Politecnico di Torino

Master of Science in ENGINEERING AND MANAGEMENT

A.Y. 2024/2025

April 2025

IMPLEMENTATION AND OPTIMIZATION OF THE QUALITY MANAGEMENT SYSTEM OF POMPE GARBARINO S.p.A: IMPROVEMENT OF BUSINESS PROCESSES AND QUALITY MONITORING OF PRODUCTION PROCESSES.

Master's Degree Thesis

Supervisor:

Prof. Maurizio GALETTO

Prof. Gianfranco GENTA

Ing. Manuela DELORENZI

Candidate:

Carolina MOSQUERA CHARRY

ACKNOWLEDGEMENTS

This thesis is dedicated to my family who have played a fundamental role during these two years of academic and cultural international experience, forming the roots that have allowed me, through a strong and stable trunk, to bear fruit and grow the crown of the tree that I have been sowing in myself every day, thanks to their unwavering support.

I also dedicate this thesis to the Carolina of two years ago, who left her country to pursue her dreams without knowing the challenges she would face during the process, filling herself with courage and resilience to never fail and demonstrating what is done with love and effort is always well rewarded.

"Don’t stop when you’re tired. Stop when you’re done".

- David Goggins

INDEX

ABSTRACT

The present thesis is the result of a study on the integrated management system of POMPE GARBARINO S.p.A, a leading company in the production of centrifugal and positive displacement pumps in the naval and industrial sector, for the implementation and adaptation of the quality management system in accordance with ISO 9001:2015. This includes the revision of the integrated manual, the integration of quality controls within the production process and the optimization of internal procedures to improve efficiency and quality of the product and service provided.

This implementation will not only focus on the adaptation of the existing integrated manual, but also on the integration of quality control during product manufacture, covering all stages of the production process of centrifugal and positive displacement pumps at POMPE GARBARINO S.p.A and the adjustments necessary to comply with international standards.

In the initial phase, investigation was conducted on the clauses and requirements of ISO 9001:2015, including the context of organization, leadership, planning, support, operations, performance evaluation and improvement together with familiarization of the current production processes and the current quality management system of POMPE GARBARINO S.p.A through direct observations of the workflow in the production area and analysis of internal documents of the company related to the quality management system, as the current integrated manual, operating procedures and quality control records.

The company's current integrated management system was then assessed for compliance with the requirements of ISO 9001:2015, using a SWOT analysis. This analysis took into account four types of strategies in which the successes were analyzed as a result of strengths, which, by being exploited, allow more opportunities to face the competition; adaptation as a mechanism for using opportunities to correct weaknesses, using points in favor of the company and being able to improve; reaction as a means of using strengths to mitigate weaknesses, using the company's

strength to get ahead and that weaknesses are minor and survival to stay in the market despite threats.

Subsequently, a new quality management system was planned and implemented emphasizing the need to establish clear and understandable process interaction within the organization with special emphasis on foundry management, to improve traceability and process efficiency. In addition, a new integrated management policy was designed that involves quality, environment and health and safety as a requirement for the establishment of new business ties, making clear the principles, strategies and actions aligned with the mission, vision and strategic objectives of POMPE GARBARINO S.p.A.

Finally, for improvements, Key Performance Indicators (KPI) were developed, using metrics such as OTIF (On Time In Full) to monitor performance, reducing delivery delays focusing on stainless steel as the most critical material during the casting process and improving customer satisfaction.

The results highlight the importance of structured process management and KPI-based decision making, which enables increased efficiency, reduced delays and improved quality assurance. The thesis ends with recommendations for continuous monitoring, process optimization and integration of digital tools that further improve the Quality Management System at Pompe Garbarino S.p.A.

1. POMPE GARBARINO S.p.A COMPANY

1.1 PROFILE AND HISTORY COMPANY

Pompe Garbarino S.p.A is a world leader company that specializes in the manufacturing of centrifugal and positive displacement pumps in Italy and worldwide. Founded in Acqui Terme in 1932, in the province of Alessandria, by Paolo Garbarino, the company was established to grow demands for pumping needs of local wineries industries and aqueducts.

