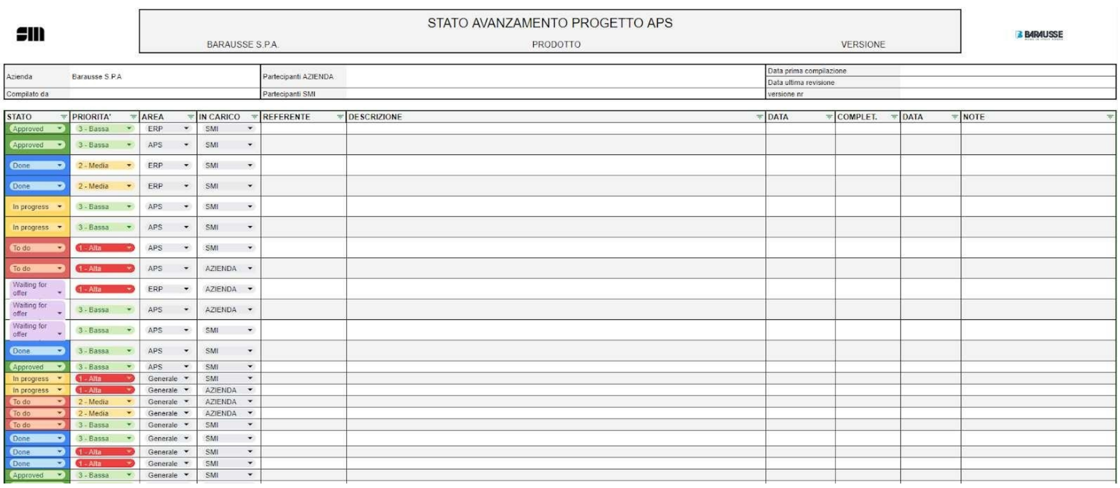

Figure 4.14 - Excel Task monitoring example

5. Conclusions

This chapter will offer a summary of the project's results, highlighting the key achievements following the implementation of the APS software at Barausse S.r.l. It will compare the initial "AS-IS" state of the company with the improved "TO-BE" state, showing the impact of the APS system on the operations. The discussion will delve into the benefits and challenges encountered during the project, aligning them with insights from existing literature to evaluate how well theory translated into practice. Additionally, the chapter will discuss the potential paths for future development of the APS system and the limitations faced during the project. Finally, the chapter will close with some final reflections on the project's outcomes, providing direction for ongoing enhancements.

5.1 Results obtained and AS-IS/TO-BE comparison

The implementation of the APS software at Barausse S.r.l. has enabled some improvements in the production planning and operational processes of the company. What follows is an in-depth analysis of the results obtained comparing the new "TO-BE" state with the initial "AS-IS" state.

Production efficiency and lead time reduction

Before the implementation the company was planning and scheduling the production manually, mainly because their MRP system worked without considering capacities and did not capture real-time constraints. The "AS-IS" state was characterized by suboptimal planning leading to potential delays, inefficient resource allocation and higher set-up times, particularly in the pressing phase. The "TO-BE" state has reduced market lead times as production orders are now better scheduled with finite capacity calculations.

More specifically, the pressing phase, which is sensitive to inefficiencies due to frequent changes in setups, benefits from APS's ability to merge orders and obtain an optimal sequence based on attributes like the species of wood and filler type. This minimizes setup times and subsequently ensures that there is an efficient production flow.

More efficient resource use and capacity planning

Resource utilization was imbalanced due to some machines that were overloaded while others were underutilized for a long time. Introducing APS, especially some features for scheduling like ALAP and ASAP, was helpful to reduce the imbalance in resource utilization. These tools also improve forecasting and planning capacity to ensure that there are no idle or overloaded machines. The “TO-BE” configuration has a better balanced machine load, which is evidenced by visuals like Gantt charts and workspaces for machine load, through which planners obtain an impression of the workloads both currently and in the future.

Enhanced Data integration and monitoring

In the "AS-IS" state data management was fragmented across the ERP system, spreadsheets and manual records. With the implementation of APS, data from multiple sources were integrated into a single platform for production planning and monitoring. This integration enables better decision-making through real-time data analysis and scenario simulations.

The "TO-BE" state enables greater visibility, improved data accuracy and immediate adjustments to production schedules based on real time inputs, such as machine breakdowns or shifts in demand. The ETL process synchronizes data between the ERP and APS, ensuring planners have access to the most current and relevant information for decision-making.

