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The Implementation of SAP S/4HANA for the Optimization of the Quality Management System in a Metal Packaging Company

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Abbreviations and Acronyms

6S – Sort, Set in Order, Shine, Standardize, Sustain, Safety
AMS – Application Management Services
AP – Purchasing Function
AS400 – Application System/400 (IBM legacy system)
ASP – Automatic Storage Management
BP – Business Partner
BPA-NI – Bisphenol A Non-Intent
DPY – Device Parity Protection
ERP – Enterprise Resource Planning
ESG – Environmental, Social and Governance
FCS – Food Contact Substance (US FDA context)
FDA – Food and Drug Administration
FI – Financial Accounting (SAP module)
FIORI – SAP's design language for user interfaces
FMEA – Failure Modes and Effects Analysis
GMP – Good Manufacturing Practice
INCOTERMS – International Commercial Terms
ISO – International Organization for Standardization
IT – Information Technology
KPI – Key Performance Indicator
LCQ – Quality Control Laboratory Function
LIC – Licensed Internal Code

LPAR – Logical Partitions
MM – Materials Management (SAP module)
MOCA – Materials and Articles Intended to Come into Contact with Food
MRP – Material Requirements Planning
OH&S – Occupational Health and Safety
OTIF – On-Time In-Full (delivery metric)
PDCA – Plan-Do-Check-Act (continuous improvement cycle)
PGQ – Quality Management Procedure
PM – Plant Maintenance (SAP module)
PO – Purchase Order
PR – Purchase Requisition
PRD – Production Function
PSQ – Quality Support Procedure
PUR – Purchasing
QC – Quality Control Function
QM – Quality Management (SAP module)
QMS – Quality Management System
REACH – Registration, Evaluation, Authorisation and Restriction of Chemicals
S/4HANA – SAP Business Suite 4 SAP HANA
SAP – Systems, Applications and Products in Data Processing
SAP ECC – SAP ERP Central Component
SD – Sales and Distribution (SAP module)
SDS – Safety Data Sheet
SLIC – System Licensed Internal Code
TEC – Technology Function
TIMI – Technology Independent Machine Interface
VOC – Volatile Organic Compounds
ZM01 – Custom document type for purchase order
ZML – Custom document type for non-stock purchase requisition
ZRLL/ZRL – Custom delivery types for returns

Abstract

The metal packaging industry, particularly in the food sector, operates in an environment characterized by increasingly stringent regulatory, quality, and sustainability requirements. In this context, digital transformation through advanced ERP systems has become essential to ensure compliance and maintain long-term competitiveness. This thesis explores the implementation of SAP S/4HANA as a lever to optimize the Quality Management System (QMS) in a company specializing in coatings and inks for metal containers intended for contact with food. The study is based on a real case and analyzes how the migration from a fragmented legacy system (AS400) to SAP S/4HANA, with a focus on the Material Management (MM) module, can address operational inefficiencies, support regulatory compliance (ISO 9001, ISO 22000, REACH, FDA), and improve quality control processes. The analysis follows the five phases of the SAP Activate methodology (Prepare, Explore, Realize, Deploy, and Run), focusing on system configuration, process mapping, master data alignment, and Business Partner parameterization. The results indicate that the adoption of SAP S/4HANA has significantly improved the company's ability to manage complex production processes, ensure data accuracy, and strengthen traceability throughout the supply chain. Real-time access to quality key performance indicators (KPIs), automated audit documentation, and improved integration between departments have helped reduce errors and speed up decision-making. In addition, the transition has enabled the adoption of more sustainable practices, such as digital label management, VOC emissions monitoring, and alignment with MOCA and environmental regulations. Although innovation was not the initial goal of the ERP transformation, the results demonstrate that SAP S/4HANA has created a digital foundation that indirectly fosters innovation by providing better control, standardization, and data-driven decision-making. By integrating quality, compliance, and sustainability into a unified system, the project demonstrates how ERP platforms can serve as enablers of strategic transformation in highly regulated industries.

Introduction

The aim of this paper is to describe and analyze a real case of digital transformation of business processes, with particular reference to the implementation of a new ERP system to support the Quality Management System (QMS) in a company operating in the food packaging coatings sector. The importance of integrated and digital process management is now essential for companies operating in a highly competitive and regulated environment, where quality, traceability, and regulatory compliance are critical success factors. In this scenario, ERP systems are fundamental tools for supporting process integration along the entire value chain. Among these, SAP S/4HANA is one of the most widely used and appreciated solutions globally for its ability to enable real-time analysis, simplify operations, and ensure complete control over business activities. However, a review of the literature highlights that there are still few detailed accounts of real-world implementations of SAP S/4HANA in the quality and regulatory field, especially in complex sectors such as food packaging, where stringent requirements (MOCA, GMP, REACH, FDA) and complex processes are involved. This observation has led to the need to fill this gap with this thesis, which aims to provide concrete evidence of a digital transformation project developed during a curricular internship. The project analyzed was carried out at **DIGIX PLUS SRL**, a young and dynamic digital consulting company founded in 2019, with headquarters in Milan and a second office in Turin. The company, which has about 30 professionals and apprentices, is an SAP Gold Partner and ARXivar Partner, and offers support to companies in various sectors in their transition to more efficient and integrated digital models. Within this stimulating and collaborative context, characterized by an open-space environment that encourages the exchange of ideas and teamwork, I had the opportunity to develop my skills by actively participating in a strategic project for an important manufacturing company. My company tutor, Emanuele Cottonaro, an SAP consultant with over 15 years of experience, guided me through all stages of the process, supporting me not only in analysis and design, but also during the delicate Go-Live phase. The thesis is divided into five chapters, each of which addresses a key aspect of the project and the digital transformation observed. The **first chapter** introduces the sectoral and regulatory context, highlighting the challenges and opportunities that companies in the food industry face in ensuring quality, traceability, and compliance. It also explores the strategic role of ERP systems as a lever for process integration throughout the supply chain. The **second chapter** explores the theoretical foundations of the Quality Management System, analyzing international standards (ISO 9001, ISO 22000) and the main continuous improvement methodologies (PDCA, 6S), which are fundamental for understanding the reference framework in which the project is set (Agus et al., 2020). The **third chapter** describes the initial scenario of the client company, analyzing in detail the critical issues of the existing information systems and “as-is” processes. The fragmentation of the

platforms (AS/400, SharePoint, Selerant) and the operational difficulties associated with manual information management and the lack of integration between the various business functions are highlighted. This analysis made it possible to identify the main gaps that the new ERP will have to fill, particularly in the procurement, production, logistics, and non-compliance management processes. The **fourth chapter** presents the strategic and operational reasons that led to the choice of SAP S/4HANA, documenting the migration path and the methodology adopted. The SAP Activate framework and the Greenfield approach were used to ensure a secure and flexible transition, minimizing risks and downtime (Bhatia, 2025). It also highlights how the company has planned the implementation of the SAP Plant Maintenance (PM) and Quality Management (QM) modules for the next phases, with the aim of further expanding functional coverage and improving the integrated management of maintenance activities and quality processes. Finally, the **fifth chapter** forms the core of the paper and describes in detail the activities carried out during each phase of the project. Particular attention is paid to the configuration of the SAP MM module, the introduction of KPI monitoring tools, the digitization of approval flows, and the optimization of the quality system. The results obtained were also validated through a post-Go-Live feedback campaign, using questionnaires distributed to all users involved. The results showed a satisfaction rate of over 85% in all areas analyzed, confirming the effectiveness of the change management strategy and the value added by the project. These findings are in line with studies linking the adoption of integrated systems and ISO standards to a reduction in non-quality costs and improved internal satisfaction (Jannah et al., 2020).

Chapter 1 – Introduction to the company and the work context

The effectiveness of task performance consists of the achievement of specific results (i.e. outcomes) required by the task itself through specific actions, maintaining or being consistent with the policies, procedures and conditions of the organizational environment. At the same time, the performance of a team is the result of the actions and collaboration of team members. Consequently, high team performance requires high individual performance of team members and effective collaboration between them.[1] Attempts to define, evaluate and manage performance have required studying the nature, factors and conditions of achieving high performance within an organization. Some authors emphasize the link between performance and skills, that is, "certain characteristics or abilities of the person that enable him or her to demonstrate the appropriate specific actions". Furthermore, an explanation of people's behavior requires that personal, contextual and behavioral factors are taken

[1] Magrini, A., Pelagalli, M. F., Pietroiusti, A., Livigni, L. U. C. I. L. L. A., Guidi, S., Moscatelli, M. A. U. R. I. Z. I. A., ... & Bagnara, S. (2015). La valutazione approfondita dello stress lavoro correlato in una grande azienda in cambiamento. *Med Lav*, *106*, 250-260.

into account. The most commonly studied and influential concepts regarding the work context are organizational culture, organizational climate and managerial skills. Organizational culture is defined as a set of basic assumptions shared, invented, discovered, or developed by a particular group. Some scholars argue that culture has a major influence on employee competencies. Unlike organizational culture, organizational climate describes the effect of different aspects of organizational environment, artifacts, and interactions on a person's personal feelings and motivation. Organizational climate is related to motivation and influences a person's personal feelings about work, interest, and concern for the customer group's conditions of innovation and creativity.[2] Overall, there is evidence of a concrete impact of workplace contextual factors on employee competencies and performance. The skills, abilities, attitudes, knowledge, and other characteristics of all employees should be activated and demonstrated in specific behaviors to be transformed into competencies and achieve job performance benefits. Organizational culture influences employee behavior by influencing a person's mental, emotional, and attitudinal states that influence effective performance. Ott (1989) has shown that the link between culture and effective performance is provided by:

1. shared pattern that follows employees' interpretations and ways of behaving;
2. from an emotional sense of involvement and commitment to organizational values to commitment and involvement at work.

The concept of organizational climate has been used at the team level. Each manager has his or her own behavioral model and management philosophy, based on assumptions, generalizations of past experiences and formulated hypotheses. Managers communicate values, norms and beliefs about the organization, its mission and goals, customers, partners and employees. Consequently, this influences how organizational culture and its strengths are perceived and shared by employees. In addition, managers can support, energize, inspire, or push, punish and frustrate subordinates. Their behavior influences employees' feelings towards themselves, team members, managers and third parties.[3] They create an emotional atmosphere that influences employees in a team. Manager behavior affects all aspects of work, employee perceptions and feelings about the organization, the team and the job itself. As a result, managers can directly or indirectly influence employee behavior by enhancing and supporting or weakening certain competencies. The theoretical constructs are related to employee performance, competencies and work context, which formed the theoretical framework for this

[2] Gherardi, S., & Murgia, A. (2015). L'in-sicurezza sul lavoro tra imposizioni formali e pratiche quotidiane: un'introduzione. *Studi organizzativi*, (2015/1).
[3] Silvia, D. R., Maddalena, S. M., Laura, B., & Alberto, S. Il feedback a 360 è collegato al successo lavorativo? Un contributo di ricerca nel contesto italiano.

research. The framework consists of constructs (factors) that are related to each other based on existing theory and some previous research described above. The framework assumes that organizational culture, team climate and manager competencies influence employee competencies. Contextual factors in the workplace (including organizational culture, team climate and manager competencies) were generally expected to influence employee competencies and performance. The dependent variables include employee competencies and performance.[4] The independent variables of the competency model are managerial competency dimensions, team climate, constructs and types of organizational culture. Moderating variables include age, gender, education, experience, industry, job family, and team size, etc. These variables have potential influence on the dependent variables. They should be controlled during the study. Managerial competencies are defined as the behavioral pattern and management philosophy of the manager, based on assumptions, generalizations of previous experiences, and formulated hypotheses. Managerial competencies are described by 12 variables. The hypothesized relationships presented below were formulated at a high level of abstraction. However, the study tested all combinations between the variables of each factor of the context-based competency model, described above. Organizational culture integrates patterns of human behavior, including ways of thinking, speaking, and acting. Organizational culture influences employee behavior by influencing a person's mental, emotional, and attitudinal states that influence effective performance, shared patterns that follow employee interpretations, and ways of behaving and controlling systems.

The first general hypothesis (H1) for this study aims to test:

Hypothesis H1: *Organizational culture has a strong effect on employee competencies.*

Team climate can change previously acquired behavioral tendencies and behavior patterns observed by group members. It is related to motivation and influences personal feelings about a person's work, concern and attention to the conditions of innovation and creativity of the customer group.
Accordingly, the second general hypothesis (H2) for this study aims to test[5]:

[4] Angelini, E. Competizione funzionale e disfunzionale all'interno dell'azienda. Due casi Introduzione.
[5] Gherardi, S., & Murgia, A. (2015). L'in-sicurezza sul lavoro tra imposizioni formali e pratiche quotidiane: un'introduzione. *Studi organizzativi*, (2015/1).

Hypothesis H2: Team climate has a strong effect on employee competencies.

A manager's behavior influences all aspects of employee work, perceptions and feelings about the organization, the team and the work itself. Accordingly, managers can directly or indirectly influence employee behavior, enhance and support or suppress some employee competencies.
The third general hypothesis (H3) for this study aims to test[6]:

Hypothesis H3: Managers' competencies have a strong effect on employees' competencies.

Competences are able to distinguish superior performance from average performance, or effective performance from ineffective performance in the workplace. Superior performance is defined as the performance of the top 10-14% in a given position, with a known economic added value based on performance deviation (up to 48% increase in productivity in a non-sales job and up to 120% in a sales job) and an explicit approach to benchmarking and development.
Accordingly, the fourth general hypothesis (H4) for this study aims to test:

Hypothesis H4: Employees with higher scores on key competencies have higher levels of performance.[7]

The research framework and reviewed literature suggest that managers' communication influences how organizational culture and its strengths are perceived and shared by employees. Furthermore, managers influence team climate. A manager's behavior influences all aspects of employees' work, perceptions and feelings about the organization, the team and the job itself.
Accordingly, the fifth general hypothesis (H5) for this study aims to test:

Hypothesis H5: Managerial competencies have a strong effect on organizational culture and team climate.

The hypothesized relationships indicated above describe the relationships between the constructs in the theoretical framework. Testing these proposed hypotheses

[6] Silvia, D. R., Maddalena, S. M., Laura, B., & Alberto, S. Il feedback a 360 è collegato al successo lavorativo? Un contributo di ricerca nel contesto italiano.
[7] Angelini, E. Competizione funzionale e disfunzionale all'interno dell'azienda. Due casi Introduzione.

helps to investigate the effect of workplace contextual factors and individual competencies and performance. The formulated hypotheses require a quantitative approach to be tested.[8] The research methodology is developed to test the hypothesized relationships. Competencies can have few dimensions with numerical levels of behavioral indicators. Each item in a cluster described one of the four types of culture[9]. A 100-point scale was used. Respondents were asked to distribute the 100 points among the statements. Statements that more accurately described the organization received more points. The sum of all points distributed among the statements was expected to equal 100.

1.1 Company Overview

The company under analysis was founded in the second half of the 1980s, following the acquisition of an industrial branch active in the chemical coatings for metal sector, with specific specialization in metal packaging for the food sector. Since its foundation, the company's mission has been to provide high-performance chemical solutions, capable of responding to the needs of safety, characteristics and regulatory compliance required by the market.

In its first years of activity, the company invested heavily in the research adopted, creating structures dedicated to the development of new statements and technical assistance to customers. At the same time, it developed its production capacity with the opening of a second site in Southern Italy, dedicated to the reproduction of lithographic inks for metal. In this same period, the company employed full technical and commercial responsibility for the business, circumscribing its own autonomous industrial identity.

During the 1990s and 2000s, the company experienced a succession of corporate developments. Initially limited to participation by an international group, the company gradually redefined its legal and operational structure. Specifically, in the second half of the 1990s it underwent a profound ownership and organizational reorganization, which led to the strengthening of a more integrated industrial model, which ended with the change of actual company name.

During this period, various international players expressed interest in acquiring the entire share capital of the company, identifying its strategic value.

Nonetheless, the management consciously evaluated maintaining self-management and internal control, once again throwing away acquisition offers aimed at totally absorbing the company in

[8] Magrini, A., Pelagalli, M. F., Pietroiusti, A., Livigni, L. U. C. I. L. L. A., Guidi, S., Moscatelli, M. A. U. R. I. Z. I. A., ... & Bagnara, S. (2015). La valutazione approfondita dello stress lavoro correlato in una grande azienda in cambiamento. *Med Lav*, *106*, 250-260.

[9] Silvia, D. R., Maddalena, S. M., Laura, B., & Alberto, S. Il feedback a 360 è collegato al successo lavorativo? Un contributo di ricerca nel contesto italiano.

multinational companies. This evaluation marked a turning point for future development: the company favored continuing to invest as an independent group, pooling resources on quality, renewal and international strengthening.

A particularly important moment is reproduced by the start, in the early 2000s, of an international expansion development that led to the creation of new foreign executive offices and strategic collaborations, specifically in the American continent. This phase has been supported by a significant use in industrial automation and digital traceability of production batches, through the inclusion of RFID technologies.

More recently, an ambitious digital transformation program has been driven by the implementation of the SAP S/4HANA ERP system, which is being carried out with the Go-Live phase at the beginning of this year. This project aims to optimize operational efficiency, enhance integration across business functions and consolidate the quality management system, specifically along the supply chain, production, and logistics.[10]

Figure 1 below illustrates the main historical milestones in the company's development.

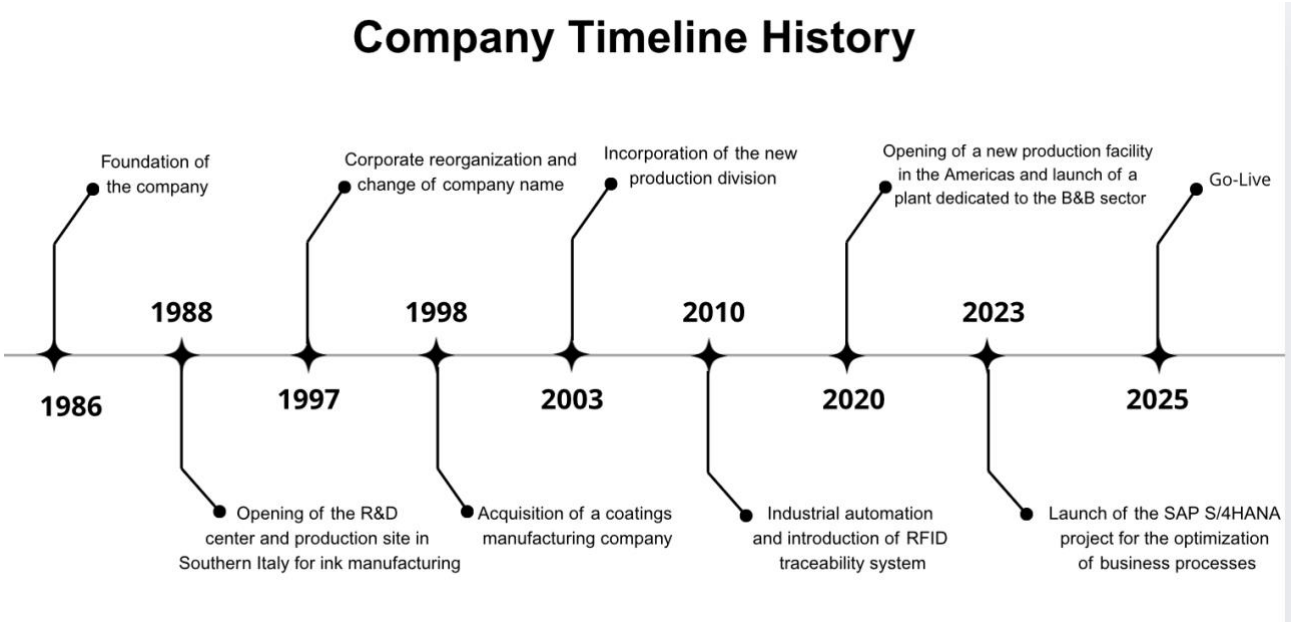

Figure 1 - Timeline of the Company's History

A fundamental principle of the business model is maintaining strong relationship with suppliers. The organization has always applied a stringent selection and continuous monitoring system, evaluated

[10] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.

each partner not only based on financial performance but also on principles such as quality, reliability, chemical safety, and adaptability. Audit activities, qualification systems and ESG (environmental, social and governance) criteria are included in procurement developments, with the aim of ensuring coherence throughout the entire supply chain.

The company is also recognized for its strong focus on research: the central laboratory, located at the main headquarters, is a true center of expertise, where hundreds of new formulations are tested and improved every year. The goal is twofold: on the one hand, to respond promptly to customer needs; on the other, to anticipate regulatory and technological developments in the food and environmental sectors. The company is currently the operational hub of an integrated and continuously evolving chemical group operating on a global scale. The combination of in-house know-how, specialized production methods, managerial independence, and constant commitment to quality has allowed the group to consolidate its competitive positioning, becoming a benchmark for producers of metal packaging intended for food applications.

1.2 Sector and scope

The metal packaging sector, in which the company under study works, involves highly specialized employment within the packaging industry. This sector includes the production of internal and external coatings for metal containers, such as cans, caps, spray cans, tubes, and capsules, mainly for the food and beverage industry. These are implementations that require high technical performance and full compliance with strict regulations, as the materials used come into direct contact with food.[11]

The metal packaging production chain is organized and involves different players: metal producers (steel, aluminum), transformers, decorators, and suppliers of chemical coatings, such as paints and inks.[12] The case study company is located at the beginning of this supply chain, in an upstream position, and supplies functional chemical products such as primers, internal coatings, paints and inks which are then applied to metal surfaces before they are transformed into containers. In this strategic role, the company explicitly contributes to regulatory compliance and the safety of the final packaging, influencing product quality throughout the downstream chain. Its activity is therefore a

[11] Capuano, A. (2021). *Imballaggi leggeri in metallo: dal packaging all'analisi economica di un campione di imprese in Italia= Light metal packaging: from packaging to economic analysis of a sample of italian companies* (Doctoral dissertation, Politecnico di Torino).

[12] Atienza, A., Sinagra, C., Moschini, A., & Minutolo, F. C. (2009). METODICA PREDITTIVA PER LA VALUTAZIONE DEI DIFETTI SU LAMINATI SOTTILI IN LEGA AA3005 PER IL SETTORE PACKAGING DERIVANTI DA INCLUSIONI SOLIDE NEI BAGNI DI FUSIONE. *la metallurgia italiana*.

critical technical link, essential to ensuring the performance of materials in the food, beverage, pharmaceutical, and cosmetic sectors.

The main area of application is represented by the food and beverage industry, with a particular focus on beverage cans, food cans, screw caps, bottle caps, and containers for dairy products, sauces or ready-made foods. In a more limited survey, the case study company also contributes with customers active in the pharmaceutical and chemical sectors, in applications that require high performances in terms of chemical resistance, sterilization or sealing. In recent years, the sector has undergone an acceleration towards environmental sustainability, driven by increasingly stringent regulations, growing consumer awareness and the objectives of a circular economic promoted by European institutions. In this context, compliance with international regulations is a fundamental requirement.

Companies in this sector must comply with a series of regulations that establish stringent principles regarding material safety, production development, and the use of chemicals. Specifically, the European regulatory framework is based on three fundamental pillars:

- Regulation (EC) No. 1935/2004 establishes general principles for materials and articles intended to come into contact with food (MOCA), ensuring that they do not transfer substances to food in quantities that could endanger human health or alter the food's composition, taste, or smell;
- Regulation (EC) No. 2023/2006 establishes Good Manufacturing Practice (GMP) for the production of MOCA, ensuring that manufacturing processes are constantly monitored and documented to guarantee the safety and quality of the materials and finished articles;
- Regulation (EC) No. 1907/2006 (REACH) regulates the Registration, Evaluation, Authorization and Restriction of Chemicals, requiring manufacturers and importers to evaluated and manage the risks associated with chemical substances in order to protect human health and the environment.

In addition, these are US regulations issued by the FDA (Food and Drug Administration)[13], which establish similar principles for products intended for the American market. Table 1 provides a summary of the relevant regulations, highlighting their scope and geographic area. This set of regulations represents the regulatory basis for the design, manufacture and control of chemical coatings used in food metal packaging.

[13] di Igiene, R. P. G. Public Health Service/Food and Drug Administration. 2011 Revision.

Regulation	Scope	Geographic Area
Regulation (EC) No 1935/2004	Materials and Articles Intended to Come into Contact with Food (MOCA)	European Union
Regulation (EC) No 2023/2006	Good Manufacturing Practices (GMP) for food contact materials	European Union
Regulation (EC) No 1907/2006 - REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals	European Union
FDA Regulations (Title 21 CFR)	US regulations for substances in contact with food	United States

Table 1 - Overview of Key Regulations for Chemical Coatings in Food Metal Packaging

According to a report published by Fortune Business Insights (2023), the global metal packaging market reached an estimated value of $146.7 billion in 2023, with a forecast to grow to $194.68 billion by 2032, driven by a compound annual growth rate (CAGR) of 3.26%.

This projection highlights the sector's continued strength, supported by the versatility of metal, the increasing demand for sustainable packaging solutions, and the material's ability to provide protection and durability over time.

CAGR (Compounded Annual Growth Rate)[14] represents the average annual growth rate of an investment or market value over a specified period, assuming constant growth. The formula used to calculate CAGR is as follows:

$$\mathrm{CAGR}(t_0, t_n) = \left(\frac{V(t_n)}{V(t_0)}\right)^{\frac{1}{t_n - t_0}} - 1$$

Where:

- t_0: initial year
- t_n: final year
- $V(t_0)$: initial value at time t_0
- $V(t_n)$: final value at time t_n

This formula makes it possible to determine the "average" annual growth rate which, if adopted regularly, would lead from the initial value to the final value in the evaluated interval. It is particularly useful in market analyses with long-term representations, such as in the case of estimating the development of the global metal packaging market from 2023 to 2032.

[14] Das, A., & Mishra, R. R. (2020). Compound annual growth (CAGR) rate of fresh tea leaf (Camellia sinensis) production in Assam: a statistical approach. *Available at SSRN 3728002*.

Figure 3 graphically shows this estimated growth. The annual values were calculated by adopting the growth rate established at the initial value of 2023, thus providing a reproduction of the constant and subsequent expansion of the market over the reference period.

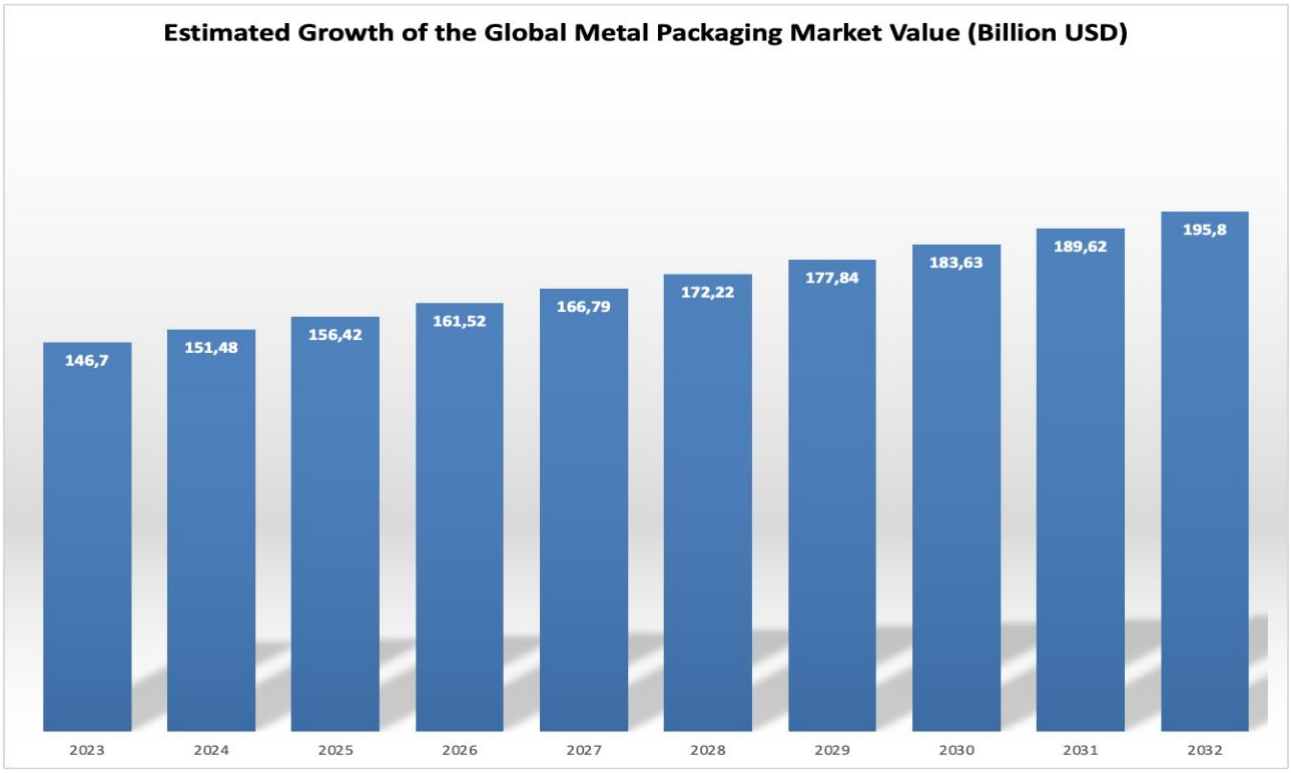

Figure 2 - Estimated growth of the global metal packaging market value (2023-2032)

Another fundamental analytical principle to segment the sector involves dividing the market by product classification. In the absence of publicly available and accessible numerical data that illustrating the composition of the global metal packaging market based on product classification, a reasoned estimate approach, based on qualitative principles, has been adopted.

Six major categories, commonly identified in key industry reports (Fortune Business Insights, Mordor Intelligence, Markets and Markets)[15] were considered: beverage cans, food containers, technical closures, aerosols, industrial drums and a residual category indicated as "Others".
For each of these categories, the following four criteria were evaluated:

1. Global production volume, estimated global quantity produced for each category;

[15] Insights, F. B. (2022). Fortune Business Insights. *February. Accessed October*, *10*, 2022.

2. Average unit value of the product, estimated average economic value of each unit of the product;
3. Number of sectors served, number of industrial sectors in which the category is used;
4. Expected growth trend, future growth projections for each segment according to market trends.

Each category was assigned a score from 1 (low) to 5 (high) for each criterion, based on qualitative insights available from market reports and an evaluation of its perceived relevance within the production chain.
The sum of these scores resulted in a total score for each category. These totals were then normalized to the overall sum, resulting in a percentage-based estimate of each segment's weight within the total market. Below the result of this analysis:

Category	Global Production Volume	Average Unit Value	Number of Sectors Served	Growth Trend	Total Score	Estimated Market Share (%)
Beverage cans	5	3	4	5	17	30
Food containers	4	4	4	4	16	28
Technical closures	3	4	3	3	13	20
Aerosol cans	3	3	3	3	12	12
Industrial drums	2	5	2	2	11	7
Others	1	2	1	2	6	3

Table 2 - Estimated market share of metal packaging market segments based on qualitative criteria

Table 2 presents the six main product categories, evaluated according to four criteria (production volume, unit value, number of sectors served, and expected growth). The resulting scores were normalized to provide an estimated percentage share of each segment within the global metal packaging market.

Figure 3 illustrates the estimated market share distribution across these product categories.

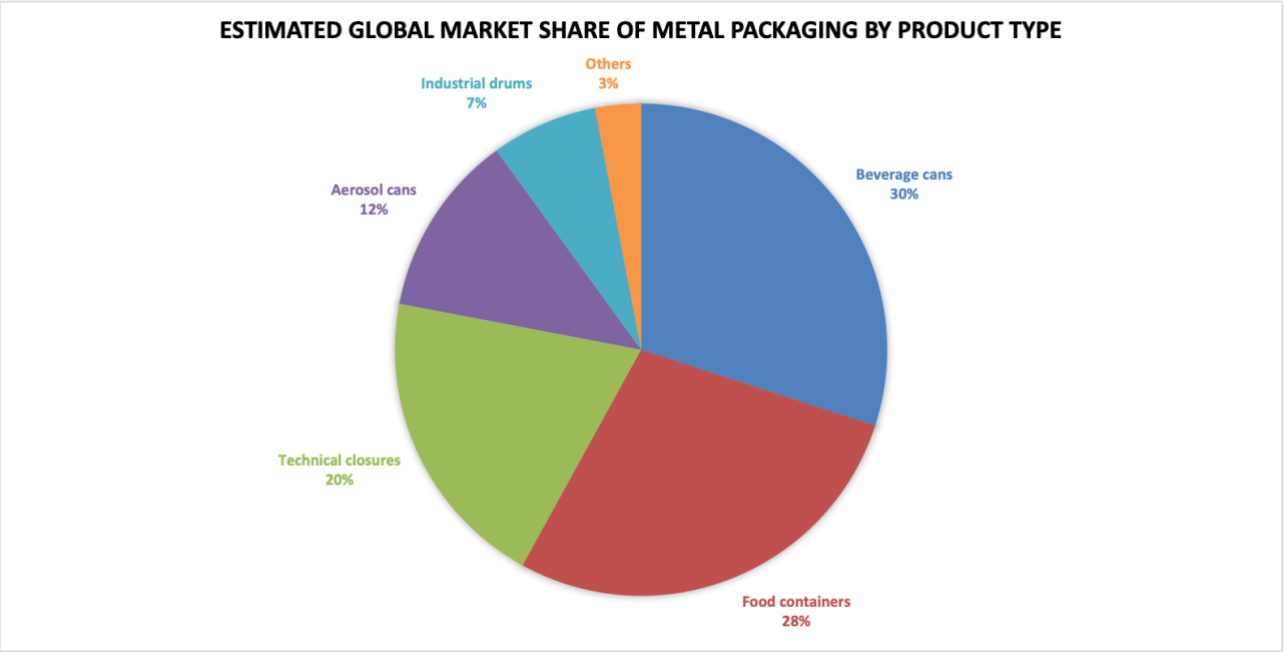

Figure 3 - Estimated global metal packaging market distribution by product category

Figure 3 accurately shows the overall market composition of metal packaging by product classification. As highlighted in the graph, beverage cans represent the most important segment, with a market share of 30%, followed by food containers (28%) and technical closures (20%). These three categories together account for almost 80% of overall demand, demonstrating the centrality of these products within the supply chain.
Aerosols account for approximately 12% of the market, while industrial drums cover a more modest share, equal to 7%. Finally, a residual item recognized as "others" covers 3%, including special products or products intended for niche markets.