The company maintains its "core business" in the maritime, offshore, and naval sectors thanks to a developing strong relationship with the Italian Navy and its founder at the 1950s, after the war, as a decision to expand into new markets. Since then, Pompe Garbarino S.p.A has become the world's top supplier of pumps for more than 150 cruise vessels, the major shipyards in Europe and Asia, and ship owners worldwide.

Beginning in the early 1980s, Garbarino decides to expand its production market by targeting the industrial sector including engineering firms, chemical and petrochemical plants, desalination plants and power stations. Garbarino decides to expand its production market by targeting the industrial sector, including engineering firms, until opened a sales branch in Milan in 1994 to gain more market share in the industrial sector.

The company’s strategic objective is focused on the constant improvement of its products, developing solutions based on specific customer requirements and selecting the most suitable materials for the different applications.

Pompe Garbarino S.p.A is the only company that produces pumps according to the customer’s customization, choosing to pursue technological advancements in challenging and complex domains rather than implementing mass production techniques, adapting strategies and capacity to manufacture over 450 distinct pump models to consistently prioritize the needs of their customers.

Furthermore, Pompe Garbarino S.p.A. offers excellent customer support, from technical consultancy to after-sales assistance, ensuring end-to-end service.

Innovation, flexibility, and customization have positioned Pompe Garbarino S.p.A. as a global benchmark in its industry.

The centrifugal pumps produced by the company to satisfy any type of customer demand are classified as follows (Pompe Garbarino, 2020):

Figure 1. MU - Pump according to EN 733

Figure 2. MU-L - Vertical in line pumps

Figure 3. MU-LDS - Vertical in line double suction pump

Figure 4. MCA - Recessed impeller torque flow pump

Figure 5. VS - Vertically suspended line-shaft pump

Figure 6. CN - Chemical pump according to ISO 2858 - 5199

Figure 7. ZN - Diathermic oil circulation pump

Figure 8. G - Multistage high pressure pump

Figure 9. BT - Side channel pump

Figure 10. AD - Self-priming pump with open impeller

1.2 QUALITY CONTROL SYSTEM

One of the consequences of globalization is the increase in global competitiveness where the customer becomes the central axis of business operations. In this sense, to speak of quality in a company implies prioritizing customer satisfaction as the main objective by encouraging mutual commitment between the company and its employees by promoting effective management procedures.

Pompe Garbarino S.p.A has ISO 9001:2015 and ISO 14001:2015 certification from RINA and NATO AQAP 2110 certification from the Italian Ministry of Defense, carrying out NATO's stringent requirement for shock proof, noise proof, vibration proof, and non-magnetic execution (Pome Garbarino, 2022).

To provide quality control throughout the whole bomb manufacturing process, the company conducts continuous material verification at each stage of the process for each type of pump, from acceptance control and intermediate tests to final testing.

Classification societies like "Registro Navale Italiano" (RINA), "American Bureau of Shipping" (ABS), "Bureau Veritas" (BV), "Lloyd's Register" (LR), "Det Norske Veritas Germanischer Lloyd" (DNV GL), "Nippon Kaiji Kyokay" (NKK), "Russian Maritime Register of Shipping" (RS) and "Russian River Register" (RRR) (Pome Garbarino, 2022) are responsible for testing, approving and certifying the pumps produced.

NATO standards are followed by the manufacturing and testing of pumps in the Naval field.

- MIL STD 167 1 (mechanical vibrations)
- MIL STD 740 1 (airborne sound)
- MIL STD 740 2 (structure borne vibrations)
- MIL S 901 D (shock test)
- Amagnetic performance

2. ISO 9001:2015 – QUALITY MANAGEMENT SYSTEMS

An Integrated Management System, according to UNE 66177:2005, is a set of organizational structure, responsibilities, procedures and resources that are established to carry out the integrated management of systems (UNE 66177, 2005). Within these management systems, there is the quality management system which comprises activities by which an organization identifies its objectives and determines the processes and resources required to achieve the desired result.