Enhanced customer order management and improved On-Time delivery

A critical issue in the "AS-IS" state was the unreliability of delivery dates because sales orders were taken without considering capacities. The new scheduler has filled this gap by offering accurate simulation of delivery dates using Call To Promise functionalities and ensuring that production schedules are matched with customer orders. As a consequence, customer satisfaction improved because the delivery commitments were realistic and achievable. The state of "TO-BE" takes care of customer orders in a better way through the workspace called "Customer Orders" improving the visibility of the statuses of the orders, possible delays and priorities. This has enabled Barausse to achieve higher levels of on-time delivery with improved customer service.

5.2 Benefits and Criticalities

As observed during the development of the project, some of the criticalities often presented in the literature have been confirmed, others have not, and some new specific challenges and benefits have also emerged. In this section, the benefits and challenges of APS typically outlined in the literature will be compared with the real outcomes noticed during the project in order to understand more accurately how APS implementation can differ in the specific case of each company.

Confirmed benefits

1. **Increased efficiency in production**: this benefit was fully confirmed in the case of Barausse. The APS system reduced lead times, especially in the pressing phase, since it optimized the scheduling of production orders and minimized setup times. The possibility to simulate different scenarios of production and consequently recalculation of the schedule in real-time proved to be a major advantage.
2. **Better resource utilization**: this was evident right from the configuration. Use of tools such as Gantt charts and machine load workspaces contributed to better visualization and decision-making, confirming what is generally argued about the use of such tools in modern manufacturing environments.
3. **Better data integration and real-time monitoring**: the integration of the ERP system with the APS platform allowed for real-time data flow and analysis, which improved the accuracy and timeliness of production decisions.
4. **Improved Customer Satisfaction**: APS system helps for better delivery date commitments and closer production scheduling to be aligned with sales orders.

Confirmed criticalities

1. **Reliance on accurate data**: this was noted during implementation, when the issues of inaccurate and incomplete data reduced the efficiency of the system in the early stages. It was really hard work to align the data from the ERP system to the APS system. In fact, data quality is indeed a critical issue as argued in the literature.

Non confirmed criticalities

1. **Resistance to change**: while the literature frequently cites organizational resistance to change as a major barrier to successful APS implementation, this was not observed in the examined case. The management and employees of the company accepted the change, recognizing the long-term benefits despite the short-term disruptions.
2. **Customization system complexity**: although this is also a potential risk, the collaborative approach between the IT team at Barausse and the software vendor allowed for a smoother process of customization. This would imply that, with proper planning and collaboration, the system customization can be managed to a higher degree of complexity than that which the literature might indicate.

Emerging criticalities

1. **Temporal inconsistencies with external suppliers:** during the initial steps, some criticalities emerged related to managing delivery dates from external suppliers. The importance of synchronizing internal and external workflows became evident, which also signals that there is a gap in the literature regarding external supplier management.

2. **Management of non-standardized work phases:** the management of non-standardized work phases, such as those related to unplanned orders or specific production cycles, presented unexpected challenges. This required the implementation of customized aggregation logics and the creation of specific views to monitor these processes.

In short, the implementation of the APS system at Barausse has shown most of the benefits and challenges described in the literature to be true. However, new emerging challenges, compared to what is generally argued in the literature, were related to the complexity of customizations to make the system fit the individual requirements of the company. However, on the whole, the positive aspects of using the system significantly overcome the negative ones, which stresses another important factor: proper planning and techniques of project management should be provided to achieve a successful implementation.

5.3 Future developments and Research Limitations

The implementation of the APS system at Barausse has established a solid foundation for more efficient production planning and scheduling. However, there are still several opportunities for further development to improve the system's effectiveness. This section outlines key areas where advancements could be made and discusses the limitations of the current research, providing directions for future exploration.

Incorporating AI and IoT capabilities: a possible future development is integrating Artificial Intelligence (AI) and Internet of Things (IoT) technologies into the system. AI can be leveraged to better anticipate demand trends, refine scheduling and improve resource management by analyzing historical and real-time data. Similarly, IoT devices could deliver real-time updates from the production floor enabling more agile and precise planning.