Although based on a qualitative estimate, these figures reflect trends considered in fundamental sector reports and provide a useful framework to understand the production history and evolutionary depth of the sector. The aim is to provide an order of magnitude useful to represent the market structure, in the absence of publicly available official data. The high percentage of containers used in the food and beverage sector indicates the need to maintain stringent standards of chemical safety, coating quality and regulatory compliance, which are critical for coating suppliers such as the company analyzed in this study.

1.3 Organizational structure and mission of the company

The company analyzed in this case study represents the operational core of an Italian industrial group with an international presence, whose current structure is the result of a process of progressive expansion and consolidation, as outlined in the previous paragraph. The company structure is designed to manage technical-production, commercial and strategic activities, maintaining a centralized governance supported by a high level of operational specialization.

The parent company, based in Italy, acts as the financial and strategic coordination company, on which all the subsidiaries depend. Among these, the main operating company, which is the subject of this case study, based in the northwestern Italy, is responsible for production, customer management, operations, and central administration. The company's production site is structured as a complex entity, divided into several physically distinct but closely integrated functional units.

The plant includes three main production departments (Buildings 3, 6 and 8), dedicated respectively to solvent-based, water-based and special product formulations. These departments are flanked by an automatic warehouse (Building 5), intended for the computerized management of raw materials and semi-finished products, and by a warehouse dedicated to inks and powders (Building 7), which complies with safety and environmental regulations. A special covered area is used for the temporary and traceable management of industrial waste.

Incoming and outgoing goods management activities are supervised by a logistics area equipped for shipments (Building 4), equipped with loading bays and systems integrated with the ERP. The functional layout is completed by the technical, mechanical, electrical, and washing support areas, which are responsible for the ordinary and extraordinary maintenance of the systems.

This infrastructural configuration, schematically represented in Figure 4 for Company 1, reflects an operating model focused on efficiency and integration between production, logistics and support services.

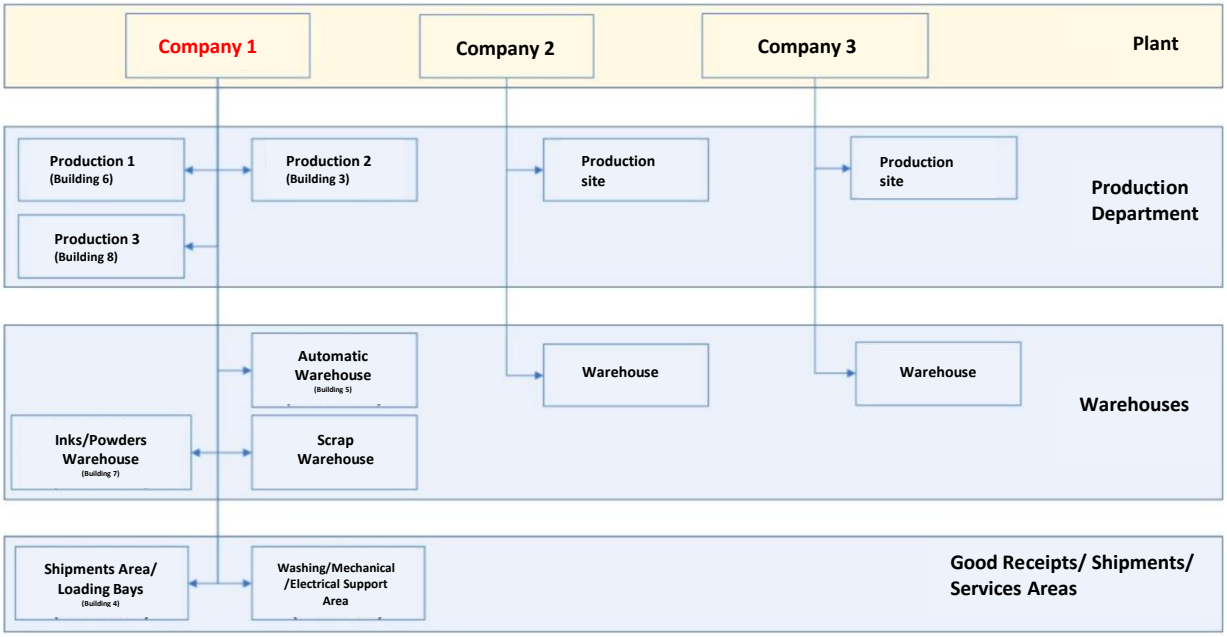

Figure 4 - Functional layout of the group's main companies and production sites

Within the same production hub, there is a separate legal entity, wholly owned, dedicated to research and development, quality control and technical assistance. These areas constitute the innovative heart of the group and guarantee continuous technical support for the formulation of new products, performance monitoring, and after-sales support.

The Italian organizational structure is completed by a production plant located in Southern Italy (represented in Figure 4 as Company 2), specialized in the production of offset inks for metal printing. At an international level, the group operates a plant in Latin America dedicated to logistics and production functions, and a commercial representation in the United States, supported by a joint venture for technical and commercial assistance in the area. This international presence is represented in Figure 4 as Company 3. This geographic distribution reflects a strategy of functional specialization and proximity to key markets.

Figure 5 below illustrates the corporate structure of the industrial group analyzed in this case study. At the top of the hierarchy is Holding S.r.l., which holds a 55.55% stake in Company 1, the group's main operating company. Company 1 acts as the operational core of the group and manages production, customer relations, and central administration. It wholly owns (100%) three subsidiaries: Company 4, dedicated to research and development, quality control, and technical assistance, which represents the group's innovation center; Company 2, a production site located in southern Italy, specializing in offset inks for printing on metal (as described in Figure 4); Company 5, a commercial entity in the United States, which supports the group's activities in the North

American market. In addition, Company 1 holds a 99% stake in Company 3, an international subsidiary based in Latin America that handles logistics and manufacturing. The remaining 1% of Company 3 is owned by Company 4. This corporate structure reflects a centralized governance strategy combined with functional specialization and geographic diversification to ensure proximity to key markets and maintain high technical and operational standards.

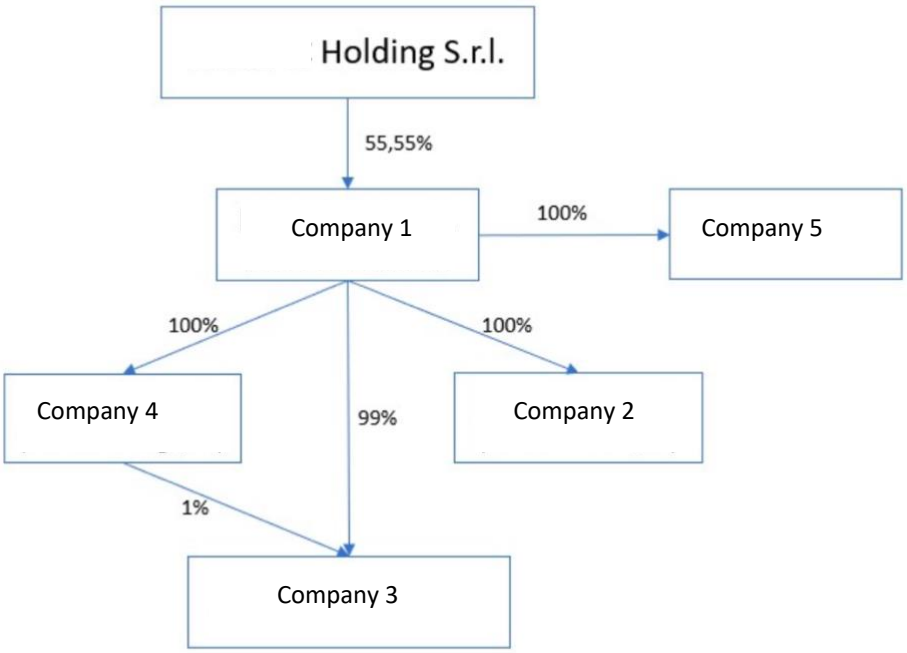

Figure 5 - Simplified organizational chart of the group's corporate structure

Figure 6 below provides a clear overview of the group's global presence, showing the main sites and their operational roles.

Figure 6 - Summary of company headquarters and their respective functions

The map shows the geographical location of the group's main operating headquarters, highlighting their respective functions and strategic role in their target markets.

Beyond its organizational form, the company's identity is strongly characterized by the values that guide its strategic decisions. Its mission is based on technical excellence, quality results and corporate social responsibility. Its commitment to environmental sustainability translates into regular investments in clean techniques and low-impact products, such as water-based paints, BPA-NI (Bisphenol A not intentionally added) systems and polyolefin dispersions.

The goal is to significantly reduce volatile organic compounds (VOC) emissions and ensure food contact safety. The revolution is intended as a cross-cutting strategic lever, promised not only through technical product development, but also through the development of organizational models and the digitalization of processes. In this direction, the current inclusion of a new generation ERP system is planned, aimed at completing business functions more efficiently.

The internal culture also promotes active customer participation, transparency in supplier management, continuous training of internal staff and the promotion of a culture of quality extended

to all areas of the company, a culture that finds concrete expression in the company's quality management system, which will be analyzed in the next chapter.

Chapter 2 – Quality Management Systems: Theory and Regulatory Framework

This chapter provides an in-depth analysis of the Quality Management System (QMS) implemented by the company analyzed in this thesis, with a focus on its structure, operational logic, and integration with key regulatory frameworks governing materials and articles intended to come into contact with food (MOCA).

The aim is to highlight how the company's organizational and procedural choices are in line with international standards, such as ISO 9001 and ISO 22000, and with specific regulatory requirements including EU Regulations 1935/2004 and 2023/2006, REACH, and FDA guidelines. Through the mapping of business processes and a comparative analysis of regulatory compliance practices, the chapter illustrates how the QMS acts not only as a tool to ensure conformity, but also as a strategic asset for risk management, customer satisfaction, and long-term value creation.

2.1 What is a Quality Management System (QMS)

A quality management system (QMS) is a formalized system that defines and documents an organization's processes, procedures, and responsibilities for achieving quality policies, practices, and objectives. It helps an organization coordinate and direct its activities to meet customer and regulatory requirements, as well as continuously improve its effectiveness and efficiency. QMS documentation establishes the framework for ensuring consistent quality and compliance by defining policies, procedures, and responsibilities.[16]

QMSs can be implemented in various formats: paper-based systems, spreadsheet-based systems, electronic QMS (eQMS) and hybrid QMS.
An example of electronic quality management software is SimplerQMS. SimplerQMS offers a complete eQMS, customized to the specific needs of life science companies. Paper QMS is a traditional QMS format that relies on documents and physical records to implement the QMS. A paper QMS is the conventional manual system that relies on physical documents, binders, and

[16] Marinello, V., & Dinicolo, G. (2018). Sistemi di Gestione Integrati. Un approccio multi prospettiva sui Sistemi di Gestione della Qualità (SGQ), Ambiente (SGA), Salute e Sicurezza sul Lavoro (SGSSL) nel contesto delle PMI. In *Percorsi di ricerca sui processi di creazione e diffusione del valore nelle PMI-Un approccio multidisciplinare* (pp. 241-262). G. GIAPPICHELLI EDITORE.

records. A paper-based QMS is easy to implement due to its low initial cost and familiarity with the system. Small businesses benefit from a paper-based QMS without technical expertise or software investment. However, growing organizations face inefficiencies, increased risk of errors, version control issues, and compliance concerns.[17] A spreadsheet-based QMS leverages Microsoft Excel, Google Sheets, or similar tools to track quality metrics, manage documents, and maintain records. A spreadsheet-based QMS is a cost-effective and customizable approach, with a more structured structure than paper-based systems[18]. The disadvantage of this QMS format is that it remains prone to human error, lacks automation, and complicates version control, making audits and regulatory compliance more complex. As businesses grow, scalability becomes inefficient, limiting their long-term sustainability.[19] Spreadsheet-based systems can be used as part of a hybrid QMS, alongside electronic or paper-based methods, allowing for a gradual shift to digital while maintaining compliance and flexibility. An on-premise eQMS is software installed on a company's on-premise servers. An on-premise eQMS allows for the management of electronic document control, audit tracking, and other QMS processes. While it offers cloud-based accessibility and potential scalability, a hybrid QMS introduces complexity. This includes system integration, potential data silos, and requires careful management to ensure seamless integration. The QMS is important for standardizing QMS processes.[20] The QMS defines formal procedures, such as standard operating procedures (SOPs) and work instructions, that govern each stage of product development, manufacturing, and service delivery. By following these defined procedures, organizations can ensure consistent results and reduce variability. A quality management system (QMS) focuses on achieving quality policy and objectives that aim to meet business and customer requirements. The QMS is articulated throughout the organization to ensure the integrity of the plant: its policies, procedures, and processes necessary to successfully achieve plant quality management.

All activities carried out at the plant, including investment projects, maintenance, engineering design and procedures, as well as raw materials and final products, are subject to the requirements of the QMS. Quality assurance must be balanced with costs, as it can be expensive and must be budgeted accordingly. Achieving the right level of quality for the plant at the lowest sustainable cost requires careful planning and effective resource allocation. Moreover, a quality management system enhances

[17] Tipa, A. (2023). *Il Sistema di Gestione della Qualità di una startup biomedicale: progettazione, implementazione e validazione.= Quality Management System of a biomedical startup: design, implementation, and validation* (Doctoral dissertation, Politecnico di Torino).
[18] PUTZULU, C. (2018). Le Risorse Umane nell'implementazione di un Sistema di Gestione della Qualita.
[19] SAGLIA, V. J. Impatto del Lean Management e del Visual Management sul Sistema di Gestione della Qualità nella scuola.
[20] La Rosa, S., & Franco, E. L. I sistemi di gestione per la qualità nelle piccole e medie imprese. *Linee guida*.

transparency in the plant's day-to-day operations, which is essential for several reasons. Ultimately, quality management plays a key role in the FMEA (Failure Mode and Effects Analysis) principle of continuous improvement, which addresses every FMEA element. A prerequisite for effective quality management is to have a robust audit and review process in the workflow.[21]

Quality systems, or quality management systems as they are often called, are the structured procedures that enable quality control to be implemented effectively. The required systems include levels of responsibility for quality control, such as hierarchical diagrams (family trees) showing who is responsible for whom and for which part of the quality spectrum, as well as procedures for the recruitment and training staff and operators.[22] Other systems cover the different quality procedures and processes that may be common to all, as well as for all components or specific to some. Quality management systems (QMS) have evolved since the beginning of industrial activities in this century. In chronological order, it is evident that operations management and quality management systems have progressively adopted a combined approach to improve productivity and product quality, better responding to customer needs and satisfaction. The historical evolution of quality and productivity systems demonstrates how initial concepts have gradually expanded with the continuous improvement of many QMSs through the integration of new practices and areas. The dates generally reflect the beginning of the concept rather than its advancements.

Quality management terminology is extensive, with numerous acronyms and a vast and complex vocabulary related to these systems.[23] Some of the most popular systems have been collected to facilitate understanding of what an organizational system should contain to provide the desired quality and service at the lowest possible cost. However, in certain industries, the adoption of the latest quality management practices remains limited. Many organizations continue to rely heavily on traditional inspection and testing processes. Since the work environment and work practices are not aligned to reduce the incidence of failures or losses, the hidden costs of quality are enormous. Survival is difficult for most of these manufacturers because, although they can provide good "product quality", their organization lacks adequate quality systems and, as a result, the "cost of quality" is high.

[21] Tsiouras, I. (2015). La progettazione del sistema di gestione per la qualità nelle organizzazioni ad alta intensità informativa. *Dalla Iso*, *9000*.
[22] Tsiouras, I. (2015). La progettazione del sistema di gestione per la qualità nelle organizzazioni ad alta intensità informativa. *Dalla Iso*, *9000*.
[23] Approvazione, D. S., & Tallone, M. SISTEMA DI GESTIONE PER LA QUALITA'. *MANUALE QUALITÀ*.

A quality management system (QMS) consists of multiple processes.[24] Each process is composed of multiple sub-processes, which in turn include activities. The system also includes the organizational structure, roles and responsibilities, resources, and infrastructure needed to achieve the quality objectives. Each of these parts has stakeholders with different goals, perspectives, and priorities. However, all these elements must work together as a unified whole to achieve the quality objectives effectively and efficiently. Alignment between processes and stakeholders must be monitored and adjusted. Resources must be aligned with process needs. And responsibility must be aligned with authority.[25] Maintaining alignment for an effective and efficient QMS requires continuous effort. This chapter discusses the key areas of alignment needed and highlights some common pitfalls.[26]

Modern quality management relies on structured methodologies designed to support companies in achieving their objectives. The operational heart of every modern QMS is the PDCA (Plan–Do–Check–Act) cycle, originally developed by Walter A. Shewhart in the 1930s and later popularized and formalized by W. Edwards Deming in the 1950s. This cycle guides the planning, execution, control, and correction of activities, promoting continuous learning within the organization. Figure 7 below provides a concise visualization of the four iterative phases, highlighting the contribution of each phase to the continuous improvement process within quality management systems.

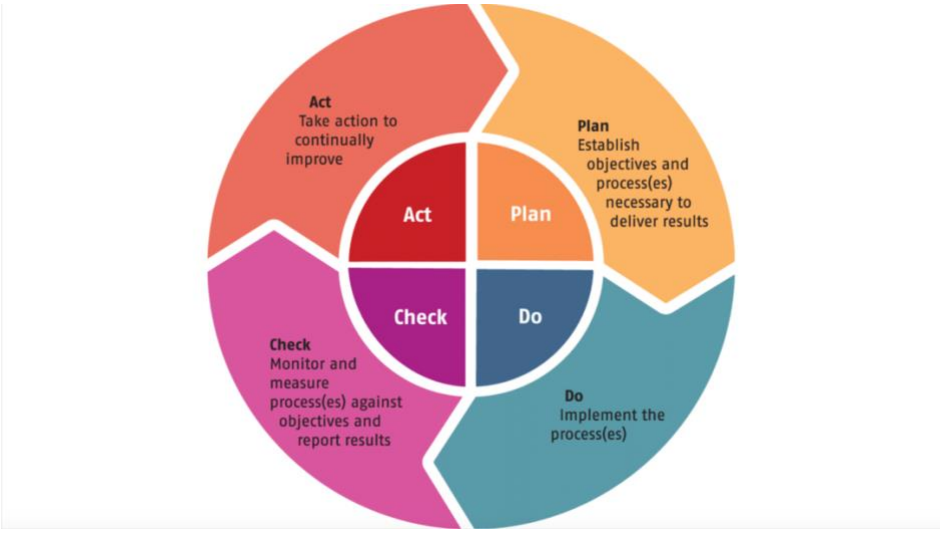

Figure 7 - PDCA (Plan-Do-Check-Act) Cycle

[24] Pulito, E. (2021). *Valutazione dell'impatto del settore aziendale sull'implementazione del Sistema di Gestione della Qualità= Assessment of the impact of the business sector on the implementation of the Quality Management System* (Doctoral dissertation, Politecnico di Torino).
[25] Fazzari, A. L. (2012). *Sistemi di gestione per la qualità* (Vol. 4). G Giappichelli Editore.
[26] Carugo, B. (2012). IL sistema DI gestione per la Qualità Secondo La Norma ISO9001: 2008. *Microbiologia Medica*, *27*(3).

In addition to the PDCA cycle, other operational methodologies have been developed to support quality and efficiency in industrial environments.

One of the most widely adopted is the 5S model, originally developed in Japan as part of the Toyota Production System, and later formalized and promoted by Hiroyuki Hirano. With the addition of a Safety component, the methodology evolved into 6S, which is particularly prevalent in high-risk industrial contexts, where order is combined with accident prevention. The 6S model is frequently represented through infographics that clearly illustrate its fundamental principles. Figure 8 provides a synthetic visualization of the six pillars, highlighting the integration of the Safety concept into the original 5S methodology.[27]

Figure 8 - 6S methodology: Seiri, Seiton, Seiso, Seiketsu, Shitsuke, Safety (https://www.certaintysoftware.com/what-is-6s-lean/)

This study examines the system in its theoretical (Chapter 2), operational (Chapter 4) and transformative (Chapter 5) dimensions. Particular focus is given to the introduction of a new ERP system and the impact on business processes and quality management practices.[28]

[27] DA, D. N. A. D. R., LA, R. P., DI, C. D. S., LA QUALITÀ, G. P., ESCA, L., & GALLO, M. REGOLAMENTO PER LA CERTIFICAZIONE DEI SISTEMI DI GESTIONE.

[28] Marinello, V., & Dinicolo, G. (2018). Sistemi di Gestione Integrati. Un approccio multi prospettiva sui Sistemi di Gestione della Qualità (SGQ), Ambiente (SGA), Salute e Sicurezza sul Lavoro (SGSSL) nel contesto delle PMI.

2.2 Standards and Certifications: ISO 9001, ISO 14001, ISO 45001, ISO 22000

It is necessary to implement other strategies and tactics. Entrepreneurs can implement different strategies. There are strategies for managing relationships with external parties, but also strategies for people within the company. External strategies related to promotion, branding, sales, distribution, and so on. Unlike the internal strategy, it usually focuses on strengthening the management system.[29] How to make employees productive, active, and creative is one of the questions that the internal strategy of the company must be able to answer. In addition, ISO certification is also a way to improve its quality management system. So far, the positive influence of ISO certification on companies, both in terms of sales and other aspects, still has many pros and cons.

However, in the business world, those who have ISO certification will have a better chance of winning the competition in the market, since this certification demonstrates the guarantee of the quality of the products or services offered, as well as the trust of consumers in the related brands. Based on OSS certification, a similar study by Ismyrlis and Moschidis (2015) concluded that the benefits of implementing ISO 9001 consisted of increased profits, costs and market share.

A positive and significant relationship between the implementation of ISO 9001 and ISO 22000 standards and the competitive performance of the company was reported in several studies on ISO 22000 Food Safety Management System, conducted by Kafetzopoulos, Gotzamani and Psomas (2013).[30] Similarly, Vlachos (2014) lists the benefits of applying ISO 22000, namely compliance with quality assurance standards, modernization of processing facilities, enforcement of legislation, credibility, experience and reputation, improved performance in terms of supply chain costs, food quality and customer satisfaction.

Research on Management Systems integration has also been conducted by many researchers such as Ferreira Rebelo, Santos and Silva (2014).[31] Reid (2014) summarizes that changing standards provides an opportunity to apply them more effectively and add value to the organization, rather than an

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[29] Agus, P., Ratna Setyowati, P., Arman, H. A., Masduki, A., Innocentius, B., Priyono Budi, S., & Otta Breman, S. (2020). The effect of implementation integrated management system ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian food industries performance. *Test Engineering and Management*, *82*(20), 14054-14069.

[30] Fahmi, K., Mustofa, A., Rochmad, I., Sulastri, E., Wahyuni, I. S., & Irwansyah, I. (2021). Effect of ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 on operational performance of automotive industries. *Journal of Industrial Engineering & Management Research*, *2*(1), 13-25.

[31] Wolniak, R. (2020). Quantitative relations between the implementation of industry management systems in European Union countries. *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska*.

implementation due to external factors, such as customer demands.[32] In addition, the new version is more attractive to non-manufacturing sectors (Reid 2014), such as the service sector. A new format, called the "high-level structure", is used in the new standard structure. Mangula (2013) also shares the same perspective. The update also includes user-friendly documents and information on supply chain management.

In addition, ISO 9001:2015 standards are more risk-oriented than previous editions. Sari, Wibisono, Wahyudi, and Lio (2017) note that this QMS applies a risk-based approach.[33] This means that, to minimize the negative impacts of ISO 9001:2015, organizations can formulate their own implementation strategies as they see fit. Like other issues related to the management of an organization, risk management is the responsibility of top management (Rybski, Jochem, and Homma, 2017). Ochieng et al. (2015) state that ISO 9001 certification affects the return on equity of organizations and, consequently, their performance. It was reported that the value of equity among ISO 9001 certified organizations was significantly higher than those that did not have the certification. On the other hand, regarding profits and revenues, no significant differences were found between ISO 9001 certified organizations and non-certified ones[34].

Ismyrlis et al. (2015), who examine the same topics, state that the least significant benefits observed mainly concern company performance, such as profits, costs, and market share. A significant difference was observed between the level of performance and some demographic variables, as a result of the implementation of ISO (International Organization for Standardization) itself, size and years of certification. In general, certified companies have benefited from the implementation of ISO. Above all, although profit-oriented companies are convinced of the results that certifications bring, their main concern remains the extent of the benefits obtained.[35] The benefits of ISO 9000

[32] Jannah, M., Fahlevi, M., Paulina, J., Nugroho, B. S., Purwanto, A., Subarkah, M. A., & Cahyono, Y. (2020). Effect of ISO 9001, ISO 45001 and ISO 14000 toward financial performance of Indonesian manufacturing. *Systematic Reviews in Pharmacy*, *11*(10), 894-902.

[33] Noryani, Y. B. G., Sari, W. I., Rosini, I., Munadjat, B., Sunarsi, D., & Mahnun, M. A. G.(2020). Did ISO 45001, ISO 22000, ISO 14001 and ISO 9001 influence financial performance? Evidence from Indonesian industries. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *17*(7), 6930-6950.

[34] Казакова, Е. В. (2019). СРАВНИТЕЛЬНЫЕ АНАЛИЗ ТРЕБОВАНИЙ СТАНДАРТОВ ISO 22000: 2007 и ISO 22000: 2018. *Моя профессиональная карьера*, *1*(4), 30-33.

[35] Purwanto, A. Ratna Setyowati Putri, Arman Hj. Ahmad, Masduki Asbari, Innocentius Bernarto, Priyono Budi Santoso, Otto Breman Sihite.(2020). The Effect of Implementation Integrated Management System ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian Food Industries Performance. *TEST Engineering & Management*, *82*, 14069.

certification are expected to outweigh the costs of achieving the standards. Take, for example, the case of some manufacturing companies in Saudi Arabia.

The companies acknowledged that they were satisfied with the benefits obtained from certification, which outweigh the costs of achieving it and, also, contributed positively to the survival and success of the organizations. In addition, to the benefit of a profit-oriented organization[36], certification improves the organization's image and expands its market share. In contrast, the financial benefits of certification are less significant. While some companies did not report any financial benefits, others reported indirect and intangible financial benefits. Vladimirov et al., 2011, conclude that the information capacity and information environment of the company become the key factors for adopting an effective food safety and quality management system.[37] The overall development and position of the company, the expected benefits and the improvement of working conditions are other factors to be considered for the adoption of the system by food producers or retailers. Vladimirov also suggests that customer satisfaction, the ability of consultants, the frequency of inspections, size and environmental protection are other factors to be considered for adoption. Implementation is hampered by some infrastructural difficulties and, consequently, by the perceived negative effects of official controls. Typically, the benefits that contribute significantly to the satisfaction of organizations are more internal, mainly related to the improvement of efficiency and food safety.[38]

The contribution of Kafetzopoulos et al. (2013) identifies a positive and significant relationship between the effective combined implementation of ISO 9001 and ISO 22000 standards and the competitive performance of certified food companies, with a significant share of variance in their performance. Orcos et al. (2019) argue that the diffusion of ISO 14001 is influenced by both performance orientation and institutional collectivism. While performance orientation slows down the diffusion of ISO 14001, institutional collectivism accelerates it. Over time, performance orientation decreases in intensity, while the accelerating effect of institutional collectivism strengthens. The number of companies adopted and certified with an Occupational Health and Safety (OH&S) management system is expected to increase significantly with the introduction of ISO

[36] Levkulych, V., & Momot, A. (2021). The use of ISO standards in the hospitality industry: a comparative analysis of European clusters. In *E3S Web of Conferences* (Vol. 277, p. 02004). EDP Sciences.

[37] Gueorguiev, T., & Kostadinova, I. (2021, October). ISO Standards Do Good: A New Perspective on Sustainable Development Goals. In *KMIS* (pp. 133-137).

[38] Nováková, R., Cekanova, K., & Pauliková, A. (2016). Integration management system–new of requirements of ISO 9001: 2015 and ISO 14001: 2015 standards. *Production Engineering Archives*, *13*(4), 35-40.

45001.[39] Guided by the requirements of the standard, companies use the Deming Cycle to promote continuous improvement of OH&S performance.

Finally, monitoring, auditing and management review constitute the performance evaluation processes. Full control of compliance obligations makes the implementation of the OH&S management system advantageous.[40] As with the other management standards mentioned above, a better corporate image is recorded, combined with a significant reduction in accident rates and associated costs. Similarly, the implementation of ISO 22000:2018 has a positive and significant effect on company performance, with a value of $\beta=0.90$ and t-value obtained of $7.47 > 1.96$. According to Vladimirov et al., in 2011, ISO 22000 increases the company's information capacity and information environment, becoming key factors for the adoption of an efficient food safety and quality management system[41]. The overall development and location of the company expected benefits and improvement of working conditions are other factors to consider for food producers or retailers who want to adopt the system. Vladimirov also suggests that customer satisfaction, consultants' capacity, inspection frequency, size and environmental protection are other factors to consider for adoption. Implementation is hampered by some infrastructural difficulties and, consequently, the perceived negative effects of official controls. In particular, the benefits that contribute significantly to the satisfaction of organizations are more internal, mainly related to the improvement of efficiency and food safety. The contribution of Kafetzopoulos et al. (2013) identifies a positive and significant relationship between the effective combined implementation of ISO 9001 and ISO 22000 standards and the competitive performance of certified food companies, with a significant share of variance in their performance. The implementation of ISO 45001:2018 also has a positive and significant effect on company performance, with a value of $\beta=0.27$ and a t-value obtained of $3.02 > 1.96$.[42] The number of companies that have adopted and certified an Occupational Health and Safety (OH&S) management system is expected to increase significantly with the introduction of ISO 45001.[43] Guided by the requirements of the standard, companies use the Deming

[39] Zivkovic, S., & Petrovic, D. (2015). Integrated protection model-ISO 45001 as a future of safety and health standards. *Economic and Social Development (Book of Proceedings), 5th Eastern European Economic and Social Development*, *21*, 200.
[40] Ramirez, J., & Lorena, L. (2022). Diseño del Sistema Integrado de Gestión bajo las normas ISO 9001: 2015, ISO 14001: 2015 e ISO 45001: 2018 de la empresa INVERGROUP Monterrey F&C SAS.
[41] Agus, P., Ratna Setyowati, P., Arman, H. A., Masduki, A., Innocentius, B., Priyono Budi, S., & Otta Breman, S. (2020). The effect of implementation integrated management system ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian food industries performance. *Test Engineering and Management*, *82*(20), 14054-14069.
[42] Fahmi, K., Mustofa, A., Rochmad, I., Sulastri, E., Wahyuni, I. S., & Irwansyah, I. (2021). Effect of ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 on operational performance of automotive industries. *Journal of Industrial Engineering & Management Research*, *2*(1), 13-25.
[43] Wolniak, R. (2020). Quantitative relations between the implementation of industry management systems in European Union countries. *Zeszyty Naukowe. Organizacja i Zarządzanie/Politechnika Śląska*.

Cycle to promote continuous improvement of OH&S performance. Finally, monitoring, auditing and management review constitute the performance evaluation processes. Full control of compliance obligations makes it advantageous to implement the safety management system. As with the other management standards mentioned above, a better corporate image is recorded, along with a significant reduction in accident rates and a reduction in associated costs.[44] The results of this study reinforce some of the findings of previous studies on Integrated Management Systems. Similar to previous studies, this study highlighted that the most relevant difficulty in implementing the Integrated Management System (IMS), sometimes referred to as IMAS (Integrated Management Approach/System) is related to personnel.

This challenge was found at both a technical and behavioral level. On the other hand, general benefits are also evident, such as increased satisfaction resulting from post-certification benefits. Some benefits found in this process contribute significantly to competitiveness, such as increased employee awareness, improved corporate image and market expansion.[45] Corporate motivations for certification can lead to different results depending on several factors. Ivanova et al. (2014) state that the level of commitment of senior management plays a key role. The study by Ferreira et al. (2014) notes that optimizing resources eliminates conflicts between individual systems. On the other hand, the creation of added value for the company becomes the focus of Sartor et al. (2019). Sartor focuses on the elimination of different types of waste as a contribution of integrated management. Sartor et al. (2019) add that certification is linked to increased productivity and process control and improved product/process quality. Psomas et al. (2014) find interesting results that "hard" TQM elements have an indirect, rather than direct, impact on quality management through their significant correlation with "soft" TQM elements.[46]

A different perspective on benefits can be found in the contribution of Odigie, who examines the following keywords: risk, safety, incident, accident, hazard, preventive action, corrective action, rework, repair, and scrap. Odigie mentions a "Plan-Do-Check-Act" workflow for an effective use of

[44] Jannah, M., Fahlevi, M., Paulina, J., Nugroho, B. S., Purwanto, A., Subarkah, M. A., & Cahyono, Y. (2020). Effect of ISO 9001, ISO 45001 and ISO 14000 toward financial performance of Indonesian manufacturing. *Systematic Reviews in Pharmacy*, *11*(10), 894-902.

[45] Noryani, Y. B. G., Sari, W. I., Rosini, I., Munadjat, B., Sunarsi, D., & Mahnun, M. A. G.(2020). Did ISO 45001, ISO 22000, ISO 14001 and ISO 9001 influence financial performance? Evidence from Indonesian industries. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *17*(7), 6930-6950.