The requirements for implementing and maintaining a quality management system in an organization are established through ISO 9001:2015, whose main objective is to increase customer satisfaction by meeting customer requirements. This standard allows quality management in an organization, helping to increase the efficiency of processes by looking for standardization of each process and thus improving customer satisfaction.

ISO 9001:2015 is based on a process-based approach that allows for understanding and coherence in compliance with requirements and gives added value to the product or service provided in an organization. The elements representing these processes are the sources of input that the whole process needs to be transformed into results, activities which present a starting point and an end point of the process, generating outputs that will be sent to certain output receivers.

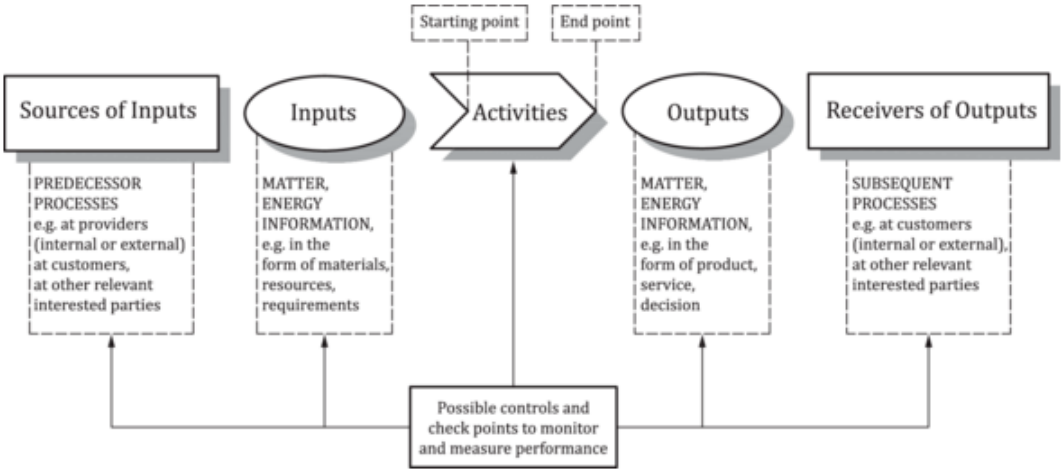

Figure 11. Schematic representation of the elements of a single process (ISO 9001, 2015)

Implementing ISO 9001:2015 is using the process approach, incorporating the Plan-Do-Check-Act (PDCA) cycle with a strong risk-based thinking orientation, ensuring the continuous control and optimization of performance and allowing the organization to identify opportunities for improvement and risks, and prevent undesired results, to deliver products according to customer needs.

The application of the PDCA cycle can be extended to all processes and the entire quality management system as Figure 12 illustrates:

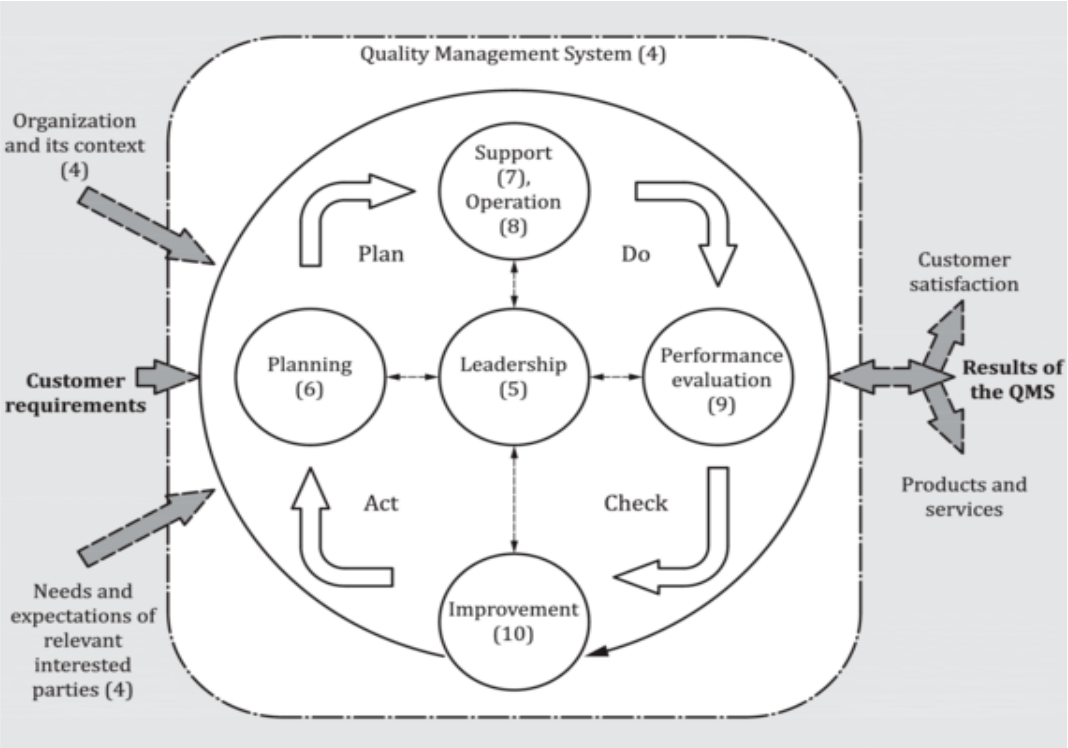

Figure 12. Representation of the structure of this International Standard in the PDCA cycle (ISO 9001, 2015).

The PDCA cycle is described as follows:

- Plan: Establish objectives and processes to achieve results in accordance with client requirements and organizational policies.
- Do: Implement processes to achieve objectives.
- Verify: Measure the performance of processes according to the objectives pursued.
- Act: Act for continuous improvement.

2.1 CONTEXT OF THE ORGANIZATION

The organizational context combines internal and external factors that impact on the organization's approach to development and achievement of its objectives. The external aspects include legal, technological, competitive, market, cultural, social and economic environments, while the internal context consider issues relating to values, culture, knowledge and performance of the organization (ISO 9001, 2015).

The organization in compliance with ISO 9001:2015 must initially understand its context and define its purpose, direction and objectives to determine the appropriate internal and external factors that affect their ability to achieve the expected results of the quality management system, adjusting the information with continuous monitoring through indicators such as organizational objectives, customer satisfaction surveys, market behavior and competition analysis.

Also, it is necessary to identify and understand the needs and expectations of stakeholders to provide products or services that meet legal, regulatory and customer requirements, in addition to a periodic review of information ensuring the achievements of the quality management system.

On the other hand, the organization must determine the scope of the quality management system, defining the boundaries and applicability of the quality management system considering internal and external factors, products, services and relevant interested parties.

Finally, the quality management system and its processes must be established, implemented, maintained and continuously improved, including the necessary processes and their interactions with the requirements set out in ISO 9001:2015.

2.2 LEADERSHIP

Leadership, in ISO 9001:2015, is the core of the quality management system with emphasis on senior management.

Senior management has the power to delegate authority and provide resources within the organization, demonstrating leadership and commitment to the quality management system by assuming responsibility and accountability for the

effectiveness of the quality management system and, ensuring that the quality policy and objectives are set and compatible with the context and strategic direction of the organization. This leadership, with a customer focus, keeps the organization focused on meeting customer requirements and improving their satisfaction.

The intentions and direction of an organization are also formally expressed by the senior management through a quality policy, which contains the principles, strategies and actions to be taken in line with the business mission, the satisfaction of its customers and interested parts and the continuous improvement related to the activities/functions affected by the Integrated Management System.

The senior management is also responsible for assigning appropriate roles in relation to the quality management system to ensure effectiveness and achievement of expected results, establishing specific responsibilities and authorities for roles and ensuring that people in the organization understand and are aware of their assignments through effective communication activities.