Enhanced scenario modelling and planning: there is potential to develop more advanced simulations tools. Expanding these capabilities would allow for modelling a wider range of possible disruptions, such as supply chain interruptions or rapid changes in demand, giving companies the possibility to mitigate unexpected events.

The project also had some limitations.

Lack of KPI assessment: due to time constraints, the project did not include an in-depth analysis of Key Performance Indicators (KPIs) after implementing the APS system. Conducting this evaluation, about production efficiency, delivery reliability and inventory turnover, would be essential for a comprehensive assessment, especially after the system has been in use for a sufficient period.

User training and adaptation: APS system is complex and demands continuous user education and adaptability. In the future, it is important to make the user interface simpler, reducing the learning curve and creating adaptable training programs that grow with new updates and functionalities.

5.4 Final comments

The implementation of the APS system at Barausse S.r.l. represents an advancement in the company’s digital transformation journey. The transition from the AS-IS to the TO-BE configuration highlighted the strategic value of adopting advanced planning and scheduling tools in modern manufacturing environments. By integrating the software with existing systems, the company achieved improvements in production efficiency, resource management and overall operational visibility as intended in the initial objectives.

Critical challenges, such as setup time optimization and alignment of the production schedule with the capacity of resources, are supported by the APS system, helping to reduce lead times and enhance customer satisfaction. However, the project also revealed other challenges, particularly concerning the customization needed to tailor the APS system to Barausse's unique production environment and logics or issues related to data accuracy and user training, which underscore the importance of a well-planned and carefully managed implementation process.

To conclude, the project demonstrates that, when digital tools are effectively implemented and tailored to a company's specific needs, they can significantly optimize operational efficiency.

The study contributes to the process of understanding the APS software use in a manufacturing environment. The insights from this provide a basis for further developments and offer valuable lessons for its implementation at other manufacturing companies.

A.1 Register of questions for APS implementation

FIRST PART: GENERAL INFO, PRODUCTION TOUR

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1. **Brief introduction of the company**

   (E.g. History, markets, products, employees, turnover, industry)

2. **What are the objectives of the meeting?**
3. **View of a typical production process from raw material to finished product** (E.g. For a significant item: processing steps, machine tools, machining centers, MP magazines, WIP, and PF)

SECOND PART: PROCESSES AND PRODUCTION PLANNING

---

1. **What is the company's production model?**

   (E.g. ETO, MTO, ATO, MTS)

2. **What are the main departments and main processes that are carried out?**

   (E.g Production cycle for a significant item)

3. **Is a layout of the plant available?**
4. **How are customer orders and/or sales forecasts handled today? Is there a priority?**

   (E.g. Customer demand, setup time optimization, constraint saturation, flow time)

5. **How are production orders generated?**
6. **Is Lean Production being used?**
7. **How is production order planning done? Which departments and resources are scheduled and which are not? Are you used to produce in advance and if so with what period?**
8. **Does the company use an MES system (Manufacturing Execution System)?**
9. **Are there any weaknesses with regard to current processes?**
10. **How do you expect APS to support current business processes?**

THIRD PART: SANMARCO’s ERP (Jgalileo)

1. **Are sales forecasts used for planning purposes?**
2. **Master data situation: items, work cycles, bills of materials**
3. **Is it possible to see the BOM of a significant article?**
4. **Is it possible to see the processing cycle of a significant item**

   (E.g. Cycle times, equipment, moulds, other constraints, attributes)

5. **Is there grouping logic by phase attributes?**
6. **What are the working centers and machine tools?**

   (E.g. Capacity, shifts, hours, manual departments with how many people, what are the finite/infinite capacity resources)

7. **Are there production orders without phases?**
8. **When are material withdrawals and disbursement of production orders made?**

FOURTH PART: OTHER ERP

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1. **What are the login credentials?**
2. **Is it possible to get the management tracks?**
3. **Analyze completeness of information needed for APS**

   (E.g. Customer orders, supplier orders, inventories, production orders (machines, estimated times, phase, cycle), item master, production cycles, bills of materials, phase attributes and constraints, resource and work centers)

FIFTH PART: CLOSING REMARKS

1. **Is additional documentation required?**
2. **Recap APS objectives regard to the issues that exist in the company today**
3. **Who will be the contact person for the project? And who will be the key users to be trained?**
4. **What will be the level of involvement of the different departments?**

(E.g. Production, purchasing, commercial and others)

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