[46] Purwanto, A. Ratna Setyowati Putri, Arman Hj. Ahmad, Masduki Asbari, Innocentius Bernarto, Priyono Budi Santoso, Otto Breman Sihite.(2020). The Effect of Implementation Integrated Management System ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian Food Industries Performance. *TEST Engineering & Management*, *82*, 14069.

the quality function, hazard prevention and operability analysis. System design based on existing processes, use of information technology and, most importantly, employee use of the system are some of the vital factors that influence the effectiveness of implementation.[47]

Hasan's contribution identifies the differences in the implementation of the internal audit process in different companies. Despite experiencing the same challenges in implementing IMAS, all companies demonstrate high motivation and good resource management, as well as enjoying similar benefits. Kakouiris et al. (2019) distinguish between primary and secondary motivations in the application of the ISO 9000 standard.[48] The study explains that once companies, driven by external motivations to pursue ISO 9000 certification, realize the full potential of the standard, they appreciate other benefits, which in turn lead to greater motivation.[49] Marti et al. (2017) offer an answer related to motivation. In essence, the benefits of the level of integration of management system documentation and management system procedures outweigh the significant negative effect of integration difficulties.[50] Zaramdini et al. (2007) suggest that certified companies show greater attention to internal motivations such as process or product improvement than to external motivations such as customer pressure or imitation of competitors. Indeed, compared to external benefits, the certification process generated greater internal benefits. Reviewing the benefits of ISO 9000, Gamboa et al. (2012) suggest the need for international and national quality bodies to adapt interpretative guides to meet the specific needs of educational institutions.[51] Furthermore, schools are encouraged to be more proactive in demonstrating the benefits of quality concepts and certification to stakeholders. The application of best practices from the industrial world to education undoubtedly leads to a new approach that is worth considering both by quality bodies and schools.

To better understand the global spread of quality and management systems, it is useful to compare the number of valid certifications for the most widely used standards. Figure 9 shows the distribution of ISO 9001, ISO 14001, ISO 45001, and ISO 22000 certificates valid as of 2023, highlighting the

[47] Levkulych, V., & Momot, A. (2021). The use of ISO standards in the hospitality industry: a comparative analysis of European clusters. In *E3S Web of Conferences* (Vol. 277, p. 02004). EDP Sciences.
[48] Gueorguiev, T., & Kostadinova, I. (2021, October). ISO Standards Do Good: A New Perspective on Sustainable Development Goals. In *KMIS* (pp. 133-137).
[49] Nováková, R., Cekanova, K., & Pauliková, A. (2016). Integration management system–new of requirements of ISO 9001: 2015 and ISO 14001: 2015 standards. *Production Engineering Archives*, *13*(4), 35-40.
[50] Zivkovic, S., & Petrovic, D. (2015). Integrated protection model-ISO 45001 as a future of safety and health standards. *Economic and Social Development (Book of Proceedings), 5th Eastern European Economic and Social Development*, *21*, 200.
[51] Ramirez, J., & Lorena, L. (2022). Diseño del Sistema Integrado de Gestión bajo las normas ISO 9001: 2015, ISO 14001: 2015 e ISO 45001: 2018 de la empresa INVERGROUP Monterrey F&C SAS.

dominance of ISO 9001 and the relative levels of adoption of the other standards. This comparison provides information on the prevalence of each management system in different sectors and regions.

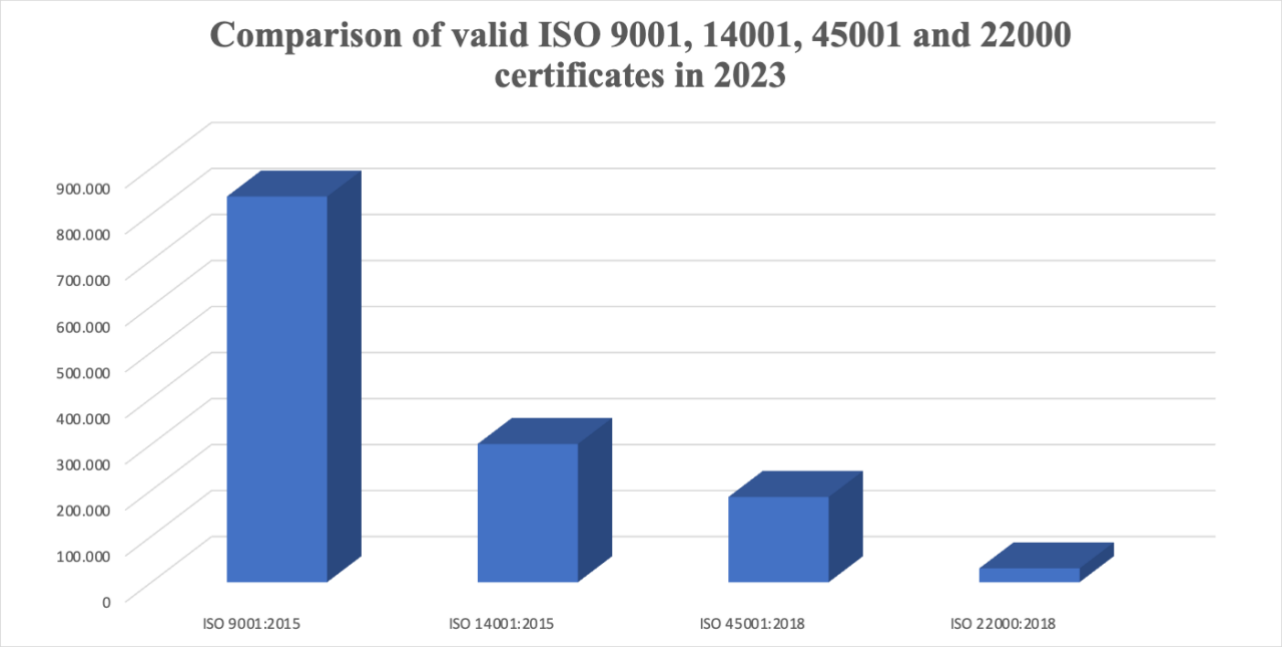

Figure 9 - Comparison of valid ISO 9001, 14001, 45001 and 22000 certificates in 2023 (https://www.iso.org/home.html)

In this scenario, Italy stands out as one of the most certified countries in the world, with 99,419 active ISO 9001 certifications, preceded by China, which leads the ranking with 130,402 certifications. The distribution of ISO 9001 certifications among the main countries is illustrated in Figure 10, which shows the 10 countries with the highest number of active certifications in 2023.[52]

[52] Fahmi, K., Mustofa, A., Rochmad, I., Sulastri, E., Wahyuni, I. S., & Irwansyah, I. (2024). Effect of ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 on operational performance of automotive industries. *Journal of Industrial Engineering & Management Research*, *2*(1), 13-25.

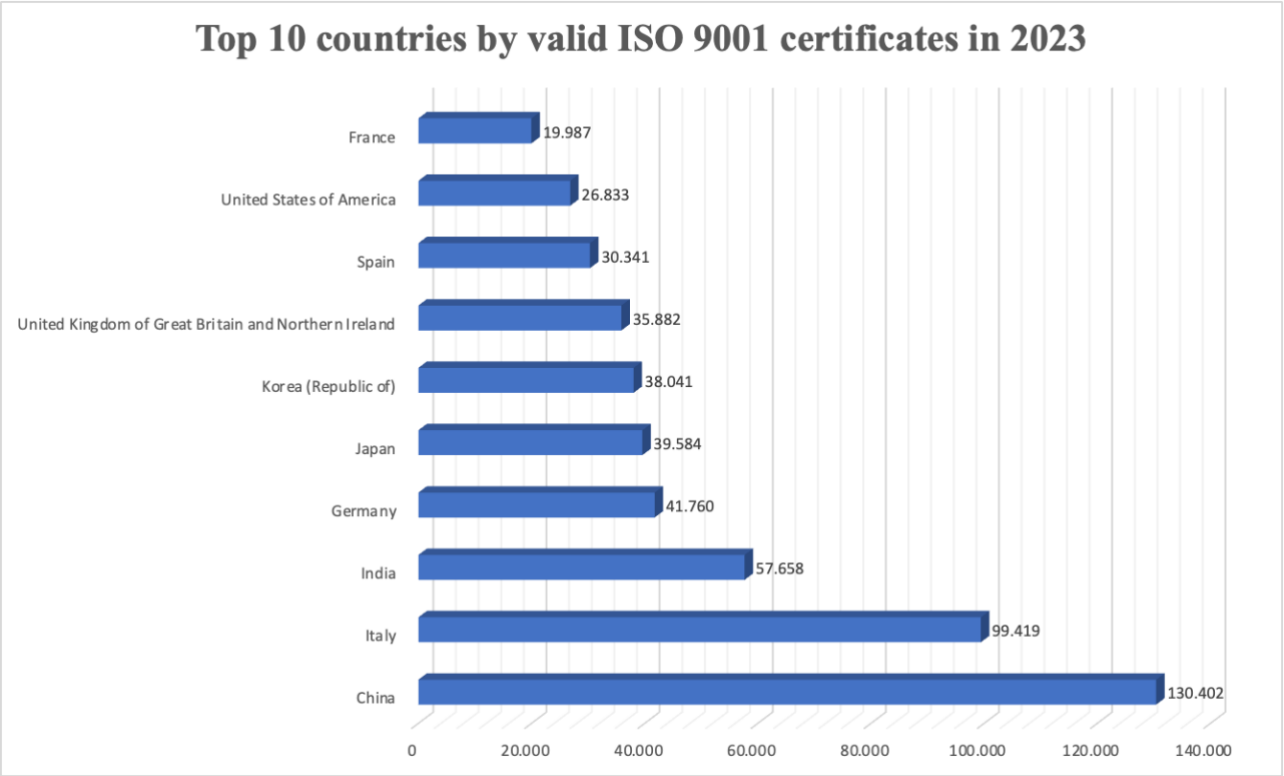

Figure 10 - Top 10 countries by number of active ISO 9001 certificates in 2023 (https://www.iso.org/home.html)

2.3 MOCA Regulations and Compliance Requirements: 1935/2004, 2023/2006, REACH, FDA

The regulatory landscape governing materials and articles intended to come into contact with food (MOCA) is complex and multi-layered. To ensure full compliance, companies operating in this sector must adhere to a combination of European and international standards. Table 3 provides a comparative overview of the main MOCA-related regulations, highlighting their mandatory nature, scope of application, and key requirements.

Regulation	Is it mandatory?	Scope of Application	Key Requirements
Reg. (EC) 1935/2004	Yes, for all EU member states	Covers all materials and articles intended to come into contact with food	No transfer of harmful substances; preservation of food quality; traceability of materials
Reg. (EC) 2023/2006 (GMP)	Yes, for all manufacturers of FCMs in the EU	Applies to the manufacturing process of food contact materials and articles	Implementation of quality assurance and quality control systems; documentation; hygiene standards
Reg. (EC) 1907/2006 (REACH)	Yes, applies to all chemical substances within the EU	Covers the registration, evaluation, and restriction of chemical substances used in materials	Obligation to register and monitor chemical substances; communication within the supply chain
FDA (USA)	Not mandatory in the EU, required for export to the US	Covers the safety and approval process for food contact substances in the US market	Submission of FCS notifications; compliance with Title 21 CFR; scientific safety assessments

Table 3 - Comparative Overview of MOCA-Related Regulations

In the context of REACH compliance, the company focuses on the proper management of chemical substances through internal audits, systematic archiving of Safety Data Sheets (SDS), and structured risk assessments.[53]

Furthermore, with a view to exporting to international markets such as the United States, the company has implemented compliance processes aligned with FDA regulations, particularly concerning the notification of Food Contact Substances (FCS Notification) and adherence to Title 21 of the Code of Federal Regulations (21 CFR).[54]

Table 4 below offers a structured summary of the main operating practices observed, directly linked to the individual regulations.

Regulation	Operational Practices in the Observed Company
Reg. (EC) 1935/2004	Implementation of traceability systems for raw materials and finished products; maintenance of batch records; alignment with supplier certifications to ensure compliance with food safety requirements.
Reg. (EC) 2023/2006 (GMP)	Development and maintenance of written procedures and production records; regular hygiene and sanitation protocols; staff training programs on GMP principles; structured supplier evaluation.
Reg. (EC) 1907/2006 (REACH)	Systematic assessment of raw materials for REACH compliance; verification and archiving of Safety Data Sheets (SDS); internal audits for chemical safety; risk assessments for new substances.
FDA (USA)	Adaptation of packaging formulations to meet US regulations; preparation of FCS notification dossiers when required; coordination with regulatory consultants; alignment with Title 21 CFR requirements.

Table 4 - Pratical application of food contact regulations in the observed company

It therefore emerged that the company substantially applies what is required by these regulations. The control activities, the management of documentation and the approach to the selection of materials demonstrate good adherence to the provisions of European and non-European regulations, confirming the effectiveness of a QMS that integrates voluntary and mandatory aspects.[55]

[53] Agus, P., Ratna Setyowati, P., Arman, H. A., Masduki, A., Innocentius, B., Priyono Budi, S., & Otta Breman, S. (2020). The effect of implementation integrated management system ISO 9001, ISO 14001, ISO 22000 and ISO 45001 on Indonesian food industries performance. *Test Engineering and Management*, *82*(20), 14054-14069.
[54] Fahmi, K., Mustofa, A., Rochmad, I., Sulastri, E., Wahyuni, I. S., & Irwansyah, I. (2021). Effect of ISO 9001: 2015, ISO 14001: 2015 and ISO 45001: 2018 on operational performance of automotive industries. *Journal of Industrial Engineering & Management Research*, *2*(1), 13-25.
[55] Казакова, Е. В. (2019). СРАВНИТЕЛЬНЫЕ АНАЛИЗ ТРЕБОВАНИЙ СТАНДАРТОВ ISO 22000: 2007 и ISO 22000: 2018. *Моя профессиональная карьера*, *1*(4), 30-33.

Overall, the MOCA, REACH and FDA regulations are not just a set of obligations but are designed to be a lever for better structuring production processes, protecting the consumer and increasing the company's reputation in the long term.[56]

2.4 The Quality Management System of the Case Study Company

The company's organizational structure is described through a process map that classifies activities into three main categories: primary processes, support processes, and monitoring processes (Figure 11 – Business process map).[57]

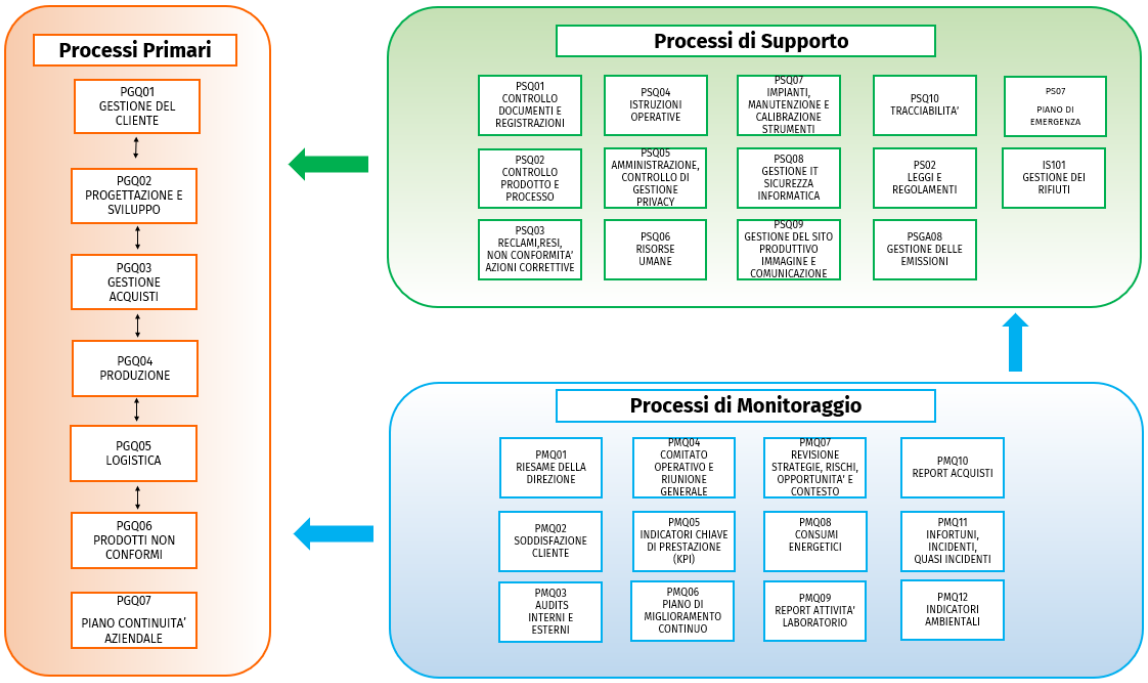

Figure 11 - Business process map

This classification represents the operational basis of the QMS and allows a clear visualization of the structure of the activities and their interconnection.

Primary processes include:

- Design and development;

[56] Gueorguiev, T., & Kostadinova, I. (2021, October). ISO Standards Do Good: A New Perspective on Sustainable Development Goals. In *KMIS* (pp. 133-137).
[57] Nováková, R., Cekanova, K., & Pauliková, A. (2016). Integration management system–new of requirements of ISO 9001: 2015 and ISO 14001: 2015 standards. *Production Engineering Archives*, *13*(4), 35-40.

- Purchasing management;
- Production;
- Logistics.

Support processes include, for example[58]:

- Product and process control;
- Human resources management;
- Plant maintenance;
- Document management;
- Information systems.

Finally, monitoring processes include:

- Analysis of key performance indicators (KPIs)[59];
- Customer satisfaction;
- Management review;
- Continuous improvement plans.

In this document, Top Management emphasizes that:

"For us, quality is not a requirement to be met, but a commitment to our customers, a daily working method and a strategic lever to generate long-term value".

This statement is accompanied by a concrete operational perspective:

[58] Zivkovic, S., & Petrovic, D. (2015). Integrated protection model-ISO 45001 as a future of safety and health standards. *Economic and Social Development (Book of Proceedings), 5th Eastern European Economic and Social Development*, *21*, 200.
[59] Zivkovic, S., & Petrovic, D. (2015). Integrated protection model-ISO 45001 as a future of safety and health standards. *Economic and Social Development (Book of Proceedings), 5th Eastern European Economic and Social Development*, *21*, 200.

"The goal is to significantly reduce emissions of volatile organic compounds (VOCs) and guarantee safety for food contact, through clean technologies and low-impact products".

These declarations reinforce the idea that quality is not merely seen as a regulatory constraint, but as an integral part of culture and strategic positioning of the company featured in the case study.

Chapter 3 – Analysis of weaknesses in the case study QMS

This chapter aims to examine the fundamental critical issues emerging in the Quality Management System (QMS) of the company under study, with a specific relationship to purchasing, production and logistics developments, on the support of a technical assessment document and the company's functioning processes. The goal is to represent the "as-is" state and generate the need for the inclusion of a completed ERP system, capable of overcoming the organizational, technical and information inefficiencies highlighted.

3.1 Critical issues across the QMS

The analysis of the company's "as-is" structure, conducted through the technical assessment document and internal operating procedures, highlighted a fragmented, highly manual-intensive management system, with low integration between the IT platforms involved in quality management. The main systems used include AS400 (central ERP), Oracle/SQL database, SharePoint, and numerous vertical software developed for specific functions (production, labeling, testing, laboratory).

These systems operate in a non-synergistic mode, with one-way information flows and no structured data sharing. The AS400 system, for example, acts as a central hub but does not receive automatic updates from other systems, except in rare cases and with rigid logic.

Each primary process, described in the previous chapter, is supported by its own PGQ (Quality Management Procedure), which defines the operational procedures, controls, and responsibilities required to ensure compliance with the company's quality standards. The entire Quality Management System is currently based on a manual approach, relying on paper records for documentation and verification. A particularly critical area lies in the management of procedures and recipes, which reside in three parallel databases, as reported in the *PGQ 04 - PRODUCTION* procedure. These databases include:

- **AS400**, is the main management system used until the end of 2024 (before the Go-Live at the beginning of January 2025) by the company. As far as procedures and recipes are concerned, the AS400 is used specifically for the management of product costs and production sheets. The production sheets, which contain both the recipe and the processing procedure of a product, are entered on AS400. Initially they are created in a provisional version and then made definitive after validation by the Quality Control Laboratory (LCQ). The AS400 contains the detail of the recipe, but not the evidence of the individual specific packaging. The production order information is present on the AS400 in aggregate form by total quantity. If a production board is modified, the information should be transferred to Technology (TEC) to align the other systems. Despite the initial entry on the AS400 and LCQ validation, the sheets are then printed and manually integrated by other functions (Production, Technology, LCQ), creating paper steps and duplications.

- **Production Automation Software**, this system is described as the one that manages the recipes and the procedure for the realization of the actual product on the plant. It allows the direct creation of a production order. Unlike the AS400, in this system the type of packaging is not necessary at the time of order creation and can be changed until the start of packaging. It is the responsibility of the Technology Function (TEC) to ensure that this system is aligned with changes to procedures/recipes.

- **Labeling Management Software**, the sources specify that this software is intended to correctly filling in the labels according to the materials contained in the product. The finished product labels are generated through a separate system identified as GHS, powered by data from the AS400. This system is explicitly named as Selerant. Selerant receives from AS400 the information necessary to generate labels and tags, manages the risk calculation for re-labeling (necessary for example for language change or service life extension, especially for shipments abroad), and, very importantly, generates the production date and expiration date at the time of label creation. All other systems that use these dates extract them from Selerant, apart from the AS400 for age verification. The labels contain detailed information from the product components and safety data (risk phrases, GHS pictograms) retrieved by Selerant. Generating these separate labels introduces a risk of inconsistencies and duplication with other systems.

The application map below (Figure 12, 13, 14) visually represents the structure of the information systems previously used within the company. It highlights the strong fragmentation between the

different management, technical and production applications, and the lack of bidirectional integration between data flows.

Every functional area (quality, production, warehousing, purchasing, laboratory) is supported by heterogeneous software tools, often developed to meet local needs, without a unified and centralized view. The AS400 management system serves as a central node for some accounting and operational activities, but many critical processes, such as product formulation, quality control, label management or testing, take place on separate platforms (such as Selerant, SQL database, SharePoint, automation software) that do not communicate directly with each other.

In particular, the map shows how the same information (e.g., product composition, expiry date, test results) can reside on several systems at the same time, updated manually and with different formats. This "as-is" application scheme helps to generate:

- Redundancy and duplication of technical and operational data;
- Uncertainty about the "official" version of the information;
- Difficulties in real-time traceability and alignment;
- High dependence on human updating activities.

Considering this setup, the need for a unified ERP system is clear: only an integrated platform can ensure data consistency, end-to-end visibility, and continuous traceability across the entire value chain.

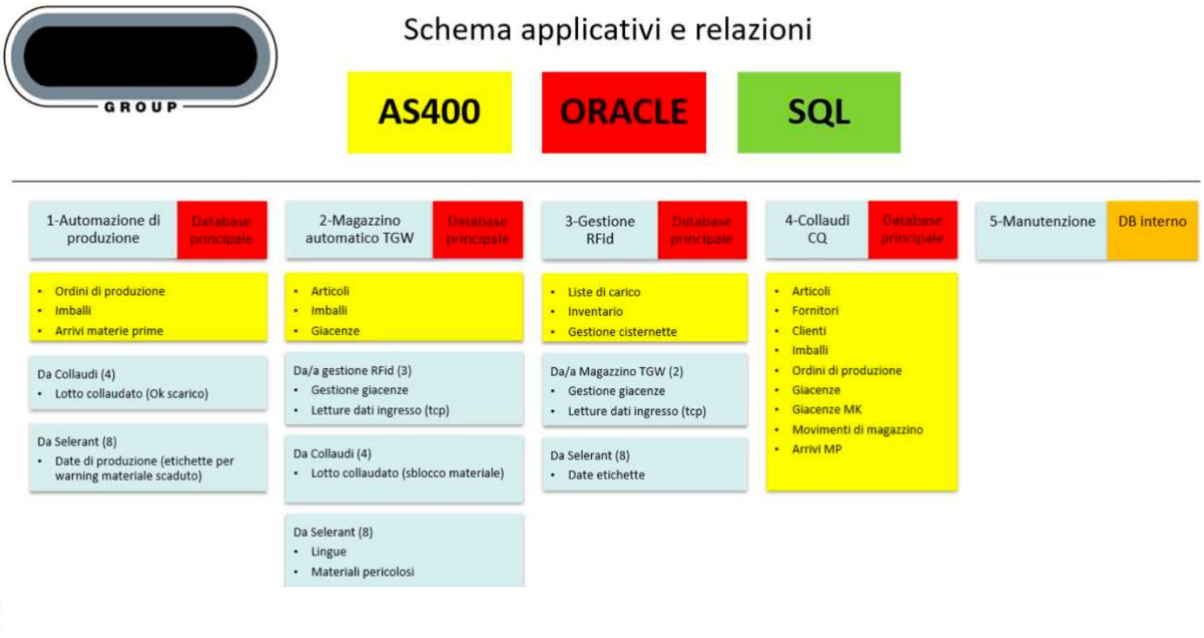

Figure 12 - Application schema and relationships of the Observed Company (1)

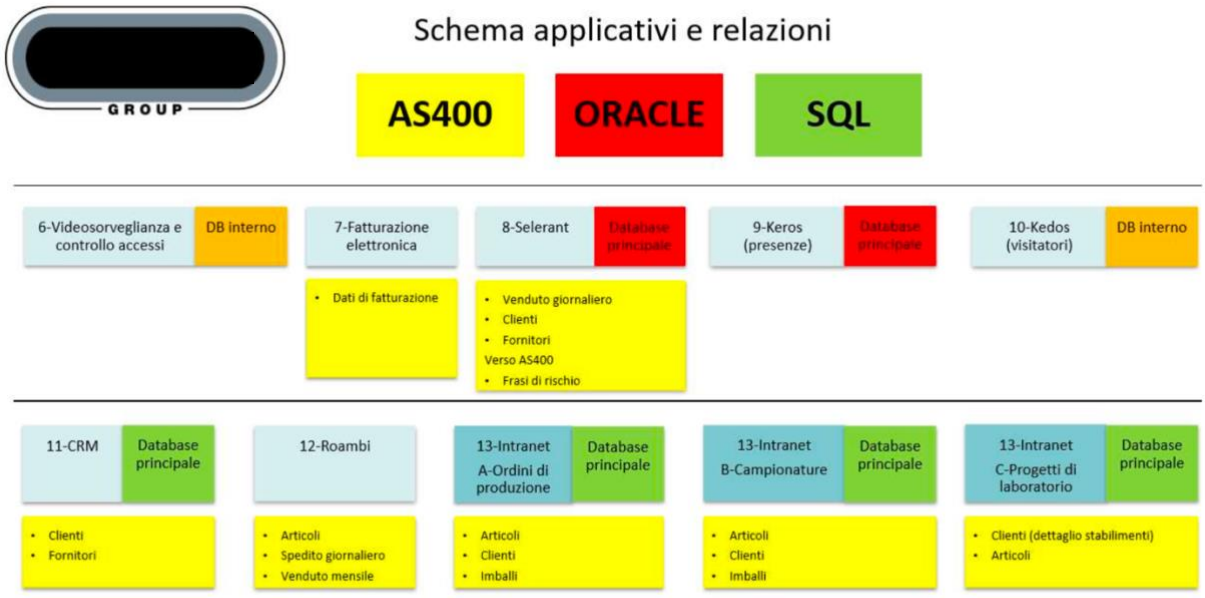

Figure 13 - Application schema and relationships of the Observed Company (2)

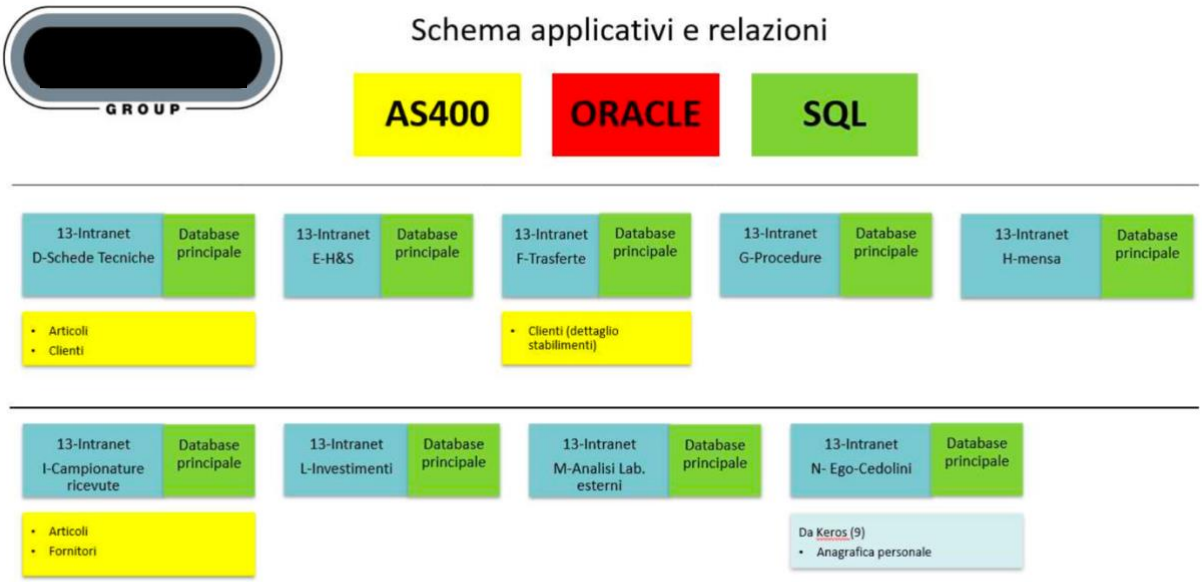

Figure 14 - Application schema and relationships of the Observed Company (3)

The central criticality of this architecture lies in the fact that the three main systems (AS400, Production Automation, Selerant) operate in parallel, without any automatic synchronization mechanism. Changes to recipes, operating procedures, and technical data are manually updated in the respective environments, exposing the system to inconsistencies, errors, and loss of traceability.

As the application map shows, each platform manages a product-critical piece of information:

- AS400 centralizes costs and production sheets, but without packaging details;
- Automation software governs the practical execution of process recipes;
- Selerant (GHS) is responsible for generating the labels, including production/expiration dates and safety information.

However, there is no bi-directional integration that ensures automatic alignment between these systems. Each update must be coordinated at a human level: this implies that any changes made in one of the three environments will not be reflected in the others, unless explicitly intervened.

In addition to the duplication of data, there is also a lack of clarity on the ownership of information: it is not always defined which system contains the "official" version of a recipe, a production cycle or a label. This makes it difficult to control versions, manage technical documentation, and track any revisions in the event of complaints or audits.

In addition, the approval flows (workflows) for the modification of recipes or technical data sheets are not digitized: the approval of a variation takes place by e-mail or verbally, without system traceability logic, nor integrated document management.

The physical traceability of materials and containers is also only partially guaranteed. While the packaging labels use RFID and report critical technical data, the management of reusable tanks still takes place on manual registers, with the filling date noted by hand. In the event of post-sales non-compliance, the reconstruction of the chain of responsibility becomes difficult, especially if several batches have been aggregated in a tank without upstream traceability.

Ultimately, the fragmentation of systems, the manual nature of changes, the absence of structured workflows and the weakness in document management make the QMS vulnerable, inefficient, and non-compliant with the standards of an advanced digital quality system.

This situation is one of the main reasons why the company embarked on a digital transformation project oriented towards the adoption of SAP S/4HANA, as described in the next chapter.

3.2 Procurement processes

The company's procurement process is formally defined in the *PGQ 03 – PURCHASING MANAGEMENT* procedure, which regulates the methods of procurement of raw materials, packaging, technical components, and services. This procedure applies to all units of the group and specifies roles, responsibilities, and operational flows.

According to the procedure, procurement is divided into five main phases:

1. *Needs planning*
2. *Material Verification*
3. *Issue of the purchase order*
4. *Inspection and acceptance*
5. *Document management and archive*

1. *Needs planning*

Requirements are determined on three levels:

- Annual: budget planning defined with the commercial area;
- Monthly: based on the forecasts of the production schedule (communicated by AP to PRD);

- Weekly: joint operational planning AP/PRD.

This structure allows, in theory, to anticipate demand and ensure production continuity.

2. Material Verification

The material to be procured is checked based on the following criteria:

- internal availability (stock);
- at the minimum stocks level;
- the analysis of the bill of materials and the list of requirements.

The procedure provides for the consultation of the master data to confirm the correct coding, or in the case of new materials, initiating a technical and quality approval process.

3. Issue of the purchase order

The purchase order is formalized on AS400, reporting the item code, quantity, price, and supplier. However, the order confirmation and technical attachments are handled separately, either by e-mail or paper document. The order can be opened (with multiple deliveries) or closed.

4. Inspection and acceptance

Upon delivery, goods are:

- visually verified (quantity, packaging, code);
- labeled with RFID;
- marked ad awaiting testing (if applicable).

Testing is carried out according to the PSQ 02 procedure. In the event of non-compliance, the material is not released for use.

5. Document management and archive

Technical data sheets, certifications, analysis reports, and order confirmations are manually archived in the Purchasing Department. The procedure does not include a dedicated information system for the digital management of supply files.

The raw material procurement process also has several critical areas related to its management. Procurement is not based on automated Material Requirements Planning (MRP) but is carried out

"on sight". This manual planning is based on the production orders (including unconfirmed orders) that generate requirements, and on minimum stock levels defined for raw materials. Although there is a system for reporting exceptions (shortages, insufficient stocks, delays), the decision and action remain the responsibility of the operator.

A further critical issue is found in the management of equivalent or alternative material codes. Even if raw materials may be identical at a chemical level but coded differently, or the same product may be made with different bills of materials (versions or alternatives), the choice of which to use is not managed by the system but is left to the purchasing department user. This can lead to inefficiencies in supplier or material selection, not always optimizing cost or availability.

Furthermore, there is no system management of purchase requests, which means that some types of purchases are not even tracked in the system. Contract management with suppliers is also not integrated, but handled separately, making it difficult to fully monitor supplier performance, analyze total purchase costs, and integrate supplier quality with the production process.

In summary, although formally structured in the PGQ 03 procedure, the procurement process has numerous areas of inefficiency and misalignment at the operational level with respect to modern, digital, and integrated supply chain management. The absence of planning supported by advanced IT tools, manual management of critical data and the lack of interconnection between contracts, RFQs, testing and supplier performance make the process highly reactive, untraceable, and vulnerable to systemic errors.

The progressive integration of information at a central level will facilitate a complete view of the passive cycle and a more effective management of suppliers, inventory, and the quality of incoming materials.

3.3 Production process

Although organized by product categories in separate buildings (Buildings 3, 6, 8), the production process, as reported in the *PGQ 04 - PRODUCTION* procedure, has several weaknesses in terms of operational management. Production planning and scheduling takes place on three levels (Budget/Forecast, Planning, Daily scheduling), but the production of finished products is managed manually, partly due to the complexity of the customized labels for each customer.