It is essential to emphasize that although authority can be delegated, responsibility and accountability for the quality management system remains with the senior management.

2.3 PLANNING

Planning involves more than documenting, it includes stages, activities, deadlines, responsibilities, resources and the schedule that allows to visualize the activities to be carried out, the interdependence between them and their planning in time.

In planning the quality management system, according to ISO 9001, the organization should identify the risks and opportunities necessary to address, contemplate avoiding, assume or eliminate risks to pursue an opportunity by launching new projects, opening new markets or looking for new customers.

Similarly, in planning how the quality objectives are achieved, the organization must determine what will be done, the resources required, who is responsible, when they are completed and how results are evaluated.

If changes in the quality management system are required, they should be carried out in a planned way. The organization must consider what the purpose of the changes and their potential consequences is, the integrity of the quality management system, the availability of resources, and the allocation of responsibilities and authorities.

2.4 SUPPORT

The support processes in production and service delivery within an organization ensure the effectiveness of the quality management system, focusing on elements necessary to ensure that quality objectives can be met.
The organization must identify and provide the resources necessary for the establishment, implementation, maintenance and continuous improvement of the quality management system. This should be done by considering the capabilities and limitations of existing internal resources and determining what is required from external suppliers (ISO 9001, 2015) .

For each process, the resources are characterized, whether human resources, with their participation as the fundamental basis of the approach to processes; infrastructure, which includes buildings and associated services, equipment (including hardware and software), transport and information and communication technologies; environment and work, which provides a suitable environment for the operation of the process through a combination of human and physical factors such as social, psychological, and physical, such as temperature and humidity; finally, monitoring and measurement such as the traceability of measurements by calibration to help the validity and reliability of results in a compliance monitoring (ISO 9001, 2015).

On the other hand, ISO 9001:2015 focuses on competence as the ability of an organization to meet a goal. To do this, it is ensured that the people working in the organization and who may affect the performance of the quality management system are competent regarding the work activity performed, based on education, appropriate training or experience and have internalized the quality policy and

objectives and be aware of the importance of their contribution to the quality management system.

In this way, the organization determines internal and external communications relating to the quality management system, establishing what to communicate, when, to whom, how and who communicates and documenting the information required by ISO 9001:2015 for the proper functioning of the quality management system, which must always be available.

2.5 OPERATION

Operation according to ISO 9001:2015 focuses on the execution of processes necessary to deliver products and services that meet quality requirements, and its objective is to ensure that all activities performed are always the best to meet customer needs.

To do this, it is necessary to carry out operational and control planning where the organization plans, implements and controls all processes ensuring a supply of products and services offered. This considers the requirements, resources to be needed and control of processes before delivering services and products to the customer. Once this information is validated, it is ensured that the whole process is fine; if otherwise, the necessary changes must be planned.

The requirements to be considered include assertive communication with the customer, as it is who will give information on the requirements that the organization needs related to the products and services, reviewing contracts that are within the parameters established by the organization for products and services, having a contingency plan at hand if necessary. The products and services offered must comply with all legal requirements and organizational standards.

Likewise, it is important to review requirements not requested by the customer but required by the products and services provided. When there is a change in products and services, it must be known, modified, made known to all employees and documented.

On the other hand, when designing a product and service, a design and development process must be established, developed and implemented starting with the planning of the design, the phases and control of activities and finally the nature, duration and complexity of the activities. The organization must verify that each step is being carried out and delegate people to be responsible for these activities, also involving customers in this process.

Different controls on suppliers must be established to ensure that products and services are of the best quality, verifying that the design and development outputs meet the requirements set and keeping the documented information. Identifying and reviewing changes in the design of products and services provided by the company can prevent adverse impacts.

In this sense, it should be considered that the internal requirements of the organization are met, applying control to external products and services, conditions of production and supply of services, preservation of the product and activities after delivery. The requirements of the organization must be adjusted and communicated to the supplier so that there is no inconvenience after delivery of the product and service, in addition to an interaction with the customer for cases of deterioration or loss.

Finally, through testing, certification and inspection, the fulfilment of defined criteria must be ensured before delivery of products to customers. If the product or service is found not to meet requirements, corrective measures should be established, have an alternative of how the situation will be handled.

2.6 PERFORMANCE EVALUATION

Performance evaluation is one of the most important parts of a quality management system as it helps to ensure that the organization monitors, measures, analyses and evaluates whether the expected results are achieved.

The organization must focus on customer feedback tracking to assess customer satisfaction through methods such as opinion polls, customer communication, customer data on delivered products or service quality, analysis of market shares

and warranty claims. This information sets an entry for management review and is used to determine whether actions are needed to improve customer satisfaction, while using data sources such as non-conformity rate and on-time delivery to determine whether processes, products and services meet requirements and identify any necessary actions and opportunities for improvement.

On the other hand, internal audits should be conducted objectively and impartially to ensure that the organization's requirements for its quality management system and international standard requirements in ISO 9001:2015, are effectively implemented and maintained. The organization must plan, establish, implement and maintain one or more audit programs including frequency, methods, responsibilities, the planning and reporting requirements that should consider the importance of the processes involved, changes affecting the organization and the results of prior audits.

Senior management should review the performance of the quality management system in line with the strategic direction of the organization to determine whether the performance is appropriate or remain fit for purpose. The organization may include additional elements in the management review such as the introduction of new products, financial results or new business opportunities.

Thus, the status of actions identified during management review are included as an entry for the next management review activity; tracking can help ensure that actions are taken in a timely way. The organization must keep documented information as evidence of the results of management review.

2.7 IMPROVEMENT

An organization must identify opportunities for improvement, as well as plan and implement actions to achieve the expected results and improve customer satisfaction in accordance with ISO 9001:2015.

Improvement actions can be implemented in products and service processes as well as in the quality management system that determines and eliminates the causes of non-conformities to prevent them from happening again by improving performance and implementing agreed solutions with the aim of achieving positive benefits.

The management of these non-conformities is carried out through corrective actions in an appropriate manner, investigating the root causes of occurrence to correct it if possible and to prevent similar situations from happening again in the future.

In this way, the organization reviews the effectiveness of any corrective action, confirming by evidence that actions have been implemented and because of this, non-conformities have not been repeated. This could be achieved by observing the performance of processes or reviewing documented information.

Through this section, the ISO 9001:2015 standard ensures that the organization continuously improves the adequacy, appropriateness and effectiveness of its quality management system, where continuous improvement can include actions to increase the consistency of outputs, products and services to increase the level of compliant outputs, improve process capabilities and reduce variations in processes; this is done to improve organizational performance and benefit its customers and relevant stakeholders.

3. CURRENT STATUS OF POMPE GARBARINO S.P.A

3.1 INTEGRATED QUALITY AND ENVIRONMENTAL MANAGEMENT SYSTEM

The POMPE GARBARINO S.p.A Integrated Quality and Environmental Management System, applying the ISO 9001:2015 standard described above, is described in the Integrated Manual (MI), which details the organization, duties and procedures foreseen during the design, development and execution stages to achieve a product which is technically and qualitatively suitable for the legal requirements, contractual requirements and relevant regulations. The documents referred to in this are organized in such a way that they allow proper control over all corporate processes affecting quality and environmental management.

The main processes of POMPE GARBARINO S.p.A are related to the realization of the product or service and therefore related to "design, realization and service in relation to centrifugal pumps, self-cleaning, volumetric and packages" (Pompe Garbarino, 2024), while complementary support processes such as organizational and cross-functional management services ensure the smooth running of the company. These processes implement the Plan-Do-Check-Act methodology with strong risk-based thinking, adopted from ISO 9001:2015.

The process-based model of the integrated management system adopted by POMPE GARBARINO S.p.A is shown in Figure 13:

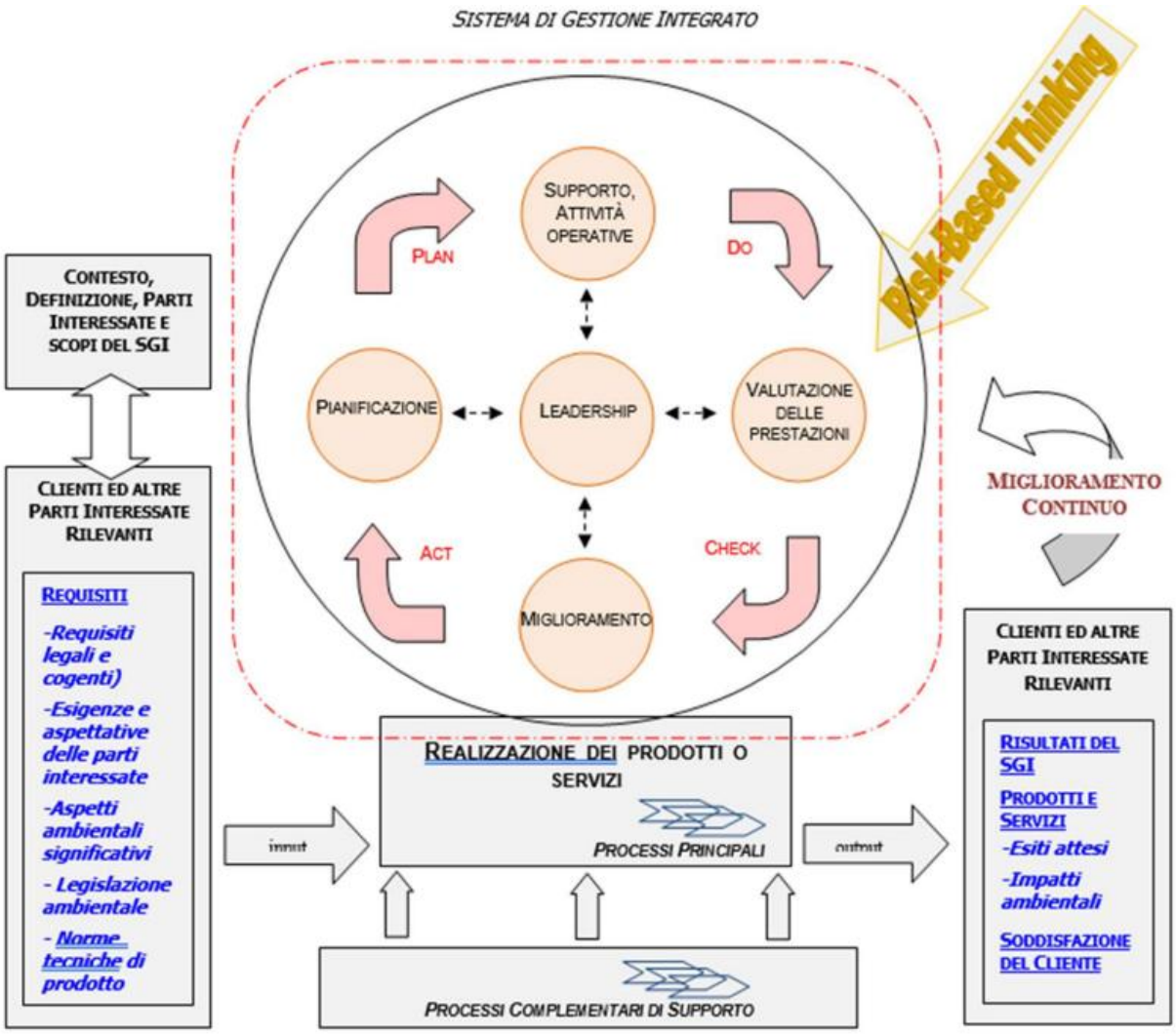

Figure 13. Integrated system model (Pompe Garbarino, 2024).

The model for the main and complementary processes established by POMPE GARBARINO S.p.A, at a detailed level, is shown in Figure 14:

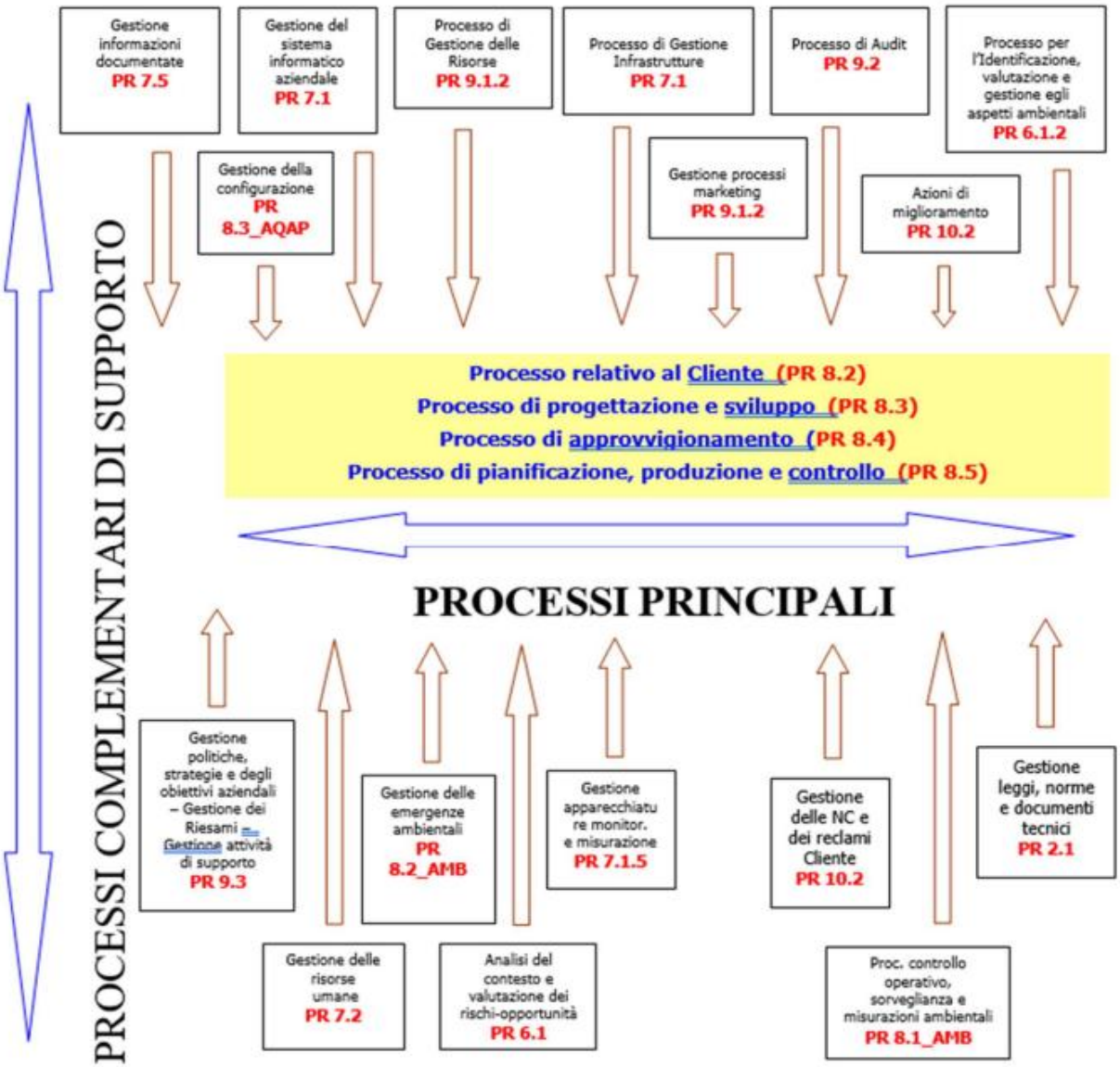

Figure 14. Representation of management processes (Pompe Garbarino, 2024).

3.1.1 CONTEXT