The creation of a production order involves several systems: it is created on SharePoint (with detail for packaging), entered on AS400 (with recipe detail but not packaging), and also created on the

production automation software. This process generates duplication and manual/paper-based steps. For example, on AS400 you see the aggregate value, while on SharePoint you see the split by packaging and language. After the initial entry, production sheets are printed and then manually integrated by various actors (Production, Technology, LCQ).

The testing phases, which are crucial for quality, are managed separately through vertical software and the results are subsequently reported in AS400 and in the testing program, causing data dispersion. The LCQ performs the tests, decides on any additions, and these are performed and updated manually on the production board.

Non-compliant products are coded by assigning letters to the status of the batch (e.g., 'K' - not shippable, 'R' - returned, 'Z' - obsolete/disputed, 'W' - incomplete). However, the complete management of non-conformities and related corrective actions does not take place within an integrated workflow, making it difficult to monitor and analyze the causes structured. Rework (such as the addition of pigment) and the use of incomplete products (marked with 'W' letter) also require manual processes and changes of status that are not always managed smoothly in an integrated system.

Production scheduling is manual and requires continuous adjustments, especially for customized products or based on tank availability. Planning takes into account confirmed orders and the availability of the tanks, with possible delays in the event of a lack of space. There is a report on the age of items, but proactive management based on the expiration or minimum shelf life accepted by customers requires manual attention. The weekly planning table is generated automatically, but the operator still carries out a corrective manual management to verify adequacy.

During the packaging phase, which can last several days, stock is only entered into the warehouse once the activity is complete. This can lead to negative stock situations in the management system if part of the product is shipped before final payment. Although the negative stock is monitored and aligned weekly, this situation reflects a discrepancy between the physical process and the accounting representation in the system.

3.4 Logistics process

The logistics process, as reported in the *PGQ 05 – LOGISTICS*, procedure presents several critical issues related to the management of movements and stocks. About incoming movements, goods arriving against a purchase order (mainly raw materials) are accompanied by a supplier's test report. Goods deemed compliant with an initial visual inspection are put in a state of blockage pending

internal testing. Internally, a company batch is associated that can be traced back to the supplier lot. However, in the AS400 management system, supplier batches are not managed for most raw materials, since several supplier batches can be combined into a single internal tank, thus losing the punctual traceability of the original batch. Incoming batch management is done only for inks.

The inventory activity is carried out only at the end of the year. There are no rotating or periodic inventories during the year, mainly due to the continuous stock misalignment caused by the duration of the production process, which allows negative stocks. For the annual inventory, data is uploaded to the management system from files generated by the automatic warehouse and manual readings with a PDA, and then manually enriched (e.g., tank stocks). The differences are then recorded through an adjustment procedure. Minor differences detected during the year are transferred to the production orders. This inventory management reflects the difficulty in maintaining constant alignment between physical and accounting stock.

Shipments are based on the creation of an "isolate", a provisional list of products and batches to be shipped to fulfill a customer order, managed on a temporary environment. If the batch is not yet available because it is in production, it is omitted and integrated later. The isolated batch is used to "reserve" the stock in the system, even if it is not a real block, and generates the picking/loading list and, subsequently, the shipping note. Manual management of iron tanks, capitalized assets that return to customers with a transport document, is still supported by an internal manual register for tax and serial management traceability.

A (nice-to-have) desire that has emerged is the need for precise traceability of the individual production unit (e.g. tanks, drums), which is increasingly requested by customers. Currently, batch traceability is ensured by the RFID tag on the package, but serial-level traceability would require new procedures, such as progressive labeling in production or generation of specific labels in shipment with bay outgoing reading.

The management of the negative stock, admitted to the system during the packaging and shipping phase before the final payment, highlights a disconnect between the physical movement of the goods and their registration in the system. Although monitored, this misalignment makes inventory management and inventory itself more complex.

3.5 Quality control and management of non-conformities

The Quality Control (QC) process, although formally defined, presents operational challenges due to data fragmentation and the lack of a centralized system for managing non-conformities and corrective actions. The testing system separate from the AS400 contains the history of batches produced with test results, quantity, supplier (for external purchases). For each product or raw material, the system contains specifications with the list of tests to be performed, even with historical versions. It generates reports and statistics. However, the interaction with the management system takes place for sampling plans, raw material arrival lists, and finished products/batches, but the data of the test itself resides in a separate system, with physical storage of counter-samples.

The management of non-conformities (NCs), both internal and external (towards suppliers or from customers), is codified at the document level through NC reports. However, this management is not supported by a centralized, integrated information system. There is no system-structured workflow for NC management, making it difficult to monitor their progress and actions taken.

Even processes such as retesting and extending product shelf life are managed based on physical counter-samples and email communications.

In summary, the management of the quality cycle (from inspection, to testing, NC management) is formally defined at a procedural level, as reported in *PSQ – 02 PRODUCT AND PROCESS CONTROL*, but operationally fragmented, not very traceable to the system and highly manual intensity. This situation makes data-driven continuous improvement less effective and can limit full compliance with more stringent regulatory requirements that demand full traceability of quality decisions.

3.6 Concluding remarks and need for improvement

The critical issues analyzed in the procurement, production, logistics and quality control processes highlight a Quality Management System that is heavily influenced by technological fragmentation and a lack of integration between systems and processes. The main limitations of the "as-is" situation can be summarized as follows:

- Widespread operating manual skills in key processes, which increases the risk of errors and reduces efficiency;
- Absence of structured and digitized workflows for approvals, non-compliance management, and quality control;

- Duplication of information between non-communicating systems (AS400, Oracle/SQL, SharePoint, vertical systems, manual registers);
- Decentralized and inconsistent management of material master data (e.g., duplicate codes, alternatives not managed in the system) and recipes/procedures;
- Only partial traceability for products, packaging, and raw materials, which compromises the ability to rebuild the entire supply chain in the event of problems;
- Non-unified document and management system.

This operational scenario, based on heterogeneous systems with poor interconnections and significant use of manual/paper-based processes, makes it difficult to fully implement the principles of a modern QMS oriented towards efficiency, traceability, and continuous improvement. Maintaining high standards of quality and regulatory compliance (as required by ISO 9001, MOCA, GMP, REACH, and FDA) becomes challenging and strongly dependent on manual operator attention.

Chapter 4 – ERP SMART: Why SAP S/4HANA instead of AS400

This chapter explores the digital transformation journey undertaken by the company to modernize its IT infrastructure and optimize core business processes. After decades of relying on the IBM AS/400 system, the organization recognized the need for a more agile and integrated solution capable of supporting its growing operational complexity, regulatory requirements, and the demands of a competitive market. The decision to transition to SAP S/4HANA was not merely technological but strategic, aiming to create a solid foundation for future innovation and process excellence.

The chapter is structured to guide the reader through this transition. It begins with an overview of the AS/400 system, highlighting its strengths as a legacy platform and the limitations that emerged as business needs evolved. This technical background is essential to understand the challenges faced during the migration. The focus then shifts to SAP S/4HANA, presenting its advanced capabilities in data processing, real-time analytics, and process integration. Special attention is given to migration strategies, including Greenfield, Brownfield, and Hybrid approaches, and to the rationale behind the company's choice of a Greenfield implementation. The discussion also considers supporting technologies such as SAP Business Technology Platform (BTP) and their role in extending system functionalities.

Finally, the chapter provides a comparative analysis of AS/400 and SAP S/4HANA within the company's operational context, illustrating how the transition impacted key areas such as Quality Management, supply chain coordination, and regulatory compliance. This progression sets the stage for the subsequent chapter, where the implementation process and measurable results are analyzed in depth.

4.1 AS400 Overview: Features and Limitations

The case study company had historically relied on IBM AS/400 platform, a robust and reliable legacy system that supported its core operations for decades until now.

Introduced in the late 1980s, AS/400 systems have undoubtedly supported corporate IT infrastructures and are currently used in various organizations thanks to their robustness and reliability[60]. They are designed to coordinate large volumes of data productively, using techniques such as hardware compression and hierarchical data management using tools like Automatic Storage Management (ASP) and Hierarchical Storage Management (HSM). These efficiencies optimize storage by compressing and arranging data across devices with different speeds and capacities[61].

However, with the adoption of SAP S/4HANA by other companies in the group, the limitations of the AS/400 system became increasingly apparent. The lack of integration with the modern SAP ecosystem created obstacles to the continuous flow of data, compromised report alignment, and made supply chain coordination more complex. In particular, critical quality and production data could not be easily shared between different entities, causing inconsistencies and delays in group-wide decision-making processes. In addition, the intensive use of paper printouts and email exchanges between departments and plants led to high paper consumption and significant time losses.

Despite its stability, AS/400 systems are based on legacy structures that, while stable, present significant challenges when integrating with modern ERP environments like SAP S/4HANA. For example, the AS/400 relies on Licensed Internal Code (LIC) frameworks, such as Technology Independent Machine Interface (TIMI) and System Licensed Internal Code (SLIC), which act as intermediaries between software and hardware. This design allowed IBM to transition from older CISC processors to RISC architectures without requiring users to improve implementations, a significant innovation at the time.

Another notable feature is support for logical partitions (LPAR), which allows the AS/400 to run multiple autonomous operating system instances on a single machine. This capability allows

[60] Van Looy, T. (2009). The IBM AS/400 A technical introduction. *IBM-AS400-technical-introduction. pdf*.

[61] Powers, S., Bradshaw, B., Lozano, P., Saldivar, O. T., & Singkorapoom, S. (2000). AS/400 Disk Storage Topics and Tools. *International Technical Support Organization International Business Machines*, *252*.

organizations to consolidate workloads and coordinate separate environments (e.g., production and test) within a single system[62].

However, these benefits have established limits in the context of digital transformation. The layered architecture and reliance on proprietary microcode complicate data extraction, conversion, and movement in SAP HANA's in-memory database, which seeks simplified, real-time data structures free of redundancies. Furthermore, while AS/400 supports robust data protection processes such as Device Parity Protection (DPY) and mirroring to guard against hardware failures, the manual nature of many operations, combined with limited supplementation capabilities, hinders the agility essential for today's business environments.

Although AS/400 systems have excelled in stability and performance over the past decades, their inherent complexity and isolation from current technologies highlight the need to migrate to advanced platforms such as SAP S/4HANA. Understanding these technical aspects is essential for designing appropriate migration strategies that minimize risks, optimize data coordination, and fully leverage the potential of next-generation ERP systems[63].

In the context of a migration to SAP S/4HANA, a thorough understanding of data management on AS/400 systems becomes critical. It is important to evaluate how data compressed and distributed in legacy systems can be extracted, converted, and reorganized to be fully compatible with SAP HANA's in-memory architecture, which eliminates the need for redundant and aggregated data, instead favoring real-time analytics.

The technical analysis of AS/400 data management provided not only a solid foundation for understanding the challenges of migrating from legacy systems but also proved instrumental in defining an integrated and optimized approach to SAP S/4HANA implementation. This phase was enriched by close collaboration between the consulting team and the client's in-house AS/400 specialists. Their deep knowledge of the legacy system's architecture and data flows allowed for a detailed mapping of critical processes, identification of potential bottlenecks, and anticipation of compatibility issues. This joint effort ensured that data extraction, transformation, and loading (ETL) activities were carefully planned and tested, minimizing the risk of disruptions during the go-live phase. Such synergy between external consultants and internal IT resources was a key success factor in achieving a smooth transition and guaranteeing business continuity throughout the migration process.

[62] Bitterer, A., & Leising, R. AS/400 Programming with VisualAge for RPG.
[63] Van Looy, T. (2009). The IBM AS/400 A technical introduction. *IBM-AS400-technical-introduction. pdf*.

4.2 Introduction to SAP S/4HANA: Innovation, Cloud, Approaches

This section examines the recent advancements and innovations of SAP S/4HANA Cloud and SAP BTP, focusing on their integration strategies, architectural frameworks, and transformative impact on business operations. By analyzing the platform's capabilities in areas such as low-code development, artificial intelligence, and predictive analytics, this research provides insights into how organizations can leverage these technologies to improve their competitive advantage and operational efficiency in an increasingly digital business environment.[64]

SAP S/4HANA represents a new generation of ERP systems designed to address the challenges of modern business environments, enabling companies to adopt integrated, real-time, and cloud-ready processes. Built on the in-memory SAP HANA database, this platform allows organizations to analyze and manage large volumes of data instantaneously, eliminating redundant data structures and supporting advanced analytics, predictive capabilities, and automation.

One of the most distinctive aspects of SAP S/4HANA is its ability to streamline complex business processes into end-to-end workflows that span across departments and geographies. This level of integration is particularly relevant for industries operating in regulated environments, such as food packaging, where quality, traceability, and compliance (MOCA, REACH, FDA) are critical.

SAP S/4HANA also embraces the cloud paradigm, offering deployment flexibility through on-premises, private cloud, and public cloud options. Combined with the SAP Business Technology Platform (BTP), organizations can extend and integrate their core ERP with custom applications, IoT solutions, and third-party services without modifying the underlying system. This modularity empowers businesses to innovate continuously while maintaining system stability.

When planning a migration to SAP S/4HANA, companies face a crucial strategic choice between three main approaches (schematized in the Table 5 below):

- Greenfield (Re-implementation): a full redesign of business processes and a fresh installation of SAP S/4HANA. This approach allows organizations to adopt SAP best practices, eliminate legacy system inefficiencies, and build a future-ready digital core;

[64]Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.

- Brownfield (System Conversion): a technical upgrade of the existing SAP ECC system to S/4HANA, preserving historical configurations and data. It is suitable for companies' seeking continuity and minimal disruption;
- Hybrid (Selective Data Transition): a flexible approach that combines elements of Greenfield and Brownfield, allowing selective migration of processes and data.

Criterion	Greenfield Approach	Brownfield Approach	Hybrid Approach
Timeline	Long (6-12+ months)	Medium (3-6 months)	Variable (4-9 months)
Cost	High	Medium	Medium-High
Historical Data	Limited (essential only)	Complete transfer	Selective transfer
Flexibility	Maximum (full redesign)	Limited (optimisations)	Balanced (mixed approach)
Risk Level	High (transformational)	Low (continuity-focused)	Moderate (integration challenges)
Best For	Obsolete systems	Stable SAP ECC systems	Partial modernisation needs
	Process reengineering	Compliance requirements	M&A integration scenarios
Customization	New best practices	Legacy adaptations	Mixed solution

Table 5 - Greenfield vs. Brownfield vs. Hybrid Approach

The company in this case study opted for the Greenfield approach after a careful evaluation of these strategies. The decision was influenced by several factors:

- The need to harmonize processes across all subsidiaries, as other group companies had already migrated to SAP S/4HANA;
- The opportunity to replace paper-based workflows with fully digital processes, especially in quality management and production;
- The desire to eliminate fragmented and manual legacy practices, enabling real-time data access and stronger process governance.

This choice also allowed the consulting team, in close collaboration with the client's AS/400 specialists, to design optimized workflows tailored to the company's regulatory requirements and operational challenges. During the pre-migration phase, joint workshops and technical assessments helped anticipate potential issues and ensured a smooth transition during the go-live phase.

The Greenfield implementation, supported by SAP S/4HANA and complemented by the potential of SAP BTP, marked a decisive step towards creating a fully integrated Quality Management System (QMS) capable of supporting the company's strategic growth and digital transformation objectives. While SAP Business Technology Platform (BTP) was not yet fully utilized during the initial implementation, the company is already exploring its potential for future enhancements. Planned developments include integrating supplier portals (SAP Ariba) and deploying mobile applications for maintenance management and quality KPI monitoring.

The emergence of SAP Business Technology Platform (BTP) represents a strategic response to the growing demand for integrated, cloud-native development and deployment environments. According to SAP's development guidelines, BTP has evolved from the previous SAP Cloud Platform, integrating comprehensive integration capabilities, advanced analytics, and AI services into a unified framework.[65] This evolution reflects the industry's broadest shift to platform-as-a-service (PaaS) solutions that enable rapid innovation and scalable application development. BTP's architecture specifically addresses the need for seamless integration between on-premises systems and cloud services, giving organizations the flexibility to manage hybrid environments while gradually transitioning to cloud-native operations.

This architecture facilitates simplified data processing by eliminating traditional aggregates and redundant data storage, resulting in a significant reduction in data footprint and improved system performance. Built-in analytics capabilities are integrated directly into transactional processes, enabling real-time business analytics without the need for separate data warehousing solutions[66].

In the specific context of the project, the company and the consulting team placed great emphasis on change management and user training, recognizing these as critical success factors for the adoption of new digital workflows and the full exploitation of SAP S/4HANA capabilities.[67]

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[65]Bhatia, R. (2025). Transforming Industries with SAP S/4HANA. *International Journal of Enhanced Research in Management and Computer Applications*, *14*(01), 01-07.

[66]Sharma, C. (2021). Financial advantages of leveraging SAP S/4HANA integration in retail: A quantitative study. *World Journal of Advanced Engineering Technology and Sciences, 1 (2), 98*, *113*.

[67]Vaka, D. K. *SAP S/4HANA: Revolutionizing Supply Chains with Best Implementation Practices*. AQUA PUBLICATIONS.

4.3 AS400 vs SAP S/4HANA Comparison in the Company Context

The migration from IBM AS/400 to SAP S/4HANA represented a crucial turning point for the company's digital transformation journey, particularly in the management of its Quality Management System (QMS). This section provides a detailed comparison between the two systems, focusing on their impact on core business processes, regulatory compliance, and operational efficiency within the organization.

Under AS/400, quality-related workflows were fragmented, with separate systems and manual interventions required for batch tracking, supplier management, and audit preparation. In contrast, SAP S/4HANA introduced a fully integrated environment where data flows seamlessly across departments, enabling real-time monitoring and end-to-end process governance.

Key improvements achieved with SAP S/4HANA include:

- Centralization of material and supplier master data, reducing errors and ensuring consistency across all subsidiaries;
- Automation of quality checks and defect reporting, cutting down approval times by 50%;
- Full batch traceability supporting over 250 batches monthly, enhancing responsiveness during customer inquiries and audits;
- Implementation of dashboards and KPIs, allowing the Quality team to monitor performance proactively rather than reactively.

These changes were made possible through a Greenfield approach, which allowed the company to redefine processes without the constraints of legacy systems. The consulting team collaborated closely with the client's internal IT specialists to extract only critical data for migration, ensuring regulatory compliance while archiving non-essential historical data externally.

To illustrate the contrast between the two systems, Table 6 highlights the most relevant features and their impact on quality operations.

Feature	IBM AS/400	SAP S/4HANA
Data Structure	Hierarchical, rigid	In-memory, real-time
Batch Traceability	Partial, manual interventions	100% automated and integrated
Audit Preparation	Manual, ~2 weeks	Automated, reduced to ~2 days
Supplier Management	Decentralized	Centralized portal (future SAP Ariba)
User Interface	Command-line, green screen	Fiori-based, user-friendly, mobile access
Reporting	Periodic, manual	Real-time dashboards and analytics
	Limited	High, supports process redesign
Regulatory Compliance	Manual tracking (MOCA, FDA, REACH)	Automated tracking and alerts

Table 6 - AS/400 vs SAP S/4HANA: Key Differences for QMS

This comparison demonstrates how the transition to SAP S/4HANA has not only enhanced system performance but also positioned the company for future digital initiatives, such as the planned adoption of SAP Ariba for supplier collaboration and SAP PM for maintenance management.

The Greenfield methodology, though requiring a significant initial investment and intensive workshops for process redesign, allowed the company to align operations with SAP best practices and meet the growing demands for quality, compliance, and efficiency.

4.4 Business choices, expected benefits, focus on SAP MM

MRP is now widely used by companies around the world, as it gives them visibility into future demand trends and helps them plan the procurement of raw materials needed for production. The SAP MM module offers a complete tool for managing materials, inventory, and purchasing processes.[68] Whether it's simplifying supply chain management, improving financial reporting, or enhancing customer service, these goals will guide the entire implementation process.

[68]Wang, Y., Liao, Y., Liu, H., Liu, H., Wang, Y., & Wang, Y. (2024). Mm-sap: A comprehensive benchmark for assessing self-awareness of multimodal large language models in perception. *arXiv preprint arXiv:2401.07529*.

During the planning phase, companies should define the scope of the implementation. This includes selecting the specific SAP modules to be implemented[69], such as SAP Financial Accounting (FI), Materials Management (MM), or Customer Relationship Management (CRM). Proper scoping helps avoid project creep and ensures that the system meets the needs of the organization. In addition, it is crucial to allocate appropriate resources, budget, time, and staff. A realistic budget that takes into account software, hardware, consulting costs, and training costs helps prevent unexpected financial hurdles.

Before being activated, it is critical to conduct thorough testing of the SAP system. These include system testing to verify its functionality, user acceptance testing (UAT) to ensure that the system meets business needs, and performance testing to validate the system's ability to handle the expected workloads.[70] Quality control ensures that the system is fully functional and ready for implementation. The evaluation phase takes place after SAP is implemented and operational. This phase ensures that the system continues to meet organizational objectives and deliver the expected benefits. Once the system is activated, companies must constantly monitor its performance.[71]

To ensure long-term success, SAP requires regular maintenance, including system updates, patches, and enhancements. SAP capabilities should be reviewed periodically to ensure that the system remains up to date with the latest security features and standards. Maintenance helps prevent system downtime and ensures that the organization continues to derive value from it. User feedback is valuable in the post-implementation phase.[72]
Continuous improvement is key to maintaining an efficient and intuitive SAP environment.

[69]Chandraju, S., Raviprasad, B., & Kumar, C. (2012). Implementation of system application product (SAP) materials management (MM-Module) for material requirement planning (MRP) in sugar industry. *International Journal of Scientific and Research Publications*, *2*(9), 1-5.

[70]Wang, Y., Liao, Y., Liu, H., Liu, H., Wang, Y., & Wang, Y. (2024). Mm-sap: A comprehensive benchmark for assessing self-awareness of multimodal large language models in perception. *arXiv preprint arXiv:2401.07529*.
[71]Kirana, D. A., Saputra, M., & Puspitasari, W. (2021). Enterprise Resource Planning of Procurement Process with SAP MM Module. *International Journal of Innovation in Enterprise System*, *5*(1), 55-64.
[72]Chandraju, S., Raviprasad, B., & Kumar, C. (2012). Implementation of system application product (SAP) materials management (MM-Module) for material requirement planning (MRP) in sugar industry. *International Journal of Scientific and Research Publications*, *2*(9), 1-5.

Chapter 5 - SAP S/4HANA Implementation and QMS Enhancements

For the company under study, the adoption of SAP S/4HANA represented a crucial step towards the digitization of business processes, with the aim of ensuring greater integration, control and traceability along the entire value chain. The project, spread over a period of 9 months, was structured according to the phases provided by the SAP Activate framework, suitably adapted to the organization's operational context.

Personally, I took part in the project from the *Realize* phase, actively contributing to the system configuration, user documentation management, training and support activities up to the *post go-live* phase. My direct involvement allowed me to closely observe the evolution of the system and the concrete impact on users' daily activities.

This chapter will illustrate, stage by stage, the main activities carried out, the design choices made, and the difficulties faced, with a special focus on the functional and organizational aspects that characterized the implementation of SAP S/4HANA within the company.

5.1 Project Phases

5.1.1 First Project Phase: Prepare Phase

During the "Prepare" phase, the consultancy firm DIGIX PLUS SRL where I did my internship aligned with the client company, which remains anonymous in our analysis in order to identify business requirements and needs while aligning with the client's business strategy. The expected benefits are mainly process optimization, improved reporting, reduced total company costs and reduced operating time. In this first phase, the consulting company analyzed the size of the company, the size of the workforce, any peculiarities dictated by the location of the company branch, or the nature of the sector under consideration, and also the software already in use in the company.[73] An example of a peculiarity that the consulting company is particularly keen to take on board is whether or not the company already has management software, so that the new software can be adapted along the lines of the existing one, in order to make it easier for employees in the various company areas to use.

Once all the necessary data has been collected in order to be able to proceed, the "prepare" phase mainly concerns the definition of the business objectives and the choice of the migration scenario.

[73] Vaka, D. K. *SAP S/4HANA: Revolutionizing Supply Chains with Best Implementation Practices*. AQUA PUBLICATIONS.

The migration scenario in particular can be of 3 types: Greenfield, Brownfield or Hybrid.[74] The company, as said before, chooses the first one.
In addition to the choice of migration scenario, the "prepare" phase requires careful management of three fundamental aspects:

- Selection of Implementation Partner;
- Constitution of the project team: Definition of roles (Project Manager, Functional/Technical Consultants, Key Users, etc.);
- Budget and time planning.

5.1.2 Second Project Phase: Explore Phase

The "Explore" phase represents the moment when the project takes concrete shape, transforming the strategic objectives into a detailed operational plan. It is here that the company, in collaboration with DIGIX PLUS SRL, delved deep into its processes to design a tailor-made SAP S/4HANA solution. This was a period of discovery and design, where every activity was aimed at understanding not only how the company operates today, but more importantly, how it could do so tomorrow by exploiting the potential of the new platform. Through intensive workshops, technical analysis and co-design sessions, the project team examines every aspect of the existing operating environment, identifying critical issues, opportunities for improvement and constraints to be met. The main objective is to create a clear and shared blueprint, a document that serves as a map for the next steps.[75] This includes not only the technical configuration of the system, but also the redesign of key processes, the data migration plan, and integrations with other business tools. In this phase, the dialogue between us consultants and business users become crucial. The key users, those who know the day-to-day processes best, worked hand in hand with the SAP experts at DIGIX PLUS SRL to translate operational requirements into effective digital solutions. Each choice is validated through prototypes and simulations, ensuring that the final solution is not only technically sound, but also practically usable.

The "Explore" phase is also the time when sensitive issues such as change management are addressed. The introduction of a new ERP system changes the way people work, and it is essential to prepare the organization for this transition at an early stage. Targeted training sessions, interactive

[74] Matilainen, A. (2024). Change requirements on product data structures in S/4HANA implementation.
[75] Kulkarni, S. (2019). Implementing SAP S/4HANA. *Implementing SAP S/4HANA*.

demonstrations and a structured communication plan help to build awareness and reduce resistance. At the end of this phase, the company will have a clear vision of the path to follow which processes will be optimized, which data will be migrated, how the new system will integrate with the existing infrastructure, and, above all, what concrete benefits can be expected. This is the solid basis on which to build the subsequent configuration, testing and go-live phases.

In the following, the activities that make up the Explore phase will be explored in detail, showing how process analysis, gap analysis and solution design contribute to turning strategy into operational reality.[76]

In this phase, the project team-composed of SAP consultants, business key users and IT managers-works to define what will be implemented, how the system will be configured and what data will have to be migrated. The first step is to select the SAP S/4HANA modules best suited to the company's needs. Each module addresses specific operational needs:

- FI/CO for financial management and controlling;
- MM (Material Management) for purchasing, warehousing and logistics;
- SD (Sales and Distribution) for sales and distribution;
- PP (Production Planning) for production planning;
- WM (Warehouse Management) for advanced warehouse management.

The selection of the SAP S/4HANA modules was not random but resulted from a careful analysis of the core processes and the specific needs of the chemical-manufacturing sector in which the company under review operates. In this specific case, a manufacturer of paints and inks, the choice of the **FI (Finance), MM (Material Management), PP (Production Planning) and SD (Sales and Distribution)** modules responds to precise operational and strategic needs.

FI (Financial Accounting) & CO (Controlling)

In the context of a paint and ink company, the FI (Financial Accounting) and CO (Controlling) modules of SAP S/4HANA go far beyond simple accounting, becoming true financial governance tools. The very nature of this industry, characterised by the use of expensive raw materials that are subject to strong price fluctuations, such as resins, pigments and special solvents - requires

[76] Bhatia, R. (2025). Transforming Industries with SAP S/4HANA. *International Journal of Enhanced Research in Management & Computer Applications*, *14*(01), 01-07.

particularly sophisticated financial control. There were other important considerations that were taken into account such as[77]:

- **Advanced financial reporting**: Need to track margins by product line, especially for customers in diversified sectors (e.g., pharmaceutical vs. food);
- **Regulatory Compliance**: Chemical sector with stringent regulations on safety and sustainability (e.g., VOC solvent traceability).

MM (Material Management)

In a company like the one examined in this paper, the management of raw materials represents a complex challenge, requiring precision, traceability, and integration with production processes. The **Material Management (MM)** module of SAP S/4HANA thus becomes an indispensable tool for ensuring operational efficiency and regulatory compliance.[78]

1. *Management of Critical Raw Materials*

Paints and inks are composed of ingredients that are often subject to stringent regulations, such as **VOC solvents** or pigments regulated by **REACH**. The MM module enabled **complete traceability by batch**, ensuring that each component is tracked from purchase to transformation into a finished product. This capability has been crucial not only for compliance, but also for managing any recalls or audits.

Another critical issue was the **limited shelf-life** of certain chemical additives, which can degrade or lose effectiveness if stored too long. SAP MM helped to optimise stocks, generating **automatic alerts** when materials approached their expiry date and suggesting reordering based on production needs by creating a customised report that could be used by anyone who requested or will request it.

In the operational context in which the company operates, although it does not have a fully automated system for generating purchase orders, a highly efficient process has been implemented that still guarantees perfect alignment between production and procurement even six months after the go-live phase.

[77] Consultancy, A. W., Blain, J., Sandison, D., & Dodd, B. (1998). *Administering SAP R/3: the FI-financial accounting and CO-controlling modules*. Que Corp..

[78] Houlihan, J. B. (1985). International supply chain management. *International journal of physical distribution & materials management*, *15*(1), 22-38.

2. Semi-Automatic Reordering System

The MM module generates procurement proposals based on[79]:

- Production plans (from module PP);
- Minimum predefined stocks;
- Supplier lead time.

These proposals come:

- Visualized in dedicated dashboards and customized reports created specifically for the company;
- They are audited by the purchasing department consisting of three employees including the purchasing manager who has direct contact with suppliers and negotiates raw material prices;
- Manually converted into orders with a few clicks without the creation of a purchase requisition (implemented only for non-stock purchases i.e., services and consumables) and thus without an approval workflow. Purchase orders are sent by e-mail to the purchasing manager, who supervises them and rejects them if necessary. It is not a blocking process in the strict sense of the term, as the purchasing department employees still have the possibility to download the order and send it by e-mail to the supplier.

PP (Production Planning)

The PP (Production Planning) module of SAP S/4HANA has played a key role in the management of batch processes, which are characterized by complex recipes and variable parameters. The correct management of formulations is particularly critical, considering that the same paint may require several variants depending on the target climate or specific application. The system allows the storage and management of hundreds of formulations, guaranteeing maximum precision in the reproduction of technical characteristics. Optimization of process times is another crucial aspect. Phases such as mixing and curing require precise timings, which the system helps to meet through[80]:

- Automated machining programming;

[79] Tong, C. (2023). An Efficient Intelligent Semi-Automated Warehouse Inventory Stocktaking System. *arXiv preprint arXiv:2309.12365*.

[80] Er, M., Arsad, N., Astuti, H. M., Kusumawardani, R. P., & Utami, R. A. (2018). Analysis of production planning in a global manufacturing company with process mining. *Journal of Enterprise Information Management*, *31*(2), 317-337.

- Real-time monitoring of critical parameters;
- Efficient allocation of production resources.

Each in-line inspection - whether it is measuring viscosity or checking colour shade - is recorded and associated with the corresponding batch, ensuring complete traceability from raw material to finished product. This level of detail is proving particularly valuable in the event of complaints or verification requests from customers.

SD (Sales and Distribution)

On the commercial side, the SD module was able to meet the particular challenges of a market that demands high levels of customization. The management of orders takes into account the technical specifications required by each of the company's customers, where even slight variations in colour shades can represent substantial differences. The system has made it possible to[81]:

- Creating customised product configurations;
- Managing complex sales conditions;
- Apply automatisms for volume discounts or special contractual clauses.

Logistics was another crucial issue, considering the hazardous nature of many products. The system handles automatically:

- All documentation required for ADR transport;
- Mandatory Regulatory Labelling;
- Specific storage and handling conditions.

Integration with advanced labelling systems completes the picture, ensuring that each package carries all the information required by international regulations. This level of operational detail, combined with flexibility in commercial management, has made it possible to reconcile customisation needs with the strict regulatory requirements of the chemical sector[82].

[81] Sharma, K., & Mutsaddi, A. (2010). *Configuring SAP ERP sales and distribution*. John Wiley and Sons.
[82] Er, M., Arsad, N., Astuti, H. M., Kusumawardani, R. P., & Utami, R. A. (2018). Analysis of production planning in a global manufacturing company with process mining. *Journal of Enterprise Information Management*, *31*(2), 317-337.

In the implementation of SAP S/4HANA, a phased strategy was adopted with the aim of optimising resources and ensuring a controlled transition. Some modules, although relevant, were classified as non-priority in the initial phase, as current operational needs are already covered by alternative solutions or integrated functionalities. These include the Quality Management module, Warehouse Management and Plant Maintenance.

QM (Quality Management) - Managed via PP

Although the QM module offers advanced functionality for quality control, the company assessed that the current requirements are sufficiently covered by the functionality embedded in the PP (Production Planning) module**.**In particular[83]:

- Batch traceability and the recording of quality parameters are already managed in PP;
- Compliance audits and non-conformity management are supported by existing processes.

Future plan:

Should more complex requirements emerge (e.g., integration with external laboratories or advanced test automation), the adoption of the QM module may be considered later.

WM (Warehouse Management) - Not necessary for low volumes

The company manages a warehouse with limited volume and complexity, making the basic functionalities of the **MM (Material Management)** module sufficient for:

- Inventory management;
- Material handling;
- The traceability of stocks.

Future plan:

Should business expansion require more advanced management (e.g., picking optimisation, management of multiple warehouses), WM can be implemented at a later stage.

PM (Plant Maintenance) - Third Party System already established

[83] Murat Kristal, M., Huang, X., & Schroeder, R. G. (2010). The effect of quality management on mass customization capability. *International Journal of Operations & Production Management*, *30*(9), 900-922.

Plant maintenance is currently managed through external specialised software. The adoption of SAP's PM module was therefore considered redundant, as[84]:

- The existing system covers all preventive and corrective maintenance needs;
- There is currently no need to duplicate functionality already available.

Future plan:
If the current system shows limitations or more integration with SAP is required, the implementation of PM may be considered.

Business Requirements Analysis for the MM module

During the Explore phase, a series of workshops were conducted with the aim of:

1. Mapping existing processes (AS-IS) in the legacy system (AS400);
2. Define future processes (TO-BE) in SAP S/4HANA, aligning them with the system's best practices;
3. Identify gaps between the standard SAP functionality and the specific needs of the company. Each workshop involved key departments (Purchasing, Logistics, Administration, Production) and was facilitated by one or more SAP consultants from DIGIX PLUS SRL, with an average duration of 2 hours per session.

In particular, six workshops were conducted focusing on the Materials Management (MM) module, with the aim of:

- Streamlining the management of the purchase-commodity-payment cycle;
- Improving material traceability;
- Optimising supplier management.

The workshops are detailed as follow:

1. WORKSHOP 1: Procurement Master Data - 17 April 2024;

[84] Bamber, C. J., Sharp, J. M., & Castka, P. (2004). Third party assessment: the role of the maintenance function in an integrated management system. *Journal of Quality in maintenance Engineering*, *10*(1), 26-36.

2. WORKSHOP 2: Non-Stock Purchases - 22 April 2024;
3. WORKSHOP 3: Raw Materials - 23 April 2024;
4. WORKSHOP 4: Freight Receipts – 24 April 2024;
5. WORKSHOP 5: Vendor Returns Management - 3 May 2024;
6. WORKSHOP 6: Purchasing Reporting - 19 June 2024;

WORKSHOP 1: Procurement Master Data - 17 April 2024

During the first workshop, the topics were:

- Supplier Master Data;
- Material master data - purchasing, plant and stock management views.

The participants present were:

- The purchasing department consists of 3 people;
- The administration office consists of 3 people;
- The technical secretariat consists of 2 people;
- Process integration & ERP Service Director;
- SAP MM Consultant of DIGIX PLUS.

Supplier Master Data

The management mode on SAP S/4HANA of business partners with supplier role was shared via the dedicated Fiori application within the user launchpad.
The main fields in the General Data, Company Data and Purchasing Data sections were analysed by introducing the organisational structure elements defined in SAP S/4HANA for the company (MLIT Company, ML01 Division, ML01 Purchasing Organisation).
The internal numbering range (progressive numbering from 300000 to 399999) already used today for the creation of suppliers received via the AS400 interface was shared.[85]
The creation of new suppliers, which from January 2025 will have to be created directly on SAP, will follow the current procedure, i.e.: the purchasing department (MLIT's buyers), which manages contact with suppliers, will, in the case of a new creation, send the administrative department the

[85] SAP, A. (2018). sap. *Emergency*, *956*, 381-2206.

general master data (company name, VAT, address, country, language) and the payment conditions negotiated with the supplier.[86]

The administration will create on SAP the new supplier generates the code, which will then be communicated to procurement.

Thus, there were no unmanaged peculiarities of SAP's standard functionalities.

Material Master

The methods of creating, editing and displaying the material master data on SAP S/4HANA using the dedicated Fiori applications were analysed.

The system-defined material types with which the company's material master data was created via an AS400 interface were shared during the workshop[87]:

- ZFER for finished products;
- ZHAL for semi-finished products;
- ZROH for raw materials;
- ZVER Packaging.

Before the go-live in January 2025, the Technical Secretariat already managed the creation of new materials, but through an interface with the AS400 system. With the implementation of SAP S/4HANA, the process was migrated to the new platform with the same ownership, but with completely redesigned tools and workflows. From January 2025, the Technical Secretariat will therefore continue to be responsible for the creation of material master data, now directly in SAP.

The purchasing department, which handles contact with suppliers, or the R&D department directly, will send the technical secretariat the technical data sheet of the new material, the customs code (HScode) and a hypothetical price.

The technical secretariat will then create the new code in the system by entering the information for which it is responsible and will communicate the code to the other offices. It will be necessary to define an operational procedure to involve the other parties that will have to enrich the registry with the data for which they are responsible (e.g., the Purchasing office to open the code on the ML01 plant, the Sales office to open the code on the sales area, the Production secretariat to enter the data necessary for the production of finished and semi-finished products).[88]

[86] Färber, F., May, N., Lehner, W., Große, P., Müller, I., Rauhe, H., & Dees, J. (2012). The SAP HANA Database--An Architecture Overview. *IEEE Data Eng. Bull.*, *35*(1), 28-33.
[87] Kulkarni, S. (2019). Implementing SAP S/4HANA. *Implementing SAP S/4HANA*.
[88] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.

In the operational continuity between AS400 and SAP, the management of packaging codes retains the same organizational approach: the Factory Automation Manager, a figure already responsible for this activity in the legacy system, will continue to be the only one enabled to directly create these records also in the new SAP S/4HANA platform.[89]

During the workshop, the main fields of the material master were also analyzed, focusing on purchasing views, MRP views and Accounting 1.

One of the most discussed aspects was the **'goods group' field**, which will require the definition of a dedicated list to correctly classify the different types of products. During the session, the need emerged to standardize these values to ensure consistency between departments, avoiding duplications or inconsistencies. In addition, the use of the **alternative unit of measurement**, with the relevant conversions, was explored, which will allow purchase orders to be managed flexibly, for example when a supplier uses a different unit of measurement from the internal one.

In the **MRP planning** section, the fields required to manage the automatic procurement of raw materials were examined. In fact, the system would be able to generate purchasing proposals based on production requirements and available stocks, thereby optimizing reordering. However, during the workshop, it was decided **not to activate automatic planning immediately**, preferring manual management by the purchasing department in the initial phase. This choice was motivated by the desire to maintain greater control during the transition period, with the possibility of re-evaluating the activation of the MRP at a later date, perhaps starting with just a few critical master data.

Finally, we analyzed the fields in the **Accounts 1 view**, which are fundamental for cost and inventory management. In particular[90]:

- **Price control**:
  - *Moving average (V)* for raw materials, to reflect changes in cost over time;
  - *Standard (S)* for finished products, based on a predefined cost.[91]

- **Classes of enhancement**:
  - 3000 for raw materials;
  - 3050 for packaging;

[89] Bardhan, D., Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., ... & Worsley-Tonks, A. (2017). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.

[90] Baker, K. R. (1993). Requirements planning. *Handbooks in operations research and management science*, *4*, 571-627.

[91] Murthy, D. N. P., & Ma, L. (1991). MRP with uncertainty: a review and some extensions. *International Journal of Production Economics*, *25*(1-3), 51-64.

- 7920 for finished products;
- T900 for semi-finished products.

These values are essential for updating prices and correctly targeting stock and cost accounts.
During this first workshop, no particularities were found that were not handled by the standard SAP S/4HANA functionality

WORKSHOP 2: Non-Stock Purchases - 22 April 2024

During this meeting, the workshop topics were:

- Non-stock purchases - Services, assets, indirect material;
- Purchase request management;
- Approval of purchase request;
- Creation of purchase order with reference to purchase request;
- Entry of goods against non-stock purchase order;
- Purchase reporting.

The participants present were:

- The purchasing department consists of 3 people
- The technical secretariat consists of 2 people
- Management **Assistant**
- Process Integration & ERP Service Director
- SAP MM Consultant

Purchase Request Management

The purchase of indirect (non-stock-managed) material, services and assets will follow the standard replenishment process, which involves the issuance of a purchase requisition (PO), its approval and conversion into an order (PO) by the purchasing department.[92]
The use of the purchase requisition is not compulsory and binding but represents a functionality and procedural step that we want to integrate into the current process, with the aim of recording in the

[92] Bharadia, R., Charkha, A., Thombre, S., Chhajed, J., & Bangad, S. (2021, December). Purchase Request Management System. In *2021 International Conference on Computational Performance Evaluation (ComPE)* (pp. 636-641). IEEE.

system all the purchase requisitions that arrive at the purchasing office in paper form with AS400, thus introducing an additional element of control for the procurement of this type of purchase.[93]
The method of creating, modifying and monitoring RoAs with a dedicated Fiori application was then shared. As foreseen by the configuration for group companies, a specific type of RdA dedicated to the company in question will be prepared in SAP S/4HANA with a dedicated numbering range.
The two accounting methods to be used, K cost centre and U unknown accounting for the purchase of assets, were explained.
The functioning of the Fiori application used for the approval of RFAs was analysed, illustrating the possible configurations provided by the approval workflow system. Approval processes can thus be differentiated by[94]:

- Plant;
- Purchasing Group;
- Accounting category (K cost centre U purchase assets);
- Goods group;
- Cost Centre;
- Cost centre manager;
- Purchasing Group.

In the project phase, approval workflows will then be configured in the system according to the required requirements. At this stage, it was not yet known who should approve the requests and what the differentiating elements of the workflows were. Evidence then emerged during the realise phase (May 2024).

Non-stock purchase order management in SAP S/4HANA

The Fiori application, which allows the creation of a purchase order in the three modes, was analysed[95]:

- Creation of PO without reference;

[93] Kartikaningdyah, E., & Agustina, A. (2016). Purchase Request through Epicor System in Manufacturing Company. *Journal of Applied Accounting and Taxation*, *1*(1), 32-36.
[94] Kartikaningdyah, E., & Agustina, A. (2016). Purchase Request through Epicor System in Manufacturing Company. *Journal of Applied Accounting and Taxation*, *1*(1), 32-36.
[95] Ojha, R., & Jaiswal, C. M. (2023). Asset Management Integration with Other S/4HANA Business Applications. In *SAP S/4HANA Asset Management: Configure, Equip, and Manage your Enterprise* (pp. 313-336). Berkeley, CA: Apress.

- Creation of PO from purchase request;
- Creation of PO from purchase order.

The information that can be managed within the purchase document has been deepened, the document type of which will be coded ad hoc for the MLIT company[96]:

- Header data
- Terms of Payment
- Partner roles
- Header texts to appear in the order press
- Offer Reference and Vendor Supplier
- Position data
- Accounting (K Cost Centre, H Asset)
- Goods group for the allocation of the relevant cost account
- Price and any price conditions for surcharges or discounts
- Invoice control flag referring to incoming goods
- Position texts to be printed
- Creation of asset master data

The printout of the purchase order already implemented in the group company in Southern Italy was viewed, showing the relevant information. As far as sending the printout by email is concerned, the functionality is to be provided but will be used at the discretion of the purchasing department.[97]
Once the purchase order was created, the goods receipt process was viewed with the dedicated Fiori application. The incoming goods process will continue to be performed by the logistics (goods receiving office) for this type of order as well.
Finally, the main standard reports for searching and monitoring purchase orders created in the system were shared.
There are therefore no particularities in the non-stock purchasing process that are not covered by the standard features.

[96] Ojha, R., & Jaiswal, C. M. (2023). Asset Management Integration with Other S/4HANA Business Applications. In *SAP S/4HANA Asset Management: Configure, Equip, and Manage your Enterprise* (pp. 313-336). Berkeley, CA: Apress.
[97] Ojha, R., & Jaiswal, C. M. (2023). Business Processes in Asset Management. In *SAP S/4HANA Asset Management: Configure, Equip, and Manage your Enterprise* (pp. 125-202). Berkeley, CA: Apress.

WORKSHOP 3: Raw Materials – 23 April 2024

The workshop topics were:

- Analysis of the current planning and procurement of raw materials with supporting AS400 reports/queries;
- Supplier list management on SAP S/4HANA with technical specification management;
- Raw material purchase order creation on SAP S/4HANA;
- Company price scheme;
- Print layout purchase order and fixed texts.

The participants present were:

- The purchasing department consists of 3 people;
- Process integration & ERP Service Director;
- SAP MM consultant.

Raw material procurement planning

AS-IS process (AS/400)

In the current AS400 system, the planning of the purchase of raw materials is not managed with the help of the MRP by automating the creation in the system of order proposals to be confirmed to the various suppliers.[98]

On a daily basis, the purchasing department using mainly two reports has evidence:

- of the stock in the system;
- of the quantity committed against production orders;
- of the quantity already ordered with reference to the order number sent to the supplier and the confirmation received from the supplier on the delivery date and quantity available. The confirmation is not a structured piece of information managed in the system, it is simply a note entered manually by the purchasing department, after receiving the delivery date and

[98] Bogatov, I., & Chalyi, S. (2021). The Usage of The Technology of Constructing "AS-IS" Models of Initial Maturity Levels of Process Management. *COMPUTER AND INFORMATION SYSTEMS AND TECHNOLOGIES*.

quantity from the supplier (the ordered quantity may be confirmed by the supplier with different delivery dates, which are recorded in the report).

This is important information because based on the confirmed quantity and the delivery date there is evidence of the coverage of the planned production and a possible reorder.

Automatic alerts, reorder points and safety stocks are therefore not managed[99].

During the workshops conducted with key users in the requirements gathering phase, some operational screenshots of the legacy AS400 system were captured to document existing processes and support the identification of critical issues to be resolved in the future configuration of SAP S/4HANA.

The image below represents a typical screen shot used daily by users for managing article availability and stock movement. This visual evidence played a key role in the **realize** phase, allowing the project team to accurately map out the functionality to be replicated or improved in the new system.

The interface is in Italian, as provided by the company in the original system.

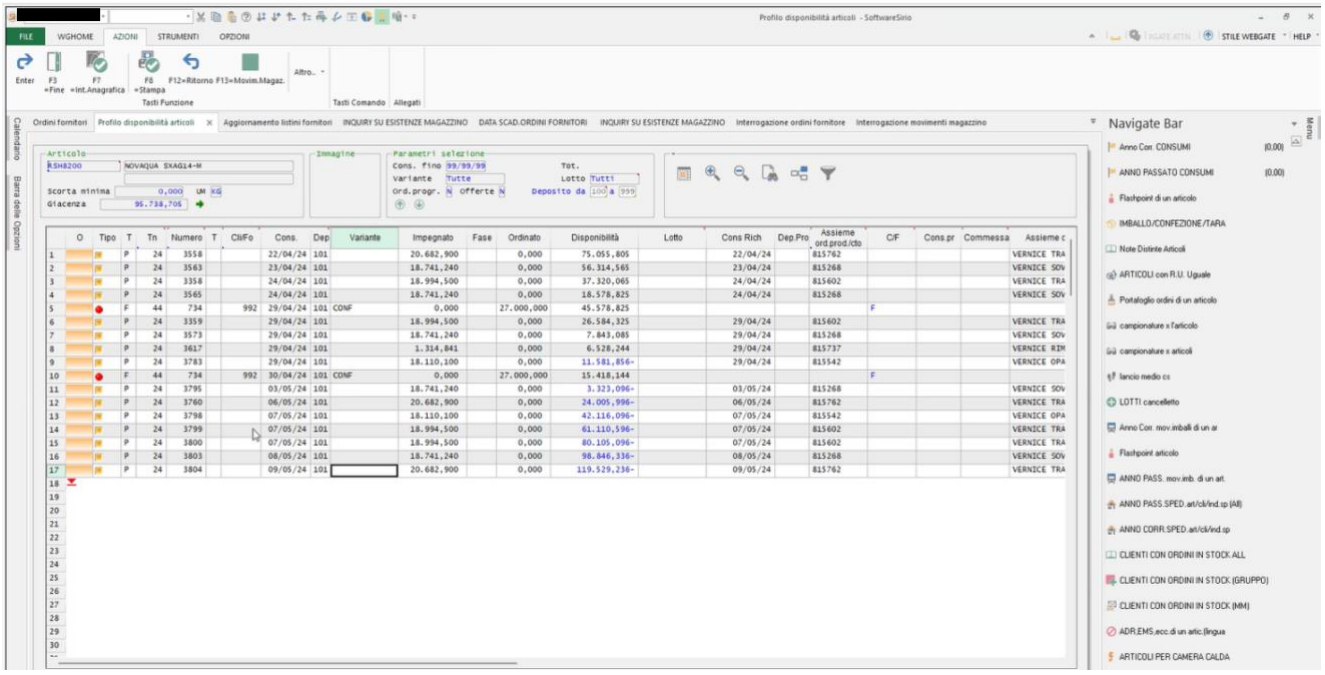


Figure 15 – "Products Availability Profile" screen from the legacy AS/400 system

In addition to the two reports mentioned above, they are used to plan raw material purchases:

[99] Bogatov, I., & Chalyi, S. (2021). The Usage of The Technology of Constructing "AS-IS" Models of Initial Maturity Levels of Process Management. *COMPUTER AND INFORMATION SYSTEMS AND TECHNOLOGIES*.

- monthly consumption analysis report by year, the analysis is made by consulting the consumption of the previous year or the two years preceding the launch date;
- ordered historical analysis report.

Before the implementation of the new software, production provides purchasing with a planning, i.e. a visibility of the possible consumption of raw materials, of one week/10 days, it is therefore necessary to analyze the consumption and order history in order to be able to give the suppliers a forecast.
Based on the analyzed reports, the purchasing department then issues the order to the supplier.

TO-BE process (SAP S/4HANA):
Also, on SAP S/4HANA there are no plans to use MRP-based planning to manage the procurement of raw materials, it will be evaluated later whether to start using it for the most critical raw materials.[100]
It is therefore necessary to provide the purchasing department with a report that gives an indication, as it does today on AS400 for each raw material:

- of the quantity in stock;
- of the quantity committed by production orders;
- of the quantity already ordered from the supplier with date and confirmed quantity.

In this regard, consideration will be given to whether to integrate the current customised report used for the other group companies, **Stock Requirement**, which was created to monitor finished products, or whether to use the intended applications of the standard (which corresponds to the collective SAP MD04 transaction).[101]
For confirmation management, it is proposed to use manual confirmation control on SAP S/4HANA, so that the date and the actual quantity confirmed by the supplier can be traced within the purchase order.
For consumption history reports by month/year and ordered history, standard SAP reports can be used:

[100] Kulkarni, S. (2019). Implementing SAP S/4HANA. *Implementing SAP S/4HANA*.
[101] Kulkarni, A. (2024). Digital Transformation with SAP Hana. *International Journal on Recent and Innovation Trends in Computing and Communication ISSN*, 2321-8169.

- MB51 (transaction code on SAP) analysis of consumption movements for a certain time range;
- Monitor purchase order positions.

Alternatively, the implementation of customized reports will be considered in later stages.
It was also pointed out that the purchasing department will still need to be able to consult (for a period to be defined) the AS400 system in order to have evidence of historical data from previous years that will not be present in SAP S/4HANA even after the go-live in January 2025.[102]

Supplier list management on SAP S/4HANA

During the analysis of the procurement processes, a substantial difference emerged between the management of price lists in AS400 and that provided in the SAP S/4HANA system. On AS400 there is no structured concept of a *supplier price list*: the economic conditions applied to a purchase are not systematically linked to the **material-supplier** pair but are managed separately or entered manually within orders. In addition to being fragmented, this approach exposes the company to the risk of price inconsistency, slows down the work of the purchasing departments and limits the possibilities of automatic control by the system.[103]
SAP S/4HANA, on the other hand, introduces an integrated model by means of *Info Records* (or in Italian, *purchase information* records), which allow the material-supplier combination to be stored in a structured and durable manner. Within each info record it is possible to enter price conditions with time validity, alternative codes used by the supplier, standard delivery times, descriptive texts or technical specifications relevant to the purchased material. This information is then called up automatically during the creation of the purchase order, ensuring consistency and operational speed.[104]
During the project workshops, the standard SAP applications for creating and editing these price lists were analyzed. Mandatory fields to be entered, such as the base price and condition validity, were shared, as well as optional fields, including the supplier material code and purchase texts. The latter allow, for example, technical specifications to be automatically entered in the order without the user having to enter them manually each time.

[102] Bhatia, R. (2025). Transforming Industries with SAP S/4HANA. *International Journal of Enhanced Research in Management & Computer Applications*, *14*(01), 01-07.
[103] Schneider, R. (2020). *Practical Guide to SAP Business Partner Functions and Integration with SAP S/4HANA*. Espresso Tutorials GmbH.
[104] Schneider, R. (2020). *Practical Guide to SAP Business Partner Functions and Integration with SAP S/4HANA*. Espresso Tutorials GmbH.

No particularities previously managed in AS400 emerged that required specific replication in SAP, precisely because the very concept of a supplier list was absent in the old system. The move to SAP therefore represents a significant evolution from the point of view of standardization and efficiency in the purchasing process.

Raw material purchase order creation on SAP S/4HANA

The structure and method of creating a purchase order for raw materials on SAP S/4HANA was analyzed.[105]

In addition to the price automatically inherited from the supplier price list, the remaining price conditions that are expected to be managed within the company's price scheme were shared:

- ZPB0: list price
- ZA01: % surplus from gross
- ZB00: Major. Absolute
- ZC00: Magg. / quantity
- ZSC1: Discount
- ZH01: Transport costs
- ZH02: Customs clearance costs

In this regard, the purchasing department gives evidence of the current management of premium discounts that at the end of the year the suppliers recognize to the company based on the quantities/values ordered and invoiced in the year. These discounts are recognized in the following year (around March/April) and managed in the system on AS400 with the recording of a credit note. There is no evidence of these discounts on the purchase orders created in the system, the discount is defined in the agreement with the supplier.[106]

At this stage, it is therefore necessary to discuss the subject with the administration in more detail in order to assess its handling on SAP and any impact on the stock value.

The fixed header and position texts currently available and present in the order printout were presented, including transport mode and packaging type.[107]

[105] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.
[106] Bardhan, D., Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., ... & Worsley-Tonks, A. (2017). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.
[107] Bhatia, R. (2025). Transforming Industries with SAP S/4HANA. *International Journal of Enhanced Research in Management & Computer Applications*, *14*(01), 01-07.

The purchasing department requires the possibility of being able to manage at header and position level of the purchase order two selection fields to indicate the type of packaging (at position level) and the mode of transport (at header level) instead of the standard texts currently provided:

- Packaging code, to be managed as a new custom field in the position where the list of usable packaging types is to be listed, which is then to be printed. The following image represents a screenshot of the AS400 system, captured during the functional analysis workshops with the company team. The screenshot, transmitted in Italian, shows the list of **packaging codes** used in the purchasing and logistics processes.

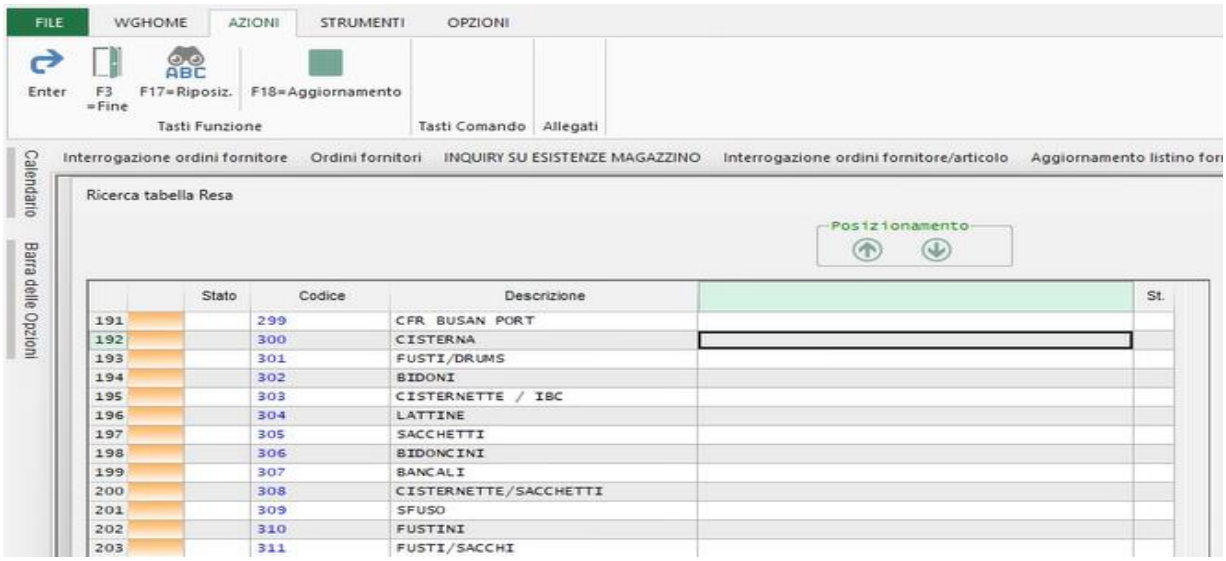


Figure 16 - "Packaging Codes Table" screen from the legacy AS/400 system

- Transport mode, to be managed as a custom field at header level in which the list of transport modes that can be used is to be listed in the order print-out.

As fixed texts, the print-out of the purchase order for raw materials shall contain the request to the supplier for order confirmation and certificate of analysis.
The purchase order must never state the company's internal material codes, but the supplier material code if present. The material description must always be present.[108]
The technical specification of the material to be printed, entered by the technical secretariat during the creation of the material, could be reported in SAP in the material master data (purchase text), if it differs per supplier, it could also be managed in the inforecord.

[108] Pattanayak, A. (2017). SAP S/4HANA embedded analytics: an overview. *Journal of computer and communications*, *5*(9), 1-7.

In the process of managing raw material purchase orders, the AS-IS analysis conducted on AS400 revealed the absence of a standardized format for printing orders, resulting in variability in the content and information transmitted to suppliers. In particular, there were no automated controls or structured fields to systematically request the order confirmation or certificate of analysis, two fundamental elements to ensure traceability and quality in the supply.
Furthermore, the AS400 system did not provide for the concept of a 'supplier list' or the direct association between material code and supplier: this resulted in the generic use of internal company codes even in external communication, generating potential misunderstandings and a lack of transparency in purchasing flows.[109]
In the new TO-BE scenario designed on SAP S/4HANA, the process is deeply revised and standardized. In particular:

- The printing of the purchase order will systematically include two fixed requests to the supplier:
  1. The order confirmation,
  2. Sending the certificate of analysis of the material supplied.
- Any reference to the company's internal material code will be excluded from printing in order to avoid confusion and protect internal management.
- Instead, the supplier's material code (if any) will be valorized, facilitating alignment between the two parties' systems.
- The description of the material will always be present in the order, ensuring correct identification of the good even in the absence of codes.

An important innovation in the TO-BE model concerns the management of the technical specification of material. Whereas in AS400 this information was managed unstructured or through parallel channels (such as Excel files or paper sheets), in SAP it will be managed centrally through two possibilities[110]:

1. Via material master - purchase text, if the specification is unique per material;
2. Via supplier-material information (inforecord), if the specification varies per supplier.

[109] Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., Meijerink, B., & Worsley-Tonks, A. (2016). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.
[110] Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., Meijerink, B., & Worsley-Tonks, A. (2016). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.

This approach improves not only the quality and consistency of the information transmitted, but also the efficiency of order generation and automatic printing of technical specifications, eliminating manual intervention by operators.

WORKSHOP 4: Freight Receipts - 24 April 2024

The workshop topics were:

- Non-stock entry
- Entry of goods against stock purchase order (101)
- Goods in transit (107/109)
- Receipt of goods on supplier's consignment account (101 K)
- Entry of goods with different consignee supplier
- Purchase reporting

The participants present were:

- The goods receiving office consists of
    - 1 Warehouse Leader
    - 1 Warehouse Administrative Assistant
    - 3 Warehouse operators
- Process integration & ERP Service Director
- SAP MM consultant

Goods revenue management

During the workshop on 24/04/2024, the current management of goods receipts was analyzed in detail and the ways in which processes will be mapped and implemented in the new SAP S/4HANA system, through standard FIORI applications and integrated logic, were shared.

Incoming goods related to non-stock purchase orders (services, consumables, assets)

AS-IS process:

Currently, the receiving office also records the acceptance of non-stock-managed goods, such as services, consumables, and assets, in addition to raw materials and packaging.

TO-BE process:

In the SAP S/4HANA system, the recording of these receipts will be handled via the standard FIORI application 'Register goods movement', which allows goods to be loaded without the need for physical storage, using the correct movement categories and document types.
No critical or non-standard features were found in this area.

Incoming goods referred to purchase orders for raw materials and stock packaging

TO-BE process:

- **Packaging:**

  Entry will take place against the purchase order, with loading being recorded in the warehouse. Batch management is not foreseen for these materials. Consumption will be automatic, triggered by payment of the production order, replicating the logic already adopted in the current system.

- **Raw materials:**

  The management of raw materials requires special attention to certain aspects:

  - **Batch management:**

    The model to be adopted in SAP has to be defined. The options evaluated include activating the standard SAP batch management (with full batch traceability) or using dummy batches to allocate the supplier batch, but without activating batch traceability in SAP movements.

  - **Goods Entry Note:**

    A request was made for the automatic generation of the goods entry note against the entry registration, a useful document to support internal controls and logistics.

  - **Management of the expiry date:**

    Currently, the expiry date of the batch is not entered on entry,but is calculated by an external system when printing labels. In the new system, it will be evaluated whether to manage this field directly on SAP in order to improve its control and integration.

Goods in transit (goods from foreign suppliers)

AS-IS process:

In the AS400 system, there is no structured management for goods in transit, e.g., goods shipped from foreign suppliers with long delivery times (e.g., sea transport from non-EU countries).
Accordingly:

- There is no specific movement to record the acquisition of goods before their physical arrival at the plant.
- Invoices from suppliers may arrive before the goods, but the inability to record the goods entry creates problems in the accounting process.
- Visibility of goods in transit is absent, causing difficulties in logistical and administrative planning.
- The time taken to record incoming goods becomes longer, with impacts on invoice reconciliation, inventory management and accounting accuracy.

TO-BE process:

For goods from non-EU countries (e.g., Asia), which require long transport times, a two-stage process has been agreed upon:

1. **Movement 107 - Goods in transit**:
   The goods are recorded in the system as acquired (for tax and administrative reasons), but without loading the physical warehouse. This first movement 107 will enable the administration to register invoices should they arrive before the actual arrival of the goods.
2. **Movement 109 - Actual Loading**:
   Upon physical arrival at the plant, the actual loading of the goods into the warehouse must be performed via a second movement, 109, which will unload the stock in transit and load the warehouse. This process is perfectly covered by the standard SAP functionality.

<u>Entry of goods on consignment</u>

AS-IS process:

In the current system, material on consignment is managed through fictitious warehouses allocated to each supplier. Regarding withdrawal from the consignment warehouse, a manual movement is currently made on AS400 that unloads the supplier's consignment warehouse and loads the warehouse, which previously went into negative against the raw materials use in production.

TO-BE process:

In SAP S/4HANA the standard process is to use 'special stock K', which precisely identifies the goods on consignment instead of the dummy stock used in AS400.

The management mode that will be adopted in SAP was then shared:

by means of the position category, the purchasing department will indicate directly in the purchase order position, the purchase on consignment type 'C'.

When accepting goods, the warehouse loading process will be identical to the goods entry of a material not managed on consignment, the system will identify from the purchase order the category position 'consignment' and adjust the goods movement to be executed (101K).
Once the goods entry has been registered, the stock will be displayed in the warehouse indicated in the order but with a special status 'consignment account'.
In accounting terms, the entry on consignment does not make any entries, the purchase of the goods and the corresponding entries are made when the goods are taken from the warehouse and used in production.
About withdrawal from the storage account, the possibility of automatically consuming the material from the storage account to avoid manual withdrawal handling will be evaluated on SAP.

Entry of goods with different consignee (ship-to-party)

Cases in which goods are purchased from supplier 1 and delivered directly to supplier 2 without passing through the company's warehouse will be handled in SAP using an alternative delivery address in the purchase order.
When supplier 2 receives the goods, it will notify MLIT of their arrival, MLIT will then proceed to load the goods into the system at the main warehouse with reference to the purchase order made to supplier 1. The stock in the warehouse will subsequently be unloaded by means of a sales and delivery order to supplier 2.

From this workshop, the analysis showed that most of the goods entry processes can be effectively managed with the standard SAP S/4HANA functionalities, with the use of the dedicated FIORI apps. No major critical issues or custom development needs emerged.
The system will allow greater control overflows, complete traceability and integration with accounting and logistics processes, reducing manual activities and improving operational visibility.

WORKSHOP 5: Vendor Returns Management - 3 May 2024

The workshop topics were:

- Analysis of the current return procedure (AS400)
- Return procedure on SAP S/4HANA
    - Return to supplier from incoming goods (122)
    - Return to supplier from return order (161)

The participants present were:

- The goods receiving office consists of
  - 1 Warehouse Leader
  - 1 Warehouse Administrative Assistant
- Process integration & ERP Service Director
- SAP MM consultant

Supplier returns management

AS-IS process:

The current operational procedure for the management of returns to suppliers was analyzed and described with the relevant documents created on the AS400 system. Below is a description of the macro-steps starting from the receipt of goods against the purchase order to the supplier:

1. The goods acceptance office loads the goods on AS400 against the order created by the purchasing office. The goods are loaded onto warehouse 101 without any system blockage even though they must be tested before being used in production. The loading of goods on warehouse 101 is done without the allocation of a batch, so when consulting the system, one only has evidence of the stock and not of the corresponding batch;
2. Labels are printed against the entry of goods, and the information reported includes the supplier lot (specified at goods entry) and an internal lot generated and printed only at the labelling stage but not allocated to the stock on the AS400 system;
3. Physically, the goods are placed in the automatic warehouse with a tag specifying that they are goods to be tested and cannot be used. There is no status of the goods in the system that specifies this blockage;
4. The test is carried out, and the outcome opens two possible scenarios:

   - Testing OK, in which case the tag indicating 'goods to be tested' is removed and the goods are then physically made available for production. No release movement or status change is recorded in the system, the goods continue to be handled without batch;
   - KO inspection, in which case a new batch is generated with a Z or K (unsuitable material) at the end. This new batch is also assigned to the relevant stock in the system to give evidence that it is not to be used. In some cases, a new label with the new batch (unsuitable) may be reprinted.

5. In the case of unsuitable goods, the testing department informs the purchasing department, giving evidence of the article code with its unsuitable quantity, supplier and supplier lot;
6. The purchasing department then informs the shipping department, which issues a manual return note to the supplier, with article and quantity. The bubble is then communicated to the acceptance office;
7. The acceptance office performs the unloading movement (for return) against the bill produced by the dispatch office. In the system, there is no link between the purchase order, the loading of goods and the return movement.

Company-owned goods stored at external warehouses 104 (Lodi) and 102 (Rivalta) are always tested after being transferred to warehouse 101 in Bosco Marengo. The procedure is the same, the return is therefore always recorded by the Bosco Marengo warehouse, never by the external warehouses. The return procedure is also the same for goods in the main warehouse but on consignment to the supplier. The goods are tested when the consignment account is loaded (not when they are taken from production), and upon the outcome of the test, the return is carried out for any unsuitable lots by unloading the consignment account against the delivery note issued by the shipping office. In general, returns can also be made after acceptance if it is found that the goods are no longer suitable for production.
In this workshop, there are no printouts or reports to support the return process.

TO-BE process:
The two SAP standard return-to-supplier modes were analyzed:

- Supplier return from goods entry;
- Supplier Return Order

<u>Supplier return from goods entry</u>
Once the goods entry has been recorded on SAP S/4HANA for a given material code, it is possible to subsequently proceed with the return to the supplier for the total or partial quantity of the goods entry[111].

[111] Kulkarni, S. (2019). Implementing SAP S/4HANA. *Implementing SAP S/4HANA*.

Using the Fiori application dedicated to recording movements, you proceed with the return (using the Redelivery operation) from the goods entry number generated on SAP, for which you want to proceed with the return.
The return from goods entry on SAP involves two scenarios:

- Registration of return without delivery note, in this case by registering the return movement the system unloads the warehouse by reopening the purchase order for the returned quantity, without producing a delivery note[112];
- Registration of return with delivery note, in this case by registering the return movement the system automatically generates the return note that can be subsequently printed and processed, enriching it with all the information required for dispatch. Recording the goods exit of the delivery proceeds with the unloading of the warehouse and the opening of the purchase order for the quantity returned to the supplier.

For the system to be able to generate the bill automatically, it is necessary that the supplier's master data have also been created as a customer and that the material to be returned has active sales views.

Supplier Return Order

This mode is used in cases where the goods entry cannot be traced, e.g., in cases where the goods entry was performed on the old system (AS400).
In such cases, the return purchase order must be created in the SAP system.[113]
A return delivery is then generated against the return order, which can then be printed out and processed, enriching it with all information preparatory to dispatch. By registering the goods exit of the delivery, the warehouse is unloaded.

WORKSHOP 6: Purchasing Reporting - 19 June 2024

The participants present were:

- Process integration & ERP Service Director
- The purchasing department consists of:
    - Purchasing Director

[112] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.
[113] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.

    - Purchasing Manager Assistant
    - Purchasing Operator
- SAP MM external consultant

The workshop topics were:

Customised reports used in AS400 to be implemented in SAP S/4HANA:

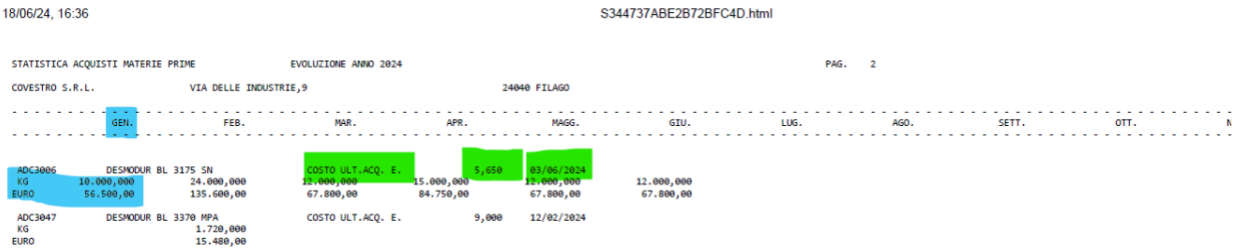
- Purchasing statistics per article 2023/2024
- Purchasing statistics price evolution
- Analysis of Purchase Distribution by Value Purchased
- Analysis of purchasing distribution by supplier ABC
- Purchasing Distribution Analysis Fascia Line

All the reports analyzed and described in the following document are used by the purchasing department for raw material procurement planning and verification. The screenshots were captured during the workshop and will therefore be in the original language.

Purchasing statistics per article 2023/2024

The report can be run for a certain time and provides monthly statistics in terms of quantity and value received (value and quantity in stock) per article and supplier. Values are always expressed in corporate currency (EUR).
The last cost, e.g., the price of the last goods entry with date, is also shown on each item.

Figures 17 and 18 show the *"Raw Material Purchasing Statistics"* report from the legacy AS/400 system. The report provides monthly data on quantities (KG) and values (EUR) of goods received per article and supplier, along with the last purchase cost and date. Figure 17 displays per-article details, while Figure 18 summarizes overall monthly totals for 2024.


18/06/24, 16:36 S344737ABE2B72BFC4D.html

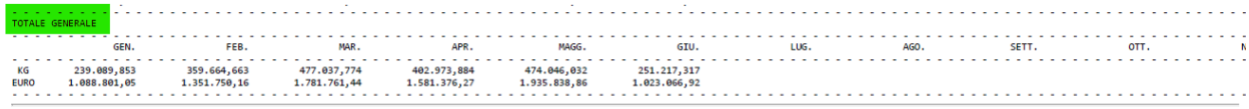
STATISTICA ACQUISTI MATERIE PRIME EVOLUZIONE ANNO 2024 PAG. 2

COVESTRO S.R.L. VIA DELLE INDUSTRIE,9 24040 FILAGO

		GEN.	FEB.	MAR.	APR.	MAGG.	GIU.	LUG.	AGO.	SETT.	OTT.	N
ADC3006	DESMODUR BL 3175 SN			COSTO ULT.ACQ. E.	5,650	03/06/2024						
KG	10.000,000	24.000,000	12.000,000	15.000,000	12.000,000	12.000,000						
EURO	56.500,00	135.600,00	67.800,00	84.750,00	67.800,00	67.800,00						
ADC3047	DESMODUR BL 3370 MPA			COSTO ULT.ACQ. E.	9,000	12/02/2024						
KG		1.720,000										
EURO		15.480,00										

Figure 17 - "Raw Material Purchasing Statistics" report (detail view) from the legacy AS/400 system

An overall total is given at the end of the report, as shown in figure 18 below:



TOTALE GENERALE

	GEN.	FEB.	MAR.	APR.	MAGG.	GIU.	LUG.	AGO.	SETT.	OTT.	N
KG	239.089,853	359.664,663	477.037,774	402.973,884	474.046,032	251.217,317					
EURO	1.088.801,05	1.351.750,16	1.781.761,44	1.581.376,27	1.935.838,86	1.023.066,92					

Figure 18 - Overall monthly totals from the "Raw Material Purchasing Statistics" report

Purchasing statistics price evolution

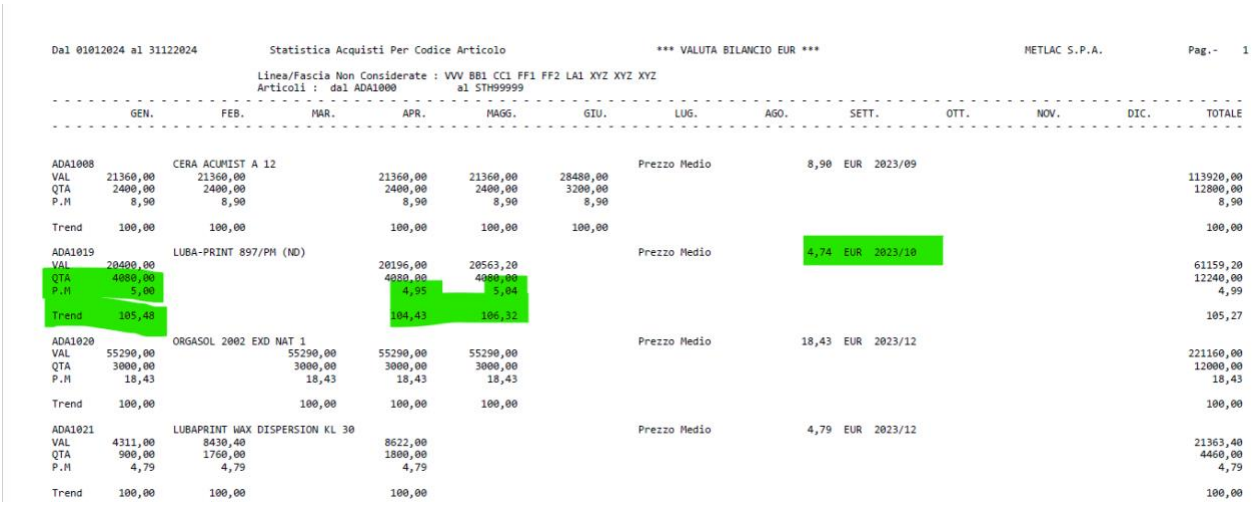
The report provides for each month of the year in selection the value and quantities received for each article regardless of the supplier.

Values are always expressed in corporate currency (EUR).

For each article, it is also reported:

- Average price and date: price of the last goods entry in the year preceding the year of selection;
- The new report developed on SAP will have to report not the last cost of the previous year, but the average price, i.e., value/quantity of the month of the previous year in which the last goods entry was recorded;
- For each month, the PM, average price paid given by Value month/quantity month;
- Trend: the percentage deviation between the average price of the month and the previous year's price reported in the report (e.g. (5-4.74)/4.74 = 5.48);
- The new version to be implemented on SAP requires the entry of the last cost (price of the last goods entry) for each month of the year of the selection period.

Figure 19 below shows monthly values and quantities received per article, along with the average price, last purchase price and date, and price trend compared to the previous year.



Dal 01012024 al 31122024 Statistica Acquisti Per Codice Articolo *** VALUTA BILANCIO EUR *** METLAC S.P.A. Pag.- 1

Linea/Fascia Non Considerate : VVV BB1 CC1 FF1 FF2 LA1 XYZ XYZ XYZ
Articoli : dal ADA1000 al STH99999

		GEN.	FEB.	MAR.	APR.	MAGG.	GIU.	LUG.	AGO.	SETT.	OTT.	NOV.	DIC.	TOTALE
ADA1008	CERA ACUMIST A 12							Prezzo Medio	8,90	EUR 2023/09				
	VAL	21360,00	21360,00		21360,00	21360,00	28480,00							113920,00
	QTA	2400,00	2400,00		2400,00	2400,00	3200,00							12800,00
	P.M	8,90	8,90		8,90	8,90	8,90							8,90
	Trend	100,00	100,00		100,00	100,00	100,00							100,00
ADA1019	LUBA-PRINT 897/PM (ND)							Prezzo Medio	4,74	EUR 2023/10				
	VAL	20400,00			20196,00	20563,20								61159,20
	QTA	4080,00			4080,00	4080,00								12240,00
	P.M	5,00			4,95	5,04								4,99
	Trend	105,48			104,43	106,32								105,27
ADA1020	ORGASOL 2002 EXD NAT 1							Prezzo Medio	18,43	EUR 2023/12				
	VAL	55290,00		55290,00	55290,00	55290,00								221160,00
	QTA	3000,00		3000,00	3000,00	3000,00								12000,00
	P.M	18,43		18,43	18,43	18,43								18,43
	Trend	100,00		100,00	100,00	100,00								100,00
ADA1021	LUBAPRINT WAX DISPERSION KL 30							Prezzo Medio	4,79	EUR 2023/12				
	VAL	4311,00	8430,40		8622,00									21363,40
	QTA	900,00	1760,00		1800,00									4460,00
	P.M	4,79	4,79		4,79									4,79
	Trend	100,00	100,00		100,00									100,00

Figure 19 - "Purchasing Statistics – Price Evolution" report from the legacy AS/400

Analysis of Purchase Distribution by Value Purchased

The report run for a certain time period provides for each raw material supplier:

- Purchase value: the value invoiced by the supplier net of VAT;
- % UP T: the percentage of the value purchased per supplier out of the total value purchased in the period under selection;
- Invoiced quantity;
- % UP T: the percentage of the quantity purchased per supplier out of the total quantity purchased in the period under selection;
- % PROG: this is the sequence of the percentage of purchase relative to the invoiced quantities;
- ABC QT: is a sorting according to the quantity purchased from a particular supplier. The 1st is the supplier from whom the highest quantity was purchased;
- % PROG: is the progressive percentage of purchase relative to the invoiced value;
- ABC VA: is a sorting according to the value purchased from a particular supplier. The 1st is the supplier from whom the highest value was purchased;
- PROGRESSIVE PURCHASING: this is a progressive value starting from the highest turnover value (supplier with the highest turnover value) and adding up the turnover value of the other suppliers;
- PROGRESSIVE QTY: is a progressive value that starts from the invoiced quantity of the supplier with the highest invoiced value (supplier with the highest invoiced value) and adds up the invoiced quantities of the other suppliers.

The output is sorted by increasing ABC VA (the first is the supplier with the highest turnover value). Values are always expressed in corporate currency (EUR).

Figure 20 below shows the distribution of purchases across suppliers within a selected period, including purchase value, invoiced quantity, and percentage contributions, sorted by supplier turnover (ABC analysis).

ANALISI DISTRIBUZIONE ACQUISTI DAL 01012023 AL 31122023 *** VALORE *** SINTETICO VALUTA BILANCIO EUR

CODICE	RAGIONE SOCIALE	VAL	VALORE ACQUISTI	% SU T.	QUANTITA	% SU T.	% PROG	ABC QT	% PROG	ABC VA	PROGR. ACQUISTI	PROGR. QTA
F001131	COVESTRO S.R.L.		16.117.025,94	11,56	3.935.319	7,63	7,63	4	11,56	1	16.117.025,94	3.935.319
F000992	NOVARESINE S.R.L.		13.655.479,80	9,79	8.660.460	16,80	24,43	1	21,35	2	29.772.505,74	12.595.779
F000077	N.BENASEDO S.P.A.		11.340.186,41	8,13	5.465.068	10,60	35,03	2	29,48	3	41.112.692,15	18.060.847
F400079	KRONOS TITAN GMBH		7.517.917,60	5,39	2.369.250	4,60	39,63	6	34,87	4	48.630.609,75	20.430.097
F000017	POLIRESIN S.R.L.		5.292.708,10	3,79	1.288.073	2,50	42,13	11	38,66	5	53.923.317,85	21.718.170
F400330	MITSUI & CO.DEUTSCHLAND GMBH		5.010.880,00	3,59	1.979.200	3,84	45,97	8	42,25	6	58.934.197,85	23.697.370
F400015	INEOS EUROPE AG Division Oxide		4.817.357,26	3,45	3.982.910	7,73	53,70	3	45,70	7	63.751.555,11	27.680.280
F400105	MELAMIN KEMICNA TOVARNA D.D.		4.389.537,20	3,15	1.803.880	3,50	57,20	9	48,85	8	68.141.092,31	29.484.160
F000746	CEPSA ITALIA S.P.A.		3.997.463,08	2,87	3.337.340	6,47	63,67	5	51,72	9	72.138.555,39	32.821.500
F400025	HELIOS TOVARNA		3.979.793,20	2,85	1.418.140	2,75	66,42	10	54,57	10	76.118.348,59	34.239.640
F001725	EVONIK OPERATIONS GMBH-FILIALE		3.798.794,98	2,72	506.804	,98	67,40	21	57,29	11	79.917.143,57	34.746.444
F400335	ARKEMA FRANCE S.A.		3.763.253,00	2,70	1.050.715	2,04	69,44	13	59,99	12	83.680.396,57	35.797.159
F400116	EVONIK OPERATIONS GMBH		3.136.538,00	2,25	490.560	,95	70,39	23	62,24	13	86.816.934,57	36.287.719
F000759	ALLNEX ITALY S.R.L.		2.861.729,30	2,05	522.580	1,01	71,40	20	64,29	14	89.678.663,87	36.810.299
F400176	BYK NETHERLANDS BV		2.852.916,30	2,05	569.580	1,10	72,50	18	66,34	15	92.531.580,17	37.379.879
F000192	GALSTAFF MULTIRESINE S.P.A.		2.848.413,91	2,04	708.762	1,37	73,87	16	68,38	16	95.379.994,08	38.088.641
F000615	SIR INDUSTRIALE S.P.A.		2.760.244,36	1,98	731.037	1,42	75,29	15	70,36	17	98.140.238,44	38.819.678
F400184	BYK-CHEMIE GMBH		2.664.160,96	1,91	357.035	,69	75,98	27	72,27	18	100.804.399,40	39.176.713
F000396	ATTILIO CARMAGNANI "AC" S.P.A.		2.646.771,29	1,90	2.053.810	3,98	79,96	7	74,17	19	103.451.170,69	41.230.523
F400616	KUKDO EUROPE GMBH		2.254.200,00	1,62	885.000	1,72	81,68	14	75,79	20	105.705.370,69	42.115.523
F400035	SI GROUP-BETHUNE S.A.S.		2.115.306,60	1,52	496.990	,96	82,64	22	77,31	21	107.820.677,29	42.612.513
F400103	ALLNEX NORWAY AS		1.671.224,78	1,20	399.382	,77	83,41	24	78,51	22	109.491.902,07	43.011.895
F400126	KUKDO CHEMICAL CO. LTD		1.659.750,00	1,19	555.000	1,08	84,49	19	79,70	23	111.151.652,07	43.566.895
F400213	MUNZING CHEMIE GMBH		1.652.176,50	1,18	302.100	,59	85,08	29	80,88	24	112.803.828,57	43.868.995
F400266	BLUE CUBE GERMANY ASSETS GMBH		1.466.550.00	1.05	247.000	.48	85.56	31	81.93	25	114.270.378.57	44.115.995

Figure 20 - "Purchase Distribution Analysis by Value" report from the legacy AS/400 system

Analysis of purchasing distribution by supplier ABC

The report run for a certain time period provides the same information as the report "Analysis of purchase distribution by purchased value" for individual suppliers with details of the material codes purchased. Statistics are then specified per individual article code providing the value and quantities invoiced by the supplier.

The output is sorted by increasing ABC VA (the first is the material purchased from the specific supplier with the highest invoice value).

Values are always expressed in corporate currency (EUR).

It shows detailed statistics per material code purchased from a single supplier, including invoice value, quantities, percentage contributions, and ABC classifications.

ANALISI DISTRIBUZIONE ACQUISTI DAL 01012023 AL 31122023 *** VALORE *** SINTETICO VALUTA BILANCIO EUR

F000017 POLIRESIN S.R.L.

ARTICOLO	DESCRIZIONE	VAL	VALORE ACQUISTI	% SU T.	QUANTITA	% SU T.	% PROG	ABC QT	% PROG	ABC VA	PROGR. ACQUISTI	PROGR. QTA
RSF7037	HEH 1118 LF		925.820,00	17,49	189.000	14,67	14,67	1	17,49	1	925.820,00	189.000
RSE5085	EPOSOL FN 63% BG		679.680,00	12,84	144.000	11,18	25,85	4	30,33	2	1.605.500,00	333.000
RSE5101	EPOSOL EPR 63% BG-DPM		675.540,00	12,76	162.000	12,58	38,43	3	43,09	3	2.281.040,00	495.000
RSE5001	EPOSOL 7 40BCS100		497.900,60	9,41	181.108	14,06	52,49	2	52,50	4	2.778.940,60	676.108
RSF7029	POLIFEN P 1000 LF		330.210,40	6,24	88.640	6,88	59,37	5	58,74	5	3.109.151,00	764.748
ADC3086	CHELATO D'ALLUMINIO CHA10		260.946,00	4,93	56.700	4,40	63,77	8	63,67	6	3.370.097,00	821.448
RSE5002	EPOSOL 9 40 BC S100		236.534,00	4,47	84.350	6,55	70,32	6	68,14	7	3.606.631,00	905.798
RSC3007	EPOBEN S 41 50% S150/X/BG		226.290,00	4,28	57.000	4,43	74,75	7	72,42	8	3.832.921,00	962.798
RSF7057	EPOFEN 2319 X		190.095,00	3,59	44.650	3,47	78,22	9	76,01	9	4.023.016,00	1.007.448
RSF7059	POLIFEN 477		178.033,00	3,36	30.775	2,39	80,61	11	79,37	10	4.201.049,00	1.038.223
RSF7027	ML 100 LF		161.100,00	3,04	40.000	3,11	83,72	10	82,41	11	4.362.149,00	1.078.223
RSF7024	POLIFEN 192 LF		109.110,00	2,06	27.000	2,10	85,82	12	84,47	12	4.471.259,00	1.105.223
RSE5031	EPOFEN 154 - PRECONDENSAT		103.977,50	1,96	26.600	2,07	87,89	13	86,43	13	4.575.236,50	1.131.823
RSF7053	POLIFEN 290		103.600,00	1,96	23.000	1,79	89,68	15	88,39	14	4.678.836,50	1.154.823
ADE5064	ADDITIVO 104 BG		100.176,00	1,89	8.348	,65	90,33	20	90,28	15	4.779.012,50	1.163.171
RSA1164	ACRIBEN 152		91.313,50	1,73	22.690	1,76	92,09	16	92,01	16	4.870.326,00	1.185.861
RSE5050	EPOSOL 315		88.996,00	1,68	24.700	1,92	94,01	14	93,69	17	4.959.322,00	1.210.561
RSF7026	HEH 1120 LF		75.280,00	1,42	21.000	1,63	95,64	17	95,11	18	5.034.602,00	1.231.561
RSE5100	EPOSOL EF 405 55% BG		63.374,50	1,20	16.150	1,25	96,89	18	96,31	19	5.097.976,50	1.247.711
RSE5109	POLISOL POH 71		37.900,00	,72	5.000	,39	97,28	23	97,03	20	5.135.876,50	1.252.711
RSF7063	POLIFEN 475 60% BUTANOLO		34.703,60	,66	5.970	,46	97,74	22	97,69	21	5.170.580,10	1.258.681
RSC3009	EPOBEN 55		33.250,00	,63	9.500	,74	98,48	19	98,32	22	5.203.830,10	1.268.181
RSF7066	EPOFEN 2384		28.058,80	,53	6.377	,50	98,98	21	98,85	23	5.231.888,90	1.274.558
RSF7005	POLIFEN 134 LF		26.173,70	,49	4.865	,38	99,36	24	99,34	24	5.258.062,60	1.279.423
RSA1110	ACRIBEN 113 50% LF		14.440,00	,27	3.800	,30	99,66	25	99,61	25	5.272.502,60	1.283.223
RSF7018	RS 136 B LF		8.340,00	,16	2.000	,16	99,82	26	99,77	26	5.280.842,60	1.285.223
RSE5063	INTERMEDIO 1327 S100		8.113,00	,15	1.900	,15	99,97	27	99,92	27	5.288.955,60	1.287.123
RSC3010	EPOBEN 514		3.752,50	,07	950	,07	100,04	28	99,99	28	5.292.708,10	1.288.073

Figure 21 - "Analysis of Purchasing Distribution by Supplier – ABC" report from the legacy AS/400 system

Purchasing Distribution Analysis Fascia Line

The report run for a certain time period provides the same information as the report "Purchase distribution analysis by ABC supplier" with the detail by Line and Product Category for raw materials.

Selecting a particular line and product category analyses all raw materials associated with it, making an analysis in terms of value and quantity invoiced by all suppliers for a given analysis period.

For each line and product category, the total quantity invoiced and the total invoiced value with the relevant % of total quantity and invoiced value of all raw materials is then reported.

Figure 22 below shows quantities and values of raw materials invoiced across all suppliers, grouped by line and product category (shown in the figure as “AD/A Additivi-Cere”), with detailed statistics per material code.

ANALISI DISTRIBUZIONE ACQUISTI DAL 01012023 AL 31122023 *** VALORE *** VALUTA BILANCIO EUR

LINEA+FASCIA AD/A ADDITIVI-CERE

QTA ACQ. NR. 1.279.460 VALORE ACQUISTATO EUR 8.190.843,12
2,48 % 5,87 %

CODICE ARTICOLO	DESCRIZIONE	VALORE ACQ.	% SU T.	QTA	% SU T.	% PROG	ABC QT	% PROG	ABC VA
ADA1114	CERACOL 17 RC 1581	2.367894,00	28,91	501.600	39,20	39,20	1	28,91	1
ADA1047	STELLUX AI	929628,00	11,35	75.600	5,91	45,11	5	40,26	2
ADA1074	LUBAPRINT 436 (ND) (M)	819640,00	10,01	217.600	17,01	62,12	2	50,27	3
ADA1087	LUBA-PRINT 694/R	670929,00	8,19	53.200	4,16	66,28	6	58,46	4
ADA1058	LANCO GLIDD 4415	489829,50	5,98	96.050	7,51	73,79	3	64,44	5
ADA1020	ORGASOL 2002 EXD NAT 1	355662,15	4,34	19.005	1,49	75,28	10	68,78	6
ADA1024	LANCO TF 1780 EFC	342175,65	4,18	24.285	1,90	77,18	9	72,96	7
ADA1102	LANCO GLIDD 5159	328848,00	4,01	79.050	6,18	83,36	4	76,97	8
ADA1080	CORONA 9-SO-(RB)	261126,00	3,19	16.020	1,25	84,61	13	80,16	9
ADA1111	CERAFLOUR 1001	173768,00	2,12	11.600	,91	85,52	14	82,28	10
ADA1034	LANCO TPW 432	148325,00	1,81	25.500	1,99	87,51	8	84,09	11
ADA1113	CERACOL 21 RC 1433	136059,00	1,66	29.450	2,30	89,81	7	85,75	12
ADA1116	MPP-611AL	128194,00	1,57	6.820	,53	90,34	20	87,32	13
ADA1035	LANCO TPW-433 C	111640,25	1,36	9.730	,76	91,10	18	88,68	14

Figure 22 - “Purchasing Distribution Analysis by Line and Band” report from the legacy AS/400 system

During each workshop, an average of three to five significant gaps from the standard functionalities offered by SAP S/4HANA were identified, highlighting areas where current processes are not immediately compatible with the new platform.

In addition to these, there were at least two customization requests per session, necessary to meet specific needs of the organization not fully covered by standard SAP tools, such as additional fields or special management logics.

Moreover, in almost all cases, at least one interaction with other system modules emerged, in particular with the Production Planning (PP) and Sales & Distribution (SD) modules**,** confirming the interdependent nature of business processes and the importance of an integrated view in solution design.

The analysis conducted during the six workshops provided a clear and in-depth view of the current state and evolutionary prospects of the processes related to the Materials Management module within the future SAP S/4HANA platform. During the meetings, it was possible to identify the existing operational criticalities, the opportunities for improvement offered by the new solution and the solutions already defined to be adopted in the new system.
One of the processes most in need of revision is the management of material and supplier master data**,** which is currently characterized by great heterogeneity. The future implementation of SAP will allow the introduction of integrated workflows and a standardized data structure, reducing errors and manual activities.

Another area of intervention concerns the management of non-stock purchases, where currently many activities are managed offline or with paper documents. With SAP, the complete digitization of the cycle**,** from Purchase Requisition (PR) to Purchase Order (PO), is envisaged, enabling greater traceability and automation.
Finally, a strategic issue is the requirements planning process **(**MRP). Today managed mainly in manual mode, with the new platform it will be possible to start a path of progressive automation, exploiting the native algorithms and logic of the SAP system.[114]
The introduction of SAP S/4HANA inevitably entails a paradigm shift from the current AS400 system. Among the main gaps identified:

- **The absence of structured batch management** in AS400[115], compared to the advanced functionalities offered by SAP for **batch traceability** and quality management;
- **Rigid and static reporting** in the current system will be replaced by interactive dashboards and flexible analytical tools in SAP.

Some deviations between business requirements and SAP standard functionalities were also highlighted. In particular:

- The need to introduce custom fields, such as packaging code or mode of transport.
- The need for articulated approval workflows for the management of purchase requisitions, which require ad hoc configurations to reflect the internal organization.

[114] Yeung, J. H. Y., Wong, W. C. K., & Ma, L. (1998). Parameters affecting the effectiveness of MRP systems: a review. *International journal of production research*, *36*(2), 313-332.
[115] Tran, T., Luu, S. T., Bui, Q., & Nomura, S. (2025). AS400-DET: Detection using Deep Learning Model for IBM i (AS/400). *arXiv preprint arXiv:2506.13032*.

The joint work between company stakeholders and the project team has already led to the resolution of some critical points:

- A new classification of product groups was defined, with the creation of five 'hybrid' categories to better reflect operational and accounting needs.
- The management of returns was redesigned by providing an automated flow, with integration between SD and MM modules and automatic generation of return slips.
- A targeted training plan was set up for the areas involved, with a focus on the Technical Secretariat, the Procurement Office and the Goods Receiving Office, to ensure a smooth transition and full adoption of the new functionalities.

During this design phase, the main improvements that the Materials Management module in SAP S/4HANA will be able to enable once it goes live were identified. These are expected benefits following future implementation, to be validated and measured in the Realize phase and subsequently in post go-live.[116]
From the point of view of operational efficiency, an:

- 40% reduction in the approval time for purchase orders, thanks to the introduction of automated digital flows and the elimination of manual steps;
- optimizing the overall timing of the purchasing and procurement process, which is currently slowed down by inconsistent and non-integrated tools;
- an estimated 30% reduction in errors in material records, through centralized, validated management with predefined mandatory fields.

In terms of control, the adoption of SAP will enable[117]:

- full traceability throughout the entire passive cycle, from purchase requisition to invoice, including non-stock materials, which today are managed in a paper-based, non-systemic way;
- the activation of proactive alerts to manage critical situations such as minimum stocks, delivery delays or unconfirmed orders in advance;

[116] Gunturu, N. S. R. (2024). An Overview on SAP S/4HANA Deployment Options and Transition Paths. *International Journal of Advanced Research in Science, Communication and Technology*, 209-216.
[117] Bardhan, D., Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., ... & Worsley-Tonks, A. (2017). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.

- smoother communication between departments, thanks to the integration of information in a single system.

Finally, with a view to management flexibility, SAP S/4HANA will provide the tools for:

- configure alternative units of measurement;
- manage advanced scenarios such as consignment accounts, goods in transit and non-stock movements, according to structured and system-tracked logic.[118]

These benefits constitute the expectations defined in the Explore phase, and will only be verified in practice later, during the Realize, Deploy and finally post go-live phases.[119]

Definition of Technical Architecture and Data Migration Strategy

During the Explore phase, a careful analysis was conducted on possible system architectures to host SAP S/4HANA, evaluating three main alternatives[120]:

- **On-Premises**: the system is physically installed on company servers, maintained and managed in-house by the IT department. It offers maximum customization, complete control over data and infrastructure, but also requires greater responsibility in terms of maintenance and security;
- **Cloud**: the system resides on external servers (infrastructure managed by the SAP supplier or by partners), accessible via the Internet. It can be Public (infrastructure shared with other customers) or **Private** (dedicated infrastructure). It guarantees flexibility, faster updates, and lower initial costs, but less direct control;
- **Hybrid**: a mix of On-Premises and Cloud, where some components remain on-premise and others are managed in the Cloud. It is often chosen in gradual transition paths.[121]

[118] Vaka, D. K. (2024). The SAP S/4HANA migration roadmap: From planning to execution. *Journal of Scientific and Engineering Research*, *11*(6), 46-54.
[119] Baumgartl, A., Chaadaev, D., Choi, N. S., Dudgeon, M., Lahiri, A., Meijerink, B., & Worsley-Tonks, A. (2016). *SAP S/4HANA: An Introduction (SAP PRESS)*. SAP PRESS.
[120] Vaid, A., & Sharma, C. (2021). *Pioneering digital transformation initiatives with cutting-edge SAP S/4HANA Solutions*.
[121] Sharma, C. (2021). Financial advantages of leveraging SAP S/4HANA integration in retail: A quantitative study. *World Journal of Advanced Engineering Technology and Sciences, 1 (2), 98*, *113*.

As a consulting team, considering the control requirements, the existing infrastructure and the complexity of the business processes, we suggested adopting the On-Premises model for the initial phase of the project. This choice makes it possible to maintain a direct and stable presence at such a delicate time as the first SAP release.
Parallel to the choice of technical architecture, the strategy for managing and analyzing company data using Business Intelligence tools was also defined. The solution chosen is SAP Analytics Cloud (SAC), an integrated cloud platform that allows data to be analyzed, visualized and planned easily and immediately.[122]

SAP Analytics Cloud supports the creation of interactive dashboards and real-time reports, enhancing decision-making with advanced analytics and AI-based prediction capabilities. This provides the company with fast and flexible access to strategic information that is crucial for monitoring performance and optimizing operational and decision-making processes.
It was also made clear that at a later stage after go-live, the integration of the CRM system, e.g., Customer Relationship Management, the solution for managing customer relationships, sales offer, negotiations and after-sales service, could be started. At present, this component is not yet part of the project, but will be included at a later stage to extend the functional coverage with SAP Sales&Service Cloud.

Data Migration Strategy: Sources, Criteria and Planning
At the same time, the mapping of data to be migrated from AS400 to SAP was started. The legacy system consultants provided extracts of the data currently in use, including:

- Material and supplier master data;
- Transactional data (stock movements, orders);
- Relevant historical and fiscal data.

These data form the basis of a structured data migration process:

- Data cleaning (removal of duplicates, correction of inconsistent coding);
- Definition of conversion rules and mapping between AS400 and SAP;
- Planning of test uploads (mock-ups) to test and validate the quality of imported data,

[122] Sharma, C. (2021). Financial advantages of leveraging SAP S/4HANA integration in retail: A quantitative study. *World Journal of Advanced Engineering Technology and Sciences, 1 (2), 98*, *113*.

- Involvement of key users to verify information.

The entire activity will be collected in the Data Migration Plan, an operational document that will accompany the subsequent phases of the project, but which will not be the subject of this paper.

5.1.3 Third Project Phase: Realize Phase

The "Realize" phase represents a crucial moment within the SAP project, where the strategic and functional choices defined in the previous phases are translated into concrete operations. It is in this phase that the system really takes shape, through configuration, development, testing and preparation for data migration.
Main activities include[123]:

- the configuration of modules according to the mapped business processes, by setting the parameters required for the system to function correctly;
- the development of possible customizations, using SAP languages and tools such as ABAP or Fiori, to adapt the system to the customer's specific needs;
- the execution of in-depth tests (Unit Test, Integration Test and UAT), which are essential to validate the implemented functionalities;
- the preparation of data migration activities, which includes simulations and controlled uploads to ensure the integrity and quality of the information transferred from the legacy system.

It was at this stage that I began my journey within the project. My contribution initially focused on configuration support, closely following my company tutor, and observing how business logic is concretely reflected in system parameters. At the same time, I played an active role in drafting the operational manuals, an activity that is as much technical as communicative, requiring precision, clarity of presentation and the ability to empathize with the end user.
The drafting of the manuals was not limited to the description of functions, but included practical examples, explanatory screens and a detailed explanation of fields and their impact on business processes. The main topics documented include the creation of material and supplier master data, the management of stock and non-stock purchases**,** purchasing reporting**,** and stock movements in the MM (Material Management) module.

[123] Rihar, L., Berlec, T., & Kušar, J. (2017). Cognitive Factors and Risk Management of Concurrent Product Realisation. In *Theory and Application on Cognitive Factors and Risk Management-New Trends and Procedures*. IntechOpen.

I also closely followed the User Acceptance Test (UAT) sessions, a key moment when end users test the system and provide concrete feedback. It was at this stage that I observed one of the most delicate challenges: managing differences in levels of competence and in expectations. Some users found it difficult to describe problems clearly, others expressed very specific, often divergent needs. Added to this was a natural resistance to change, especially for those functions that modified long-established habits.

This situation required a constant effort of listening, understanding and mediation, which made me realize how much the success of an IT project depends not only on the technical goodness of the solutions adopted, but also on the ability to lead people in change. Creating a common language between users, consultants and developers turned out to be crucial to guarantee a shared and functional result.

Looking back, the Realize phase represented for me the real entry into the project world, an intense training experience that allowed me to experience first-hand the complexity and the value of an integrated system like SAP.

5.1.4 Fourth Project Phase: Deploy Phase

The "Deploy" phase represents the moment when the SAP project reaches its operational climax: the system, developed, tested, and validated up to that point, prepares to become the new digital heart of the organization.[124]
Among the key activities in this phase is the planning and execution of the final data migration, known as *cutover*. This is an extremely delicate and choreographed process, which involves:

- the definition of a freeze period, during which it is no longer permitted to modify data in legacy systems, so as to ensure consistency and integrity;
- the organization of downtime, e.g., the interval in which the previous systems are taken offline to allow the last upload of data into the new environment;
- the final migration and validation, during which technical teams and key users perform thorough checks to ensure that the data is correctly loaded, complete and reliable.

[124] Hunt, E. C., Sproat, S. B., Kitzmiller, R. R., Hunt, E. C., Sproat, S. B., & Kitzmiller, R. R. (2004). System Deployment. *The Nursing Informatics Implementation Guide*, 189-212.

At the same time, all final technical and functional checks are put in place: environments are frozen, accesses defined, and every component of the system is monitored in preparation for the official switch-on.

The Go-Live, the moment when SAP S/4HANA is activated in the production environment, represents the start of full operation. It is a step that requires strong cohesion between all those involved: consultants, IT, key users and company management. In this phase, every detail is essential, every critical issue must be managed in real time. An extraordinary operational mode is activated, in which the team guarantees a constant presence and a rapid response to any need.

For me, having followed the project from the previous stages, experiencing Go-Live first-hand was a strong emotion. On the one hand, there was the excitement of seeing such complex work finally materialized; on the other, I would not hide the fact that I felt a certain sense of agitation. The knowledge that every task had to run smoothly, that every detail counted, and that behind every transaction there was a user ready to judge the effectiveness of the system... all this contributed to a positive, but real tension.

During Go-Live, I joined my tutor and the support team in direct assistance to users. There were many requests, often simultaneous, and every response had to be clear, timely, reassuring. In those days I learnt how to handle the unexpected, how to communicate calmly even when the pressure was on, and above all to understand how important it is to actively listen to users.

I updated the manuals in real time, supplementing them with feedback from the field, and provided practical support in using the new features, especially those related to the Fiori interface. Every clarification provided, every doubt resolved, every thank you received were small signs that the system was becoming part of the company's daily routine.

Ultimately**,** this phase was the most engaging and transformative for me. Not only because of the technical complexity, but because it was the moment when I really felt I was part of a living, shared project with a concrete impact on people.

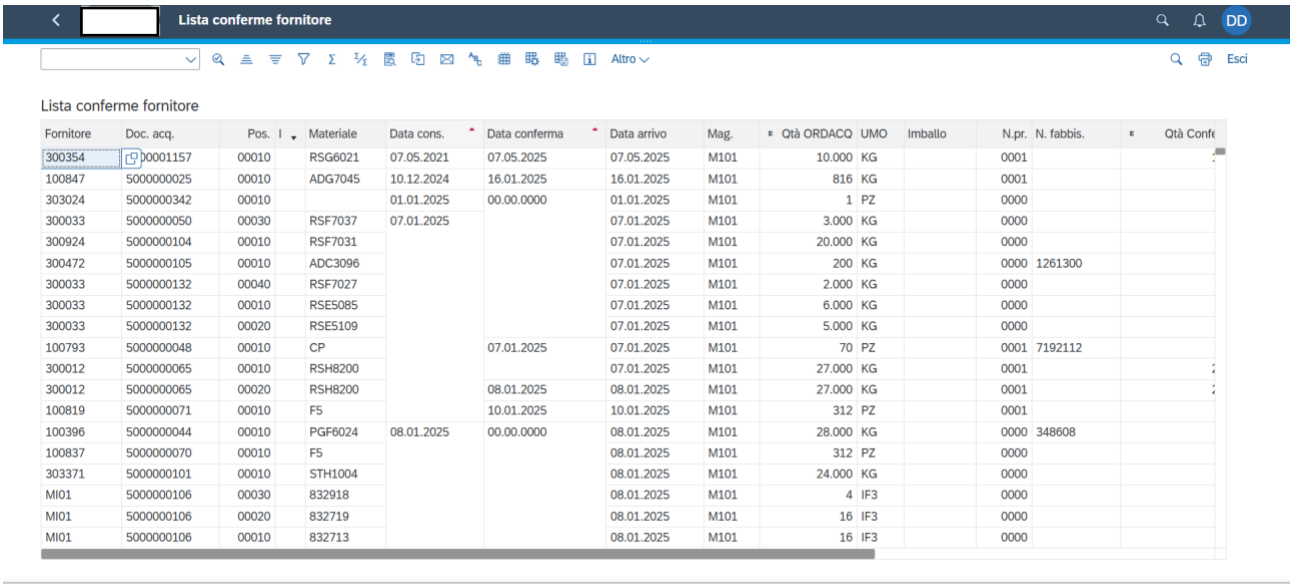
During the Go-Live period, one of the most significant situations I experienced concerned the purchasing department, which needed to quickly monitor supplier order confirmations without having to manually open each individual document in the system.

This need, which emerged in real time, highlighted how crucial it is that the system is not only technically functional, but also effective and adherent to the company's operational reality. To respond promptly, a customized query was created, capable of generating an immediate report with the necessary information (order number, items, supplier, confirmation date, confirmed quantity, etc.). Subsequently, a dedicated 'Monitor supplier confirmations' tile was created within the user

launchpad (see Figure 23). The images that follow will be in Italian, as the launchpad was configured for Italian users.

Figure 23 - "Monitor Supplier Confirmations" custom SAP Fiori app

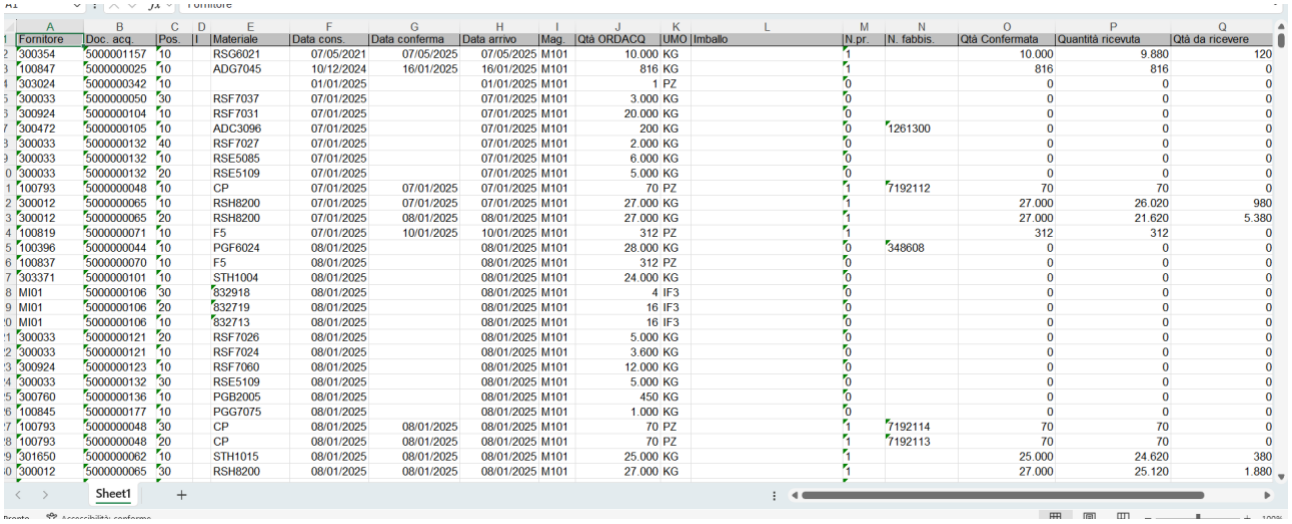
The report is designed to specifically extract, by means of selection parameters (such as supplier, material, plant, and date range), a number of key information for the purchasing department.
The users' main need was to have an immediate and concise view of the orders: when they had been issued, whether the supplier had sent a confirmation, and above all whether a certain delivery date had been given for the requested quantity.
In addition to these essential fields, additional information has been included in the report (shown in Figure 24) at the request of the users themselves, in order to make the tool more versatile for other types of analysis and consultation.



Fornitore	Doc. acq.	Pos.	Materiale	Data cons.	Data conferma	Data arrivo	Mag.	Qtà ORDACQ	UMO	Imballo	N.pr.	N. fabbis.	Qtà Confe
300354	0001157	00010	RSG6021	07.05.2021	07.05.2025	07.05.2025	M101	10.000	KG		0001		
100847	5000000025	00010	ADG7045	10.12.2024	16.01.2025	16.01.2025	M101	816	KG		0001		
303024	5000000342	00010		01.01.2025	00.00.0000	01.01.2025	M101	1	PZ		0000		
300033	5000000050	00030	RSF7037	07.01.2025		07.01.2025	M101	3.000	KG		0000		
300924	5000000104	00010	RSF7031			07.01.2025	M101	20.000	KG		0000		
300472	5000000105	00010	ADC3096			07.01.2025	M101	200	KG		0000	1261300	
300033	5000000132	00040	RSF7027			07.01.2025	M101	2.000	KG		0000		
300033	5000000132	00010	RSE5085			07.01.2025	M101	6.000	KG		0000		
300033	5000000132	00020	RSE5109			07.01.2025	M101	5.000	KG		0000		
100793	5000000048	00010	CP		07.01.2025	07.01.2025	M101	70	PZ		0001	7192112	
300012	5000000065	00010	RSH8200			07.01.2025	M101	27.000	KG		0001		
300012	5000000065	00020	RSH8200		08.01.2025	08.01.2025	M101	27.000	KG		0001		
100819	5000000071	00010	F5		10.01.2025	10.01.2025	M101	312	PZ		0001		
100396	5000000044	00010	PGF6024	08.01.2025	00.00.0000	08.01.2025	M101	28.000	KG		0000	348608	
100837	5000000070	00010	F5			08.01.2025	M101	312	PZ		0000		
303371	5000000101	00010	STH1004			08.01.2025	M101	24.000	KG		0000		
MI01	5000000106	00030	832918			08.01.2025	M101	4	IF3		0000		
MI01	5000000106	00020	832719			08.01.2025	M101	16	IF3		0000		
MI01	5000000106	00010	832713			08.01.2025	M101	16	IF3		0000		

Figure 24 - "Supplier Confirmations List" report in SAP Fiori (Italian interface)

As for all reports produced, both custom and standard, the possibility of exporting them in Excel format was ensured, in order to facilitate the use and sharing of data within departments (see Figure 25 below).



Fornitore	Doc. acq.	Pos.	I	Materiale	Data cons.	Data conferma	Data arrivo	Mag.	Qtà ORDACQ	UMO	Imballo	N.pr.	N. fabbis.	Qtà Confermata	Quantità ricevuta	Qtà da ricevere
300354	5000001157	10		RSG6021	07/05/2021	07/05/2025	07/05/2025	M101	10.000	KG		1		10.000	9.880	120
100847	5000000025	10		ADG7045	10/12/2024	16/01/2025	16/01/2025	M101	816	KG		1		816	816	0
303024	5000000342	10			01/01/2025		01/01/2025	M101	1	PZ		0		0	0	0
300033	5000000050	30		RSF7037	07/01/2025		07/01/2025	M101	3.000	KG		0		0	0	0
300924	5000000104	10		RSF7031	07/01/2025		07/01/2025	M101	20.000	KG		0		0	0	0
300472	5000000105	10		ADC3096	07/01/2025		07/01/2025	M101	200	KG		0	1261300	0	0	0
300033	5000000132	40		RSF7027	07/01/2025		07/01/2025	M101	2.000	KG		0		0	0	0
300033	5000000132	10		RSE5085	07/01/2025		07/01/2025	M101	6.000	KG		0		0	0	0
300033	5000000132	20		RSE5109	07/01/2025		07/01/2025	M101	5.000	KG		0		0	0	0
100793	5000000048	10		CP	07/01/2025	07/01/2025	07/01/2025	M101	70	PZ		1	7192112	70	70	0
300012	5000000065	10		RSH8200	07/01/2025	07/01/2025	07/01/2025	M101	27.000	KG		1		27.000	26.020	980
300012	5000000065	20		RSH8200	07/01/2025	08/01/2025	08/01/2025	M101	27.000	KG		1		27.000	21.620	5.380
100819	5000000071	10		F5	07/01/2025	10/01/2025	10/01/2025	M101	312	PZ		1		312	312	0
100396	5000000044	10		PGF6024	08/01/2025		08/01/2025	M101	28.000	KG		0	348608	0	0	0
100837	5000000070	10		F5	08/01/2025		08/01/2025	M101	312	PZ		0		0	0	0
303371	5000000101	10		STH1004	08/01/2025		08/01/2025	M101	24.000	KG		0		0	0	0
MI01	5000000106	30		832918	08/01/2025		08/01/2025	M101	4	IF3		0		0	0	0
MI01	5000000106	20		832719	08/01/2025		08/01/2025	M101	16	IF3		0		0	0	0
MI01	5000000106	10		832713	08/01/2025		08/01/2025	M101	16	IF3		0		0	0	0
300033	5000000121	20		RSF7026	08/01/2025		08/01/2025	M101	5.000	KG		0		0	0	0
300033	5000000121	10		RSF7024	08/01/2025		08/01/2025	M101	3.600	KG		0		0	0	0
300924	5000000123	10		RSF7060	08/01/2025		08/01/2025	M101	12.000	KG		0		0	0	0
300033	5000000132	30		RSE5109	08/01/2025		08/01/2025	M101	5.000	KG		0		0	0	0
300760	5000000136	10		PGB2005	08/01/2025		08/01/2025	M101	450	KG		0		0	0	0
100845	5000000177	10		PGG7075	08/01/2025		08/01/2025	M101	1.000	KG		0		0	0	0
100793	5000000048	30		CP	08/01/2025	08/01/2025	08/01/2025	M101	70	PZ		1	7192114	70	70	0
100793	5000000048	20		CP	08/01/2025	08/01/2025	08/01/2025	M101	70	PZ		1	7192113	70	70	0
301650	5000000062	10		STH1015	08/01/2025	08/01/2025	08/01/2025	M101	25.000	KG		1		25.000	24.620	380
300012	5000000065	30		RSH8200	08/01/2025	08/01/2025	08/01/2025	M101	27.000	KG		1		27.000	25.120	1.880

Figure 25 - Excel export of the "Supplier Confirmations" report from SAP

5.1.5 Fifth Project Phase: Post-Go-Live Support Phase

- **Monitoring and Optimisation**

  After the Go-Live, continuous monitoring of the system is activated to promptly identify and solve any technical or functional problems. The support team constantly analyses the performance of the SAP environment, carrying out tuning actions to ensure operational efficiency and system stability.[125]

- **Change management**

  To facilitate the adoption of the new system, constant coaching is provided to end users, through additional training sessions, direct support via chat, calls, or virtual meetings. This accompaniment facilitates the integration of the new operating methods into the company's routine, reducing resistance and difficulties in use.

- **Planning for future updates**

  In this phase, future system updates are planned, such as planned SAP releases, security patches and the introduction of new functionalities. Improvements based on user feedback and emerging needs are also evaluated, thus ensuring continuous evolution and alignment of the system with business strategies.

[125] Sharma, D. P. (2010). Selection, implementation & support of SAP ERP system approach in manufacturing industry. *Global Digital Business Review*, *4*(1), 1931-8146.

During this phase, users can receive direct support via chat, calls, meetings via Microsoft Teams or by opening tickets on the dedicated Service Cloud portal. This system enables a structured handling of requests, monitoring their status and ensuring timely responses.

During the Post-Go-Live, a critical issue emerged concerning the fragmented management of material master data, which had previously been entrusted to the individual business areas. As agreed in the workshop on 17/04/2024 during the "Explore" phase, each area was supposed to enter the mandatory fields for its own process, but this led to delays and data that were not always complete or correct.
In order to improve the quality and timeliness of the master data, it was decided to centralize this activity in the technical secretariat, which previously only created the necessary views (basic data 1 and 2, sales, purchasing, inventory, accounting and cost views), without entering data. The technical secretariat now fully manages the master data entry, ensuring uniformity and control. In this context, I again supervised the manuals, direct training, and the collection of feedback to facilitate this transition.

One difficulty encountered was the need to maintain constant and clear communication between the technical secretariat and the various departments, which was essential to avoid errors or omissions in master data. This required closer coordination and a significant commitment from everyone, especially in the first months of implementation of the new operating model.

5.2 Focus SAP MM: Configuration Design

5.2.1 Organisational Structure on SAP

The following organizational elements were configured for the company under review:

5.2.1.1 Division and warehouses

Table 7 below lists the company, plant, and warehouse codes with their corresponding descriptions, reflecting the physical and logical storage locations defined in SAP.

Company	Plant	Warehouses	Warehouse description
MLIT	ML01	M101	Central warehouse
		M102	External warehouse 1
		M104	External warehouse 2
MLIT	ML01	M800	Scrap Warehouse

Table 7 - SAP MM organisational configuration: division and warehouses

5.2.1.2 Commercial structure

Table 8 below shows the mapping of company code, plant, sales organisations, distribution channel, product sectors, and purchasing organisations set up in the system.

Company	Company code	Plant	Sales organisation	Distribution channel	Product sectors	Purchasing organisation
Company name	MLIT	ML01	ML01 - ML09	01	01-02-03-08-09	ML01

Table 8 - SAP MM organizational configuration: commercial structure

The diagram in figure 26 illustrates the sales organizational structure configured in SAP. It includes a company code branching into two sales organizations, one handling direct sales (ML01) and the other intercompany transactions (ML09). Both use the same distribution channel (01) and are subdivided into product sectors such as Beer & Beverage (01), Food (02), Ink (03), Others (08), and Services (09), supporting process segmentation and reporting.

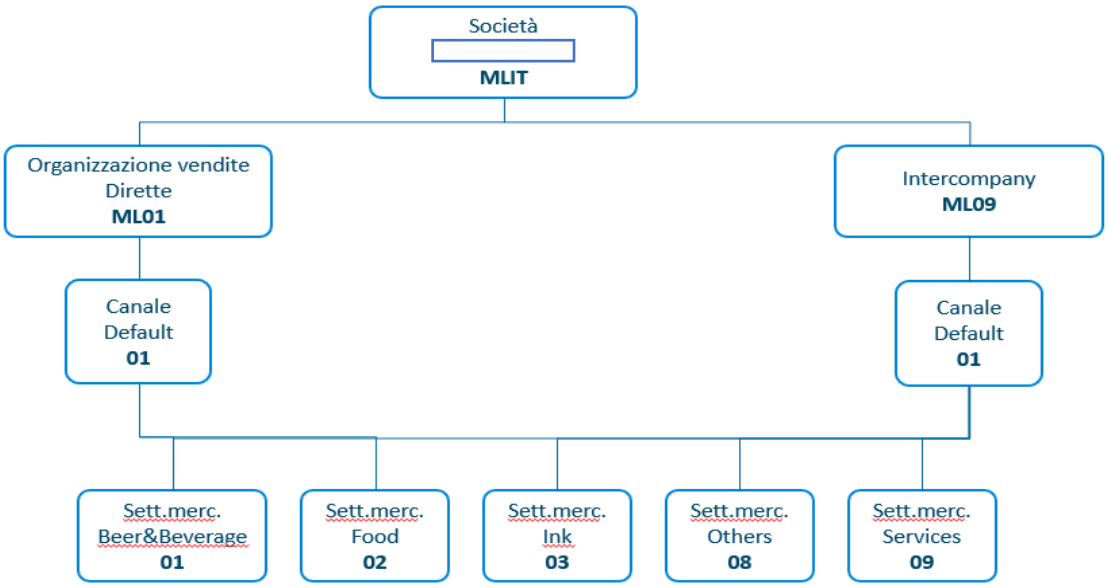


Figure 26 - SAP sales structure with two sales organizations, a default distribution channel, and multiple product sectors

5.2.2 Business partners

There are no additions to the BP types and numbering ranges already provided for in the system.

The tables below summarize the business partner (BP) configuration in SAP. The first table (Table 9) defines groupings, internal ranges, and account groups for different BP categories such as customers, suppliers, goods destinations, and contacts.

BP Grouping	N. Digit	Internal range	Grouping	Account group	
Customers	6	100000 - 199999	ZM01	ZM01	Customer
Goods destinations	6	500000 - 599999	ZM02	ZM02	Ship-to-party
Suppliers	6	300000 - 399999	ZM03	ZM03	Supplier
Contact	6	900000 - 999999	ZM09		

Table 9 - Business Partner groupings and internal ranges configured in SAP

The second table (Table 10 below) lists the BP roles assigned to each grouping, distinguishing financial (FI) and sales or purchasing (SD, PUR) roles.

BP Grouping	BP role	Description
Customers	ZCUST	FI Customer
		SD Customer
Suppliers	ZVEND	FI Vendor
		PUR Vendor

Table 10 - BP roles assigned to each grouping, with descriptions for financial and purchasing processes

Master data management for BPs, including creation, modification, and viewing, is handled through the standard Fiori app F3163 (*Manage Business Partner* Master Data).

5.2.2.1 Creating Custom Roles

In order to manage FI and SD customer data (and speculatively FI and purchase supplier data) in a single role, two separate custom roles were created:

- ZCUST: for customer master data
- ZVEND: for supplier master records

5.2.2.2 Definition of BP Views

By launching the BUSD transaction, BP Views can be managed. In this case, two views were created and called with the same name as the custom roles, thus:

- ZCUST: copying from standard BP view FLCU00
- ZVEND: copying from standard BP view FLVN00

In this way, we created two custom views copied from the views used to manage the FI data, of suppliers and customers respectively.

To merge the FI roles with the SD and MM roles, the objects (datasets, call-up applications, screen sequences and sub-header IDs) that are missing must be added to the standard roles FLCU01, for customers, and FLVN00, for suppliers.

5.2.2.3 Definition of role categories

Role categories (or role types) are used to relate roles according to attributes.

SPRO > Cross-Application Components > SAP Business Partner > Business Partner > Basic Settings > Business Partner Roles > Define BP Roles

From the interactive structure, select 'Role Types' (as shown in Figure 27):

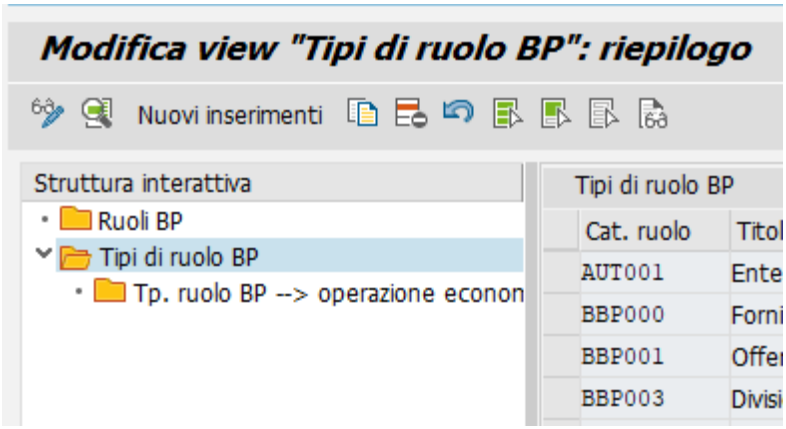


Figure 27 - SAP configuration view for BP role types

Then create in copy from the standard (from FLCU00 and FLVN00) two custom role categories ZCUST and ZVEND.

5.2.2.4 Creating BP Roles

Always from the route:

SPRO > Cross-Application Components > SAP Business Partner > Business Partner > Basic Settings > Business Partner Roles > Define BP Roles

From the interactive structure, select 'Role Types'.

Access the 'BP Roles' section, as shown in Figure 28 below:

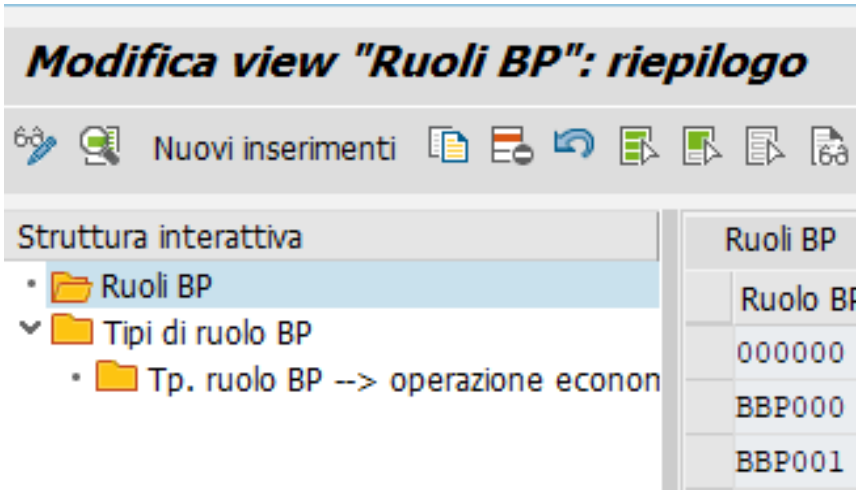


Figure 28 - SAP configuration view for defining BP roles

Then create in copy from the standard (from FLCU00 and FLVN00) two custom BP roles ZCUST and ZVEND

By associating the role category and the previously created BP view (see example in Figure 29 below):

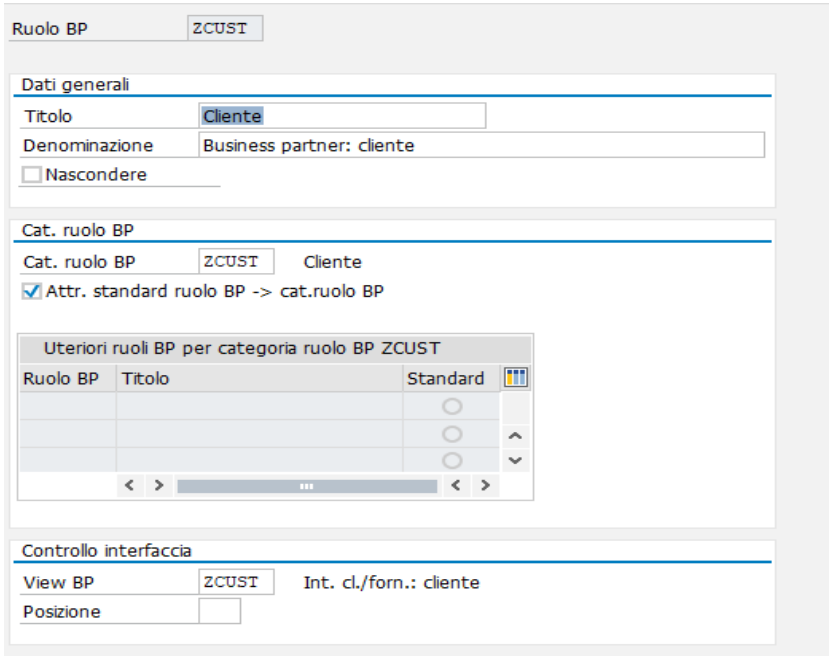


Figure 29 - SAP configuration screen for the custom BP role ZCUST, showing the assignment of the role category and BP view

5.2.3 Master data

5.2.3.1 Materials

The material types (shown in Table 11) used by the company will be those defined at group level, with external numbering range. In SAP, the material valuation method defines how the inventory value and the cost of goods sold are calculated:

- **Moving Average Price (MAP):** The material price is continuously updated with each goods receipt or invoice posting. It reflects the actual purchase or production costs over time. This method is more dynamic and is typically used for raw materials or items with frequently fluctuating prices;
- **Standard Price:** The material price remains fixed over a period, and all stock postings are valued at this standard cost. Price differences between the standard cost and actual purchase or production costs are posted as variances. This method is common for finished and semi-finished products where stable costing is required for planning and variance analysis.

Material Type	Description	External range	Stock Management	Price Management	Logistics Batch
ZFER	Finished products	800000 - 899999 400000 - 400999 T* (inks)	Quantity and value	**Standard Price**	YES
ZHAL	Semi-finished products	900000 - 999999	Quantity and value	**Standard Price**	YES
ZROH	Raw materials	AAA0000 - ZZZ9999	Quantity and value	**Moving Average**	YES
ZVER	Packaging	AA - ZZ	Quantity and value	**Moving Average**	NO
ZCAM	Samples	TBD	Quantity and value	**Standard Price**	TBD
ZDIEN	Services	AAAA - ZZZZ	None	**None**	NO

Table 11 - SAP configuration of material types

Master data management (creation, modification, visualization) will be carried out with the help of the F1602 standard FIORI app (Manage Product Master).

5.2.3.2 Batches

In this company scenario, SAP batch management will be activated for the following material types: ZROH (raw materials), ZFER (finished products) and semi-finished products (ZHAL). The logic of determination is as follows in Table 12:

Material type	Event generating it	Batch SAP	Dummy batch
Finished products	Production or packaging order creation	**Encoding = AMnnnnPPP** • A = letter identifying the year • M = letter identifying the month • nnnn = **0001- 4999 range**	NO
Semi-finished products	Production order creation	**Dummy coding = SAP material code**	**Encoding = CAMnnn** • C = fixed 'I' character • A = letter identifying the year • M = letter identifying the month • nnn = incremental counter*
Raw materials	Goods entry	**Dummy coding = SAP material code**	**AAMnnn** • AA = last 2 digits current year • M = letter identifying the month • nnn = incremental counter*

Table 12 - SAP batch management configuration

The configuration defines distinct batch coding logics based on the event triggering batch creation: production or packaging orders for finished and semi-finished products, and goods receipt for raw materials. Each coding structure incorporates year, month, and incremental counters to ensure unique identification. Dummy batches are also used where applicable.

5.2.4 Purchases

5.2.4.1 Material purchases coded and managed on a stock basis (raw materials, semi-finished products, finished products)

For material purchases managed on a stock basis (raw materials, semi-finished, and finished products), a single custom purchase order type (ZM01) is defined in SAP. This document type uses a specific number range (5000000000–5099999999) and is associated with the standard partner determination scheme 0002, ensuring correct partner roles are applied during procurement.
The system coded document type ZM01 for creating purchase orders is shown in Table 13:

SAP document type	Description	Range	Interval
ZM01	PO "Company Name"	50	5000000000-5099999999

Table 13 - SAP purchase order document type configuration

SPRO > Materials Management > Purchasing > Partner Determination > Partner Determination Procedure (Purchasing Document) > Assign Partner Schemas to Document Types

5.2.4.2 Other purchases (assets, services, non-stock material)

It is envisaged that a single type of purchase order, ZM01, will also be used for the purchase of non-stock materials, services, and assets.

For this type of purchase, the use of purchase requisition (PR) is envisaged, coded in the system as document type ZML as shown in Table 14:

SAP document type	Description	Range	Interval
ZML	PR "Company Name"	07	50000000-59999999

Table 14 - SAP configuration for non-stock purchases and Purchase Requisitions

The flexible workflow for Purchase Requisition type ZML has been activated by flagging the "Workflow" column, as shown in Figure 30:

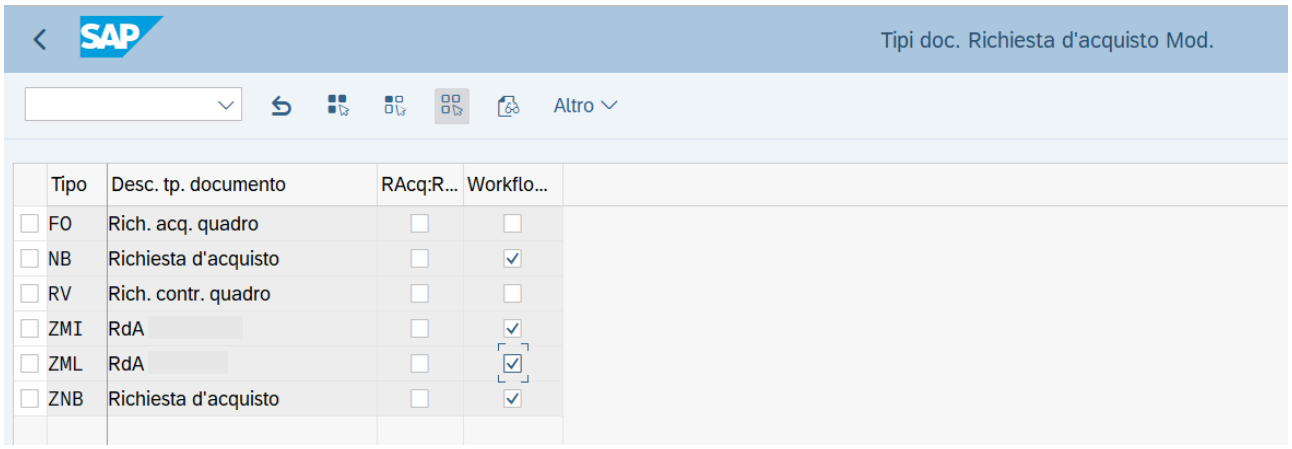


Figure 30 - SAP configuration of Purchase Requisition document types

5.2.5 Accounting

The following standard system-coded accounts will be used:

5.2.5.1 Assets

It is planned to use customized accounting H 'Assets Italy'.

5.2.5.2 Services

It is planned to use the standard K 'Cost centre' accounting and purchase account determination by commodity group.

5.2.6 Mapping Commodity Groups Cost Accounts

To enable the automatic determination of cost accounts in purchase orders for services and non-stock materials, the system was configured to assign a valuation class to each commodity group.
This setup ensures that the correct general ledger (G/L) accounts are used during procurement.

The configuration path is:
SPRO > Materials Management > Purchasing > Material Master Data > Entry Aids for Items Without Material Master

5.2.7 Purchase price lists

To manage purchase price lists and ensure correct price determination, SAP scheme groups were defined and assigned to procurement organizations. This configuration allows the system to apply specific pricing procedures and costing schemes tailored to each organization.

The relevant configuration paths are:

1) SPRO > Materials Management > Purchasing > Conditions > Define Pricing > Define Scheme Groups

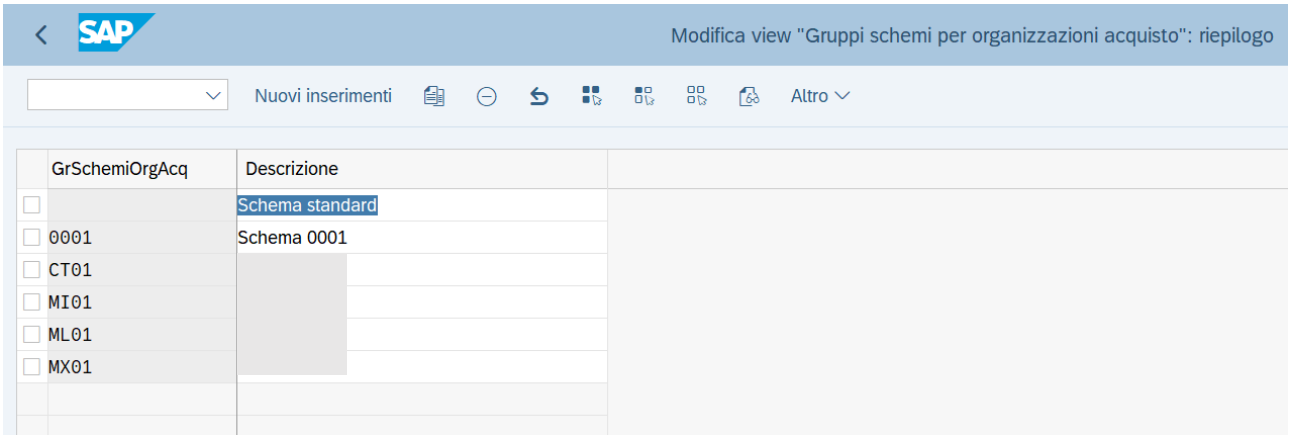


Figure 31 - SAP configuration of purchasing scheme groups

Figure 32 - Assignment of scheme groups to purchasing organizations in SAP

2) SPRO > Materials Management > Purchasing > Conditions > Define Pricing > Set Costing Scheme – Purchasing

The company price scheme ZML001 was defined as shown below in Figure 33:

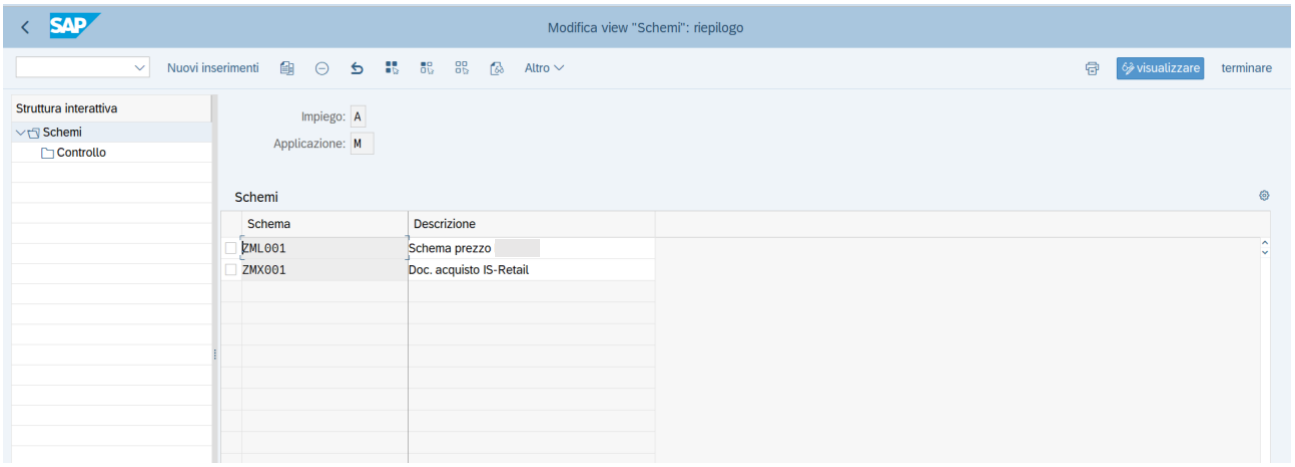


Figure 33 - SAP configuration of costing schemes for purchasing

As shown in Figure 34, this configuration specifies condition types such as gross price, absolute and percentage surcharges, quantity-based surcharges, discounts, transport costs, and customs charges. Variables **ADDITIONAL_COSTS_MANDATORY** and **ADDITIONAL_COSTS_INCOTERMS** were added in table ZCUSTOM_PARAMETR to enforce mandatory header conditions for Incoterms below:

- **EXW:** Ex Works
- **FCA:** Free Carrier
- **CIP:** Carriage and Insurance Paid To
- **FOB:** Free On Board
- **CFR:** Cost and Freight
- **CIF:** Cost, Insurance and Freight

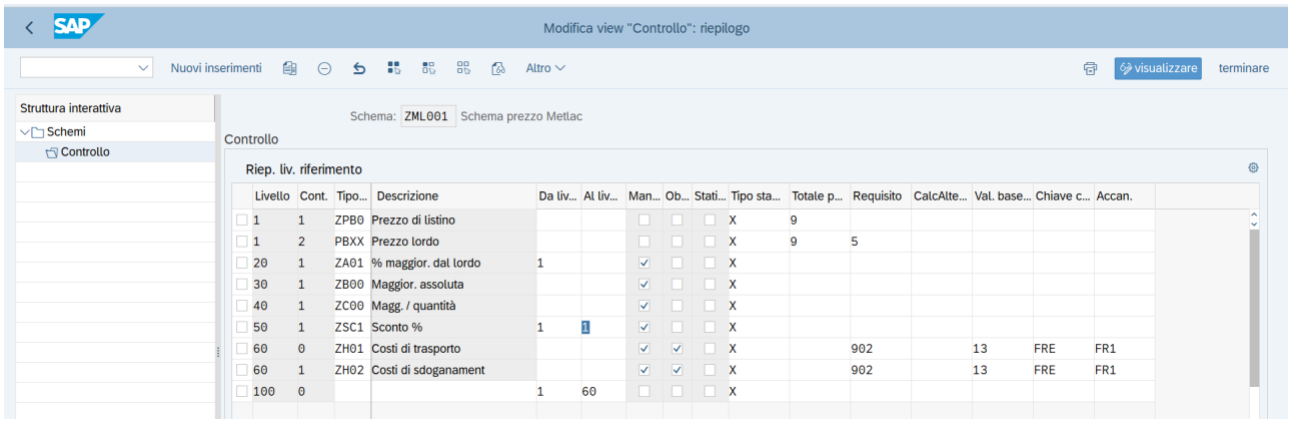


Figure 34 - SAP pricing procedure configuration for scheme ZML001

5.2.8 Vendor Returns Configuration

Two custom delivery types were created for the management of returns to suppliers:

- ZRL delivery of returns against return order;
- ZRLL delivery of incoming goods.

This setup was defined under:

1) Logistics Execution > Shipping > Deliveries > Define delivery types

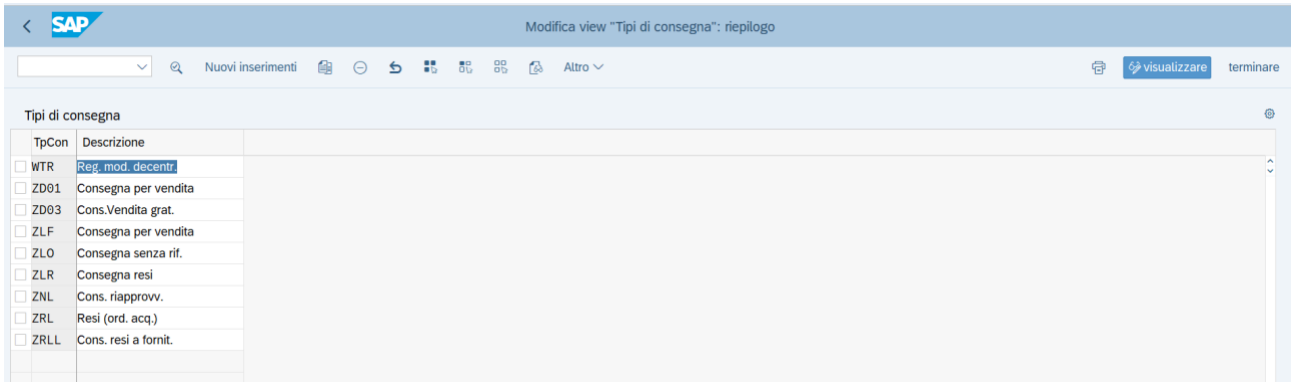


Figure 35 - SAP configuration of delivery types

2) General Logistics > Management of packaging and dispatch units > Bases > Delivery > Determine delivery types > Set delivery types for outbound delivery.

   This step defines the assignment between the RL delivery category (used for returns management) and the custom delivery type ZRLL as shown below in Figure 36:

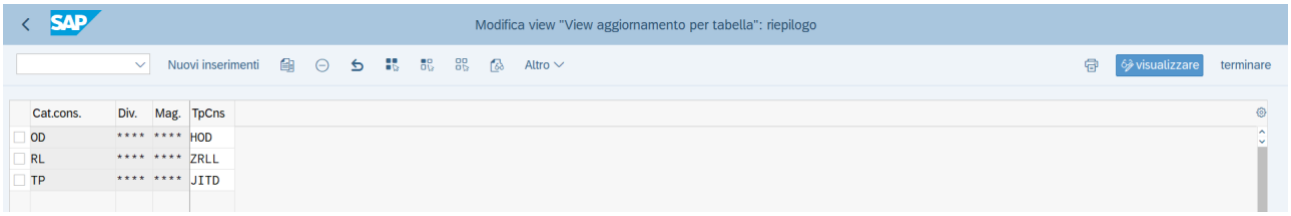


Figure 36 - SAP configuration linking the RL delivery category to the custom delivery type ZRLL for returns management

3) Materials Management > Purchasing > Purchase Order > Return Order > Returns to Supplier.

The delivery type to be used for the return order type ZM01 and division ML01 is indicated as shown in Figure 37. This customizing allows the delivery conditions and all the information necessary for the goods to be released when the return order is created. With the VL10B transaction, the delivery note is then created against the return order.

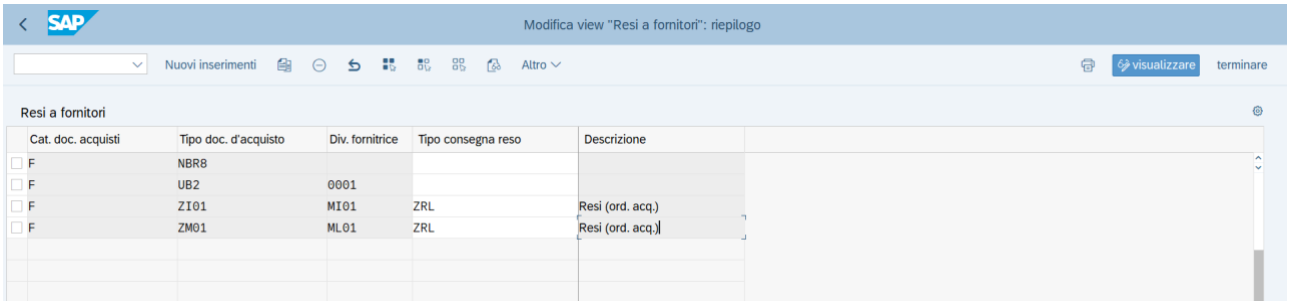


Figure 37 - Assignment of delivery type ZRL to return order ZM01 for automatic delivery creation

4) Logistics execution > Shipping > Determine shipping location/accept goods > Configure determine shipping location from warehouse

As shown in Figure 38, this customizing defines how the place of dispatch (shipping point) is determined for each delivery type. In this scenario, the determination is based on the warehouse (indicator “L”).

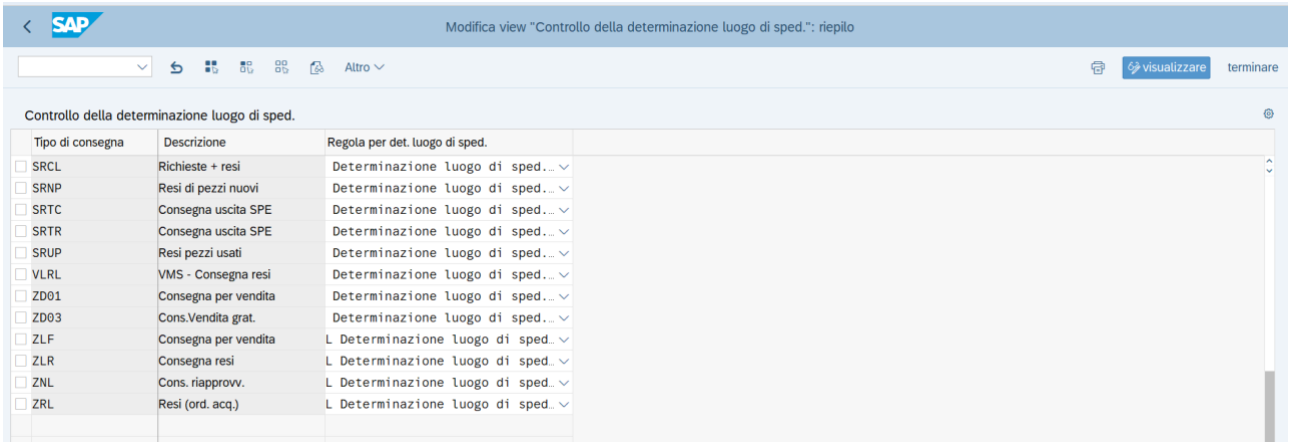


Figure 38 - SAP configuration of shipping point determination by warehouse for each delivery type

NB: the ZRLL return delivery copied from the standard RLL does not include the determination of the place of dispatch by warehouse in standard SAP. There is a workaround which was applied to enable this determination.

5.3 Concrete Improvements in the Quality System (QMS): Measurable Results

The adoption of SAP S/4HANA led to a clear quantum leap in processes related to the company's Quality System, with tangible and measurable results in the short term. The areas where the greatest benefits were seen were in data management, monitoring through KPIs, reduction of operational errors, and efficiency in audit and compliance processes.[126]

5.3.1 Data Accuracy and Traceability

One of the main benefits introduced was the consolidation of material and supplier master records into one centralized system, which reduced master errors by 40% compared to the previous situation managed on fragmented legacy systems.

In production, batch traceability is now 100% guaranteed, with over 250 batches tracked monthly through unique coding. This has led to a drastic reduction in the time taken to search for information on a batch: from around 2 hours to less than 5 minutes per operation.

[126] Alaa, A. S., Pasławski, J., & Nowotarski, P. (2019, May). Quality Management to continuous improvements in process of Ready Mix Concrete production. In *IOP Conference Series: Materials Science and Engineering* (Vol. 518, No. 2, p. 022019). IOP Publishing.

5.3.2 Real-Time Quality KPIs

Thanks to SAP S/4HANA, the company can introduce advanced integrated monitoring tools and analytics dashboards, which began delivering measurable improvements in key quality indicators within the first six months post go-live.

These results were derived from a combination of:

- System analytics and KPIs tracked directly in SAP S/4HANA;
- Reports generated by DIGIX PLUS SRL's project management office (PMO) based on periodic evaluations and data extracted from the client's SAP environment;
- Feedback collected from end-users during workshops and post-go-live surveys to validate operational improvements.

The most relevant achievements are detailed below:

1. **Reduction in Returns to Suppliers (-25%)**
   Prior to SAP implementation, supplier returns were manually logged and often delayed due to fragmented legacy systems (AS400). With SAP MM module integration:
   - Non-conforming batches are now identified faster using batch-level quality data and automated defect alerts;
   - Supplier returns decreased by **25%**, improving supplier relationships and reducing logistical costs.

2. **OTIF (On-Time In-Full) Improvement (+11%)**
   The OTIF indicator, which measures the percentage of customer orders delivered on time and in full, increased from 78% pre-implementation to 89% post-implementation.
   This gain is attributed to:
   - Automated alerts on material expiry dates preventing last-minute shortages;
   - Real-time visibility into inventory and production schedules, allowing proactive adjustments.

3. **Automated Reporting: From 5 to 15 Reports**

Before SAP S/4HANA, the company relied on 5 manual reports, created in Excel by consolidating data from multiple systems. This process was labor-intensive and prone to errors.

Post-implementation, SAP Fiori apps and embedded analytics enabled the automatic generation of over 15 periodic reports, including:

- Standard operational KPIs (e.g., scrap rates, defect frequency);
- Targeted defect analysis reports, focusing on recurring quality issues by product line or supplier;
- Compliance-related reports aligned with ISO 9001 and GMP requirements.

This automation not only reduced the workload of quality teams but also provided **real-time insights** for decision-making, supporting continuous improvement initiatives.

To make these results more tangible, Figure 39 below illustrates a **before-and-after comparison** for these KPIs:

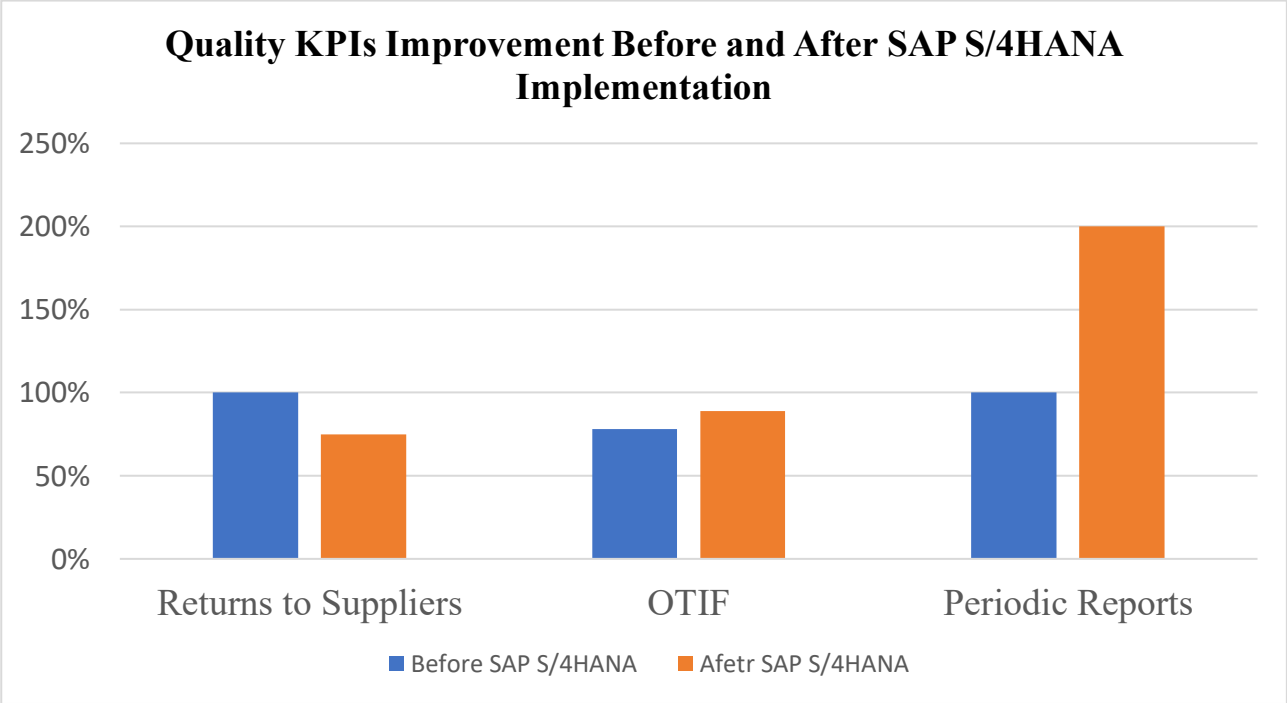


Figure 39 - Quality KPIs Improvement Before and After SAP S/4HANA Implementation

This data demonstrates the immediate operational benefits of migrating from a fragmented legacy system to SAP S/4HANA's integrated environment.

5.3.3 Reducing Operational Errors

The implementation of SAP S/4HANA brought significant enhancements to process accuracy and error prevention by leveraging automation and embedded validation controls:

- **Reduction in Purchase Order Errors (-30%)**

  Key mandatory fields (e.g., material codes, quantities, prices and eventually transportation costs) were enforced through SAP's validation rules. This eliminated frequent mistakes such as incomplete or incorrect orders, which previously required manual correction and caused delays in procurement workflows.

- **Faster PO Approvals (-50% Approval Time)**

  Before SAP, approval processes for purchase orders for non-stock materials and services were highly informal and fragmented, often managed through verbal communication, emails, or instant messaging. This led to potential loss of critical information and unclear responsibilities, increasing the risk of delays and errors.
  With SAP S/4HANA, a structured digital workflow was introduced:

  - Each purchase order is now created, submitted for approval, and tracked directly within the system, ensuring end-to-end visibility;
  - Automatic notifications and task assignments are sent to the relevant approvers, significantly reducing manual follow-ups and preventing bottlenecks;
  - Every step of the process is logged in real-time, providing a complete digital audit trail that enhances transparency and supports compliance requirements.

- **Improved Master Data Governance**

  The centralization and standardization of Material Master Data and Business Partner records in SAP reduced transactional discrepancies, further supporting error reduction in procurement and logistics processes.

- **Impact on Compliance and Efficiency**

  These improvements not only reduced operational workloads but also aligned processes with internal audit and regulatory requirements, strengthening the company's quality and compliance framework.

5.3.4 Audit and Compliance: Document Efficiency

The integration of SAP S/4HANA brought significant improvements to audit preparation and compliance management processes:

- **Reduction of Audit Preparation Time (-60%)**

  Previously, audit preparation was a manual and time-consuming process. Documentation was scattered across multiple systems (AS400, Excel sheets, email archives), requiring extensive cross-checking and manual compilation. This often meant starting preparation weeks in advance.
  With SAP, all documentation (e.g., batch records, supplier certifications, quality inspections) is now digitally linked and easily retrievable through embedded analytics and Fiori apps. As a result, the average preparation time for internal and external audits decreased from 5 working days to 2 days, a 60% reduction.

- **Increased Traceability and Compliance**

  100% of production and quality records are now traceable within SAP S/4HANA. This ensures full compliance with ISO 9001, ISO 22000, MOCA, REACH, and FDA requirements. Auditors can access real-time data and complete digital audit trails, reducing the risk of non-conformities.

- **Time Savings and Efficiency Gains**

  The automation and centralization of documentation led to an estimated saving of over 200 hours/year, equivalent to approximately one full-time resource during audit periods. This is particularly impactful during peak regulatory periods or unannounced inspections.

- **Improved Stakeholder Confidence**

  The digital audit trail has also increased confidence among customers and regulatory bodies, as all quality and compliance data is now transparent, accurate, and readily accessible.[127]

[127] Alaa, A. S., Pasławski, J., & Nowotarski, P. (2019, May). Quality Management to continuous improvements in process of Ready Mix Concrete production. In *IOP Conference Series: Materials Science and Engineering* (Vol. 518, No. 2, p. 022019). IOP Publishing.

5.3.5 Post-Go-Live User Feedback and Change Management Assessment

Following the Go-Live phase of the SAP S/4HANA implementation, DIGIX PLUS SRL adopted a structured approach to assess the project's impact and user satisfaction across the client company. A survey was distributed to all functional areas involved in the implementation, aiming to gather feedback on four key dimensions:

- System Usability & User Experience: measuring how intuitive and user-friendly the new SAP environment was perceived;
- Change Management & Support: evaluating the effectiveness of change management initiatives and the level of support provided throughout the transition;
- Perceived Impact on Day-to-Day Operations: assessing improvements or challenges in operational workflows post-implementation;
- Trainers' Effectiveness: capturing how well the training sessions prepared employees to use SAP S/4HANA effectively.

The Project Manager from Digix Plus consolidated all responses into a detailed Excel analysis, aggregating results from 18 respondents across various departments.

The findings highlight strong positive feedback across all categories, confirming the success of the implementation and change management strategy. As visualized in Figure 40 below, the aggregated scores were:

- System Usability & User Experience: 87%
- Change Management & Support: 85%
- Perceived Impact on Day-to-Day Operations: 88%
- Trainers' Effectiveness: 90%
- Overall Satisfaction: 87.5%

These results indicate a high level of user adoption and satisfaction. Particularly noteworthy is the 90% rating for Trainers' Effectiveness**,** reflecting the quality of the hands-on training and the support provided during critical phases like User Acceptance Testing (UAT) and Go-Live.

The Change Management & Support category, while slightly lower at 85%, still demonstrates a solid performance considering the scale of organizational change involved.

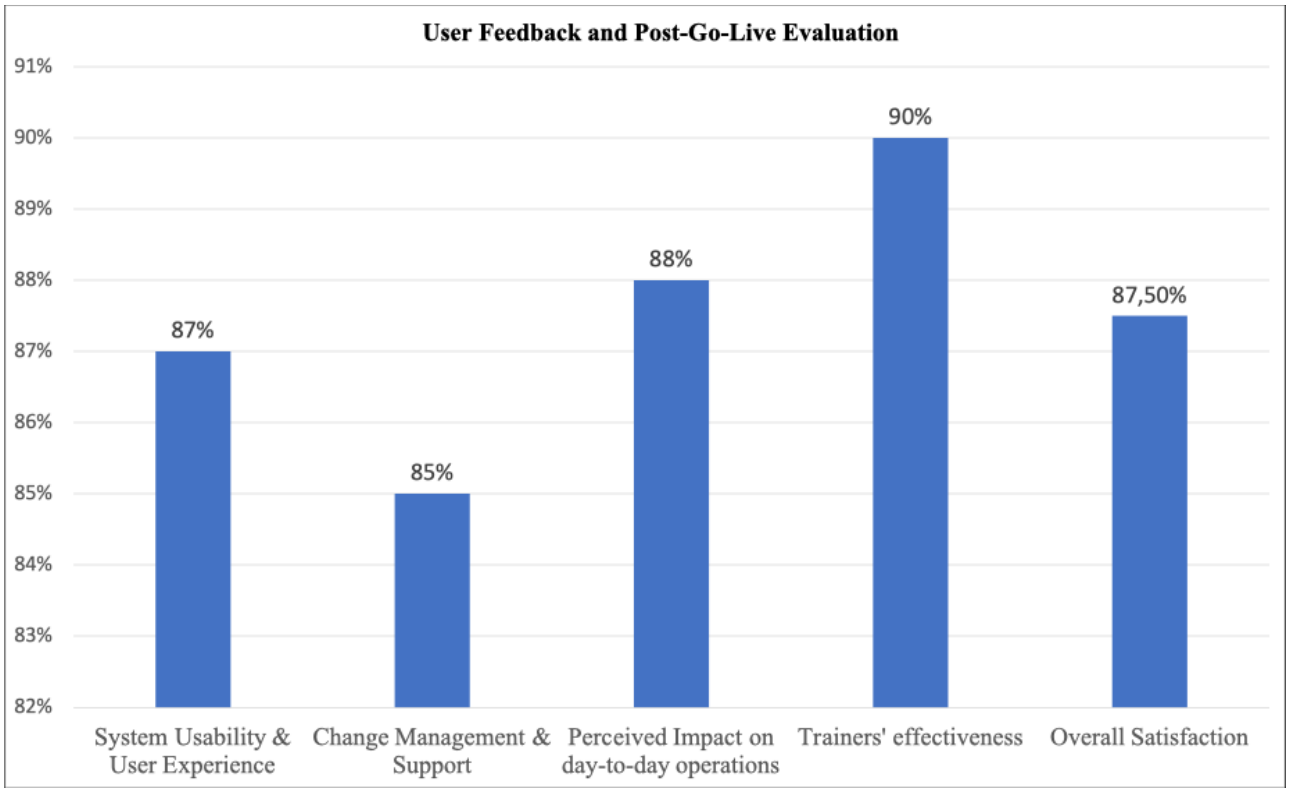


Figure 40 - User Feedback and Post-Go Live Evaluation

The bar chart in Figure 40 offers a clear visualization of the post-Go-Live evaluation, illustrating consistent satisfaction levels across all key dimensions. The results emphasize that the combination of robust training, proactive change management, and technical support was instrumental in facilitating a smooth transition and mitigating user resistance.

5.3.6 Future Developments and Additional Implementations

Building on the success of the initial Greenfield implementation, the company is pursuing further enhancements to extend digitalization and strengthen the QMS:

- Implementation of SAP Ariba to improve supplier collaboration and procurement efficiency, integrating digital supplier portals and advanced contract management;
- Full activation of MRP (Material Requirements Planning) to optimize raw material planning and inventory levels, enabling proactive management of production demand;
- Deployment of SAP Plant Maintenance (PM) to digitize preventive and corrective maintenance processes, improving asset reliability and cost control;
- Planned integration of the Quality Management (QM) module for advanced quality planning, inspection, and non-conformance management, aligning with regulatory requirements (MOCA, REACH, FDA).

These evolutive steps demonstrate the company's commitment to continuous improvement and innovation, supported by SAP S/4HANA and the SAP Business Technology Platform (BTP).

5.3.7 Conclusions and Impact on the Quality System

The results achieved in this phase clearly demonstrate a tangible and measurable return on investment (ROI). Thanks to the implementation of SAP S/4HANA, the company has been able to streamline processes and significantly reduce non-quality costs, achieving estimated annual savings of around €150,000. Equally important is the improvement in customer satisfaction: complaints related to traceability errors have decreased by 30%, a direct consequence of more accurate and transparent batch tracking throughout the supply chain. In addition, the company has reached 100% compliance with GMP and ISO 9001:2015 standards. This achievement not only facilitates audit readiness but also strengthens confidence among customers and regulatory bodies, confirming the robustness and reliability of the new Quality Management System. The digital transformation has provided the company with a solid and future-proof foundation for continuous improvement, innovation, and sustained competitiveness in an increasingly demanding market environment.

Conclusions

This thesis has analyzed a real-life case of digital transformation focused on the implementation of SAP S/4HANA to support the Quality Management System (QMS) in a leading company in the food packaging coatings sector. The experience gained during the internship at Digix Plus highlighted how an ERP project of this magnitude goes far beyond the mere replacement of a management system. It represents a comprehensive process of redefining and optimizing business operations.

The introduction of SAP S/4HANA enabled the company to embark on a digitalization journey that has already delivered tangible benefits in terms of traceability, operational efficiency, and responsiveness to the sector's stringent regulatory requirements. As confirmed by recent studies, the adoption of advanced ERP systems can have a substantial impact on organizational performance, enhancing integrated information management and decision-making capabilities (Sharma & Mutsaddi, 2010). However, it became evident that the Go-Live is not the conclusion of the journey, but rather the beginning of an ongoing evolutionary process toward an increasingly agile and data-driven organization.

Currently, Digix Plus continues to provide support through Application Management Services (AMS), assisting the company in the day-to-day operation of the system and in continuously

improving and optimizing the processes already implemented. This proactive approach allows the organization to respond effectively to emerging operational needs, maintaining the high effectiveness and efficiency of the solutions adopted.

The concrete results achieved in the post-implementation phase further underline the success of the project:

- **40% reduction** in errors in material and supplier master data due to the centralization of records;
- **Complete traceability** of over 250 production batches monitored monthly, reducing information retrieval times from two hours to less than five minutes;
- **Increase in OTIF (On-Time In-Full)** from 78% to 89% and a **25% reduction in returns to suppliers**;
- **30% reduction** in errors in purchase orders and halving of return approval times thanks to the implementation of digital workflows;
- **Over 200 hours saved annually** in preparing audit documentation, with a **60% reduction** in preparation time;
- **Estimated financial savings of approximately €150,000 per year** in non-quality costs and a **30% decrease in customer complaints** related to traceability errors.

These achievements are not merely performance indicators; they represent a paradigm shift in business management, where ERP technology acts as a powerful enabler of competitiveness, innovation, and resilience within an increasingly complex and regulated market (Agus et al., 2020).

One particularly significant insight from the project was the crucial role of change management. The success of an ERP implementation depends not only on the technology's quality but also on the organization's ability to guide people through the cultural change process. Building awareness, developing new skills, and fostering collaboration across different business units proved fundamental to ensuring effective system adoption and consolidating the benefits achieved.

Looking ahead, the project's future prospects are equally promising. The company plans to extend SAP S/4HANA's functionalities with the implementation of Material Requirements Planning (MRP), aiming to optimize demand planning and supply chain management. Additionally, integrating the SAP Ariba supplier portal represents a strategic move to fully digitize interactions with external partners, simplifying processes such as supplier qualification, audits, and compliance monitoring. Planned future developments also include deploying the SAP Plant Maintenance (PM) module for

centralized management of both routine and extraordinary maintenance, thus contributing to better control of operational costs and further enhancement of the quality system.

In this context, the case study demonstrates that adopting an advanced ERP system is not a destination but rather a starting point for continuous improvement and organizational evolution.

On a personal level, this experience has provided me with the opportunity to actively contribute to a complex and stimulating project. It allowed me to face real-world challenges, collaborate in a dynamic and results-oriented environment, and acquire valuable skills that will be fundamental for my professional future. This journey confirmed that the success of modern organizations lies in their ability to integrate technology, people, and processes within a long-term strategic vision.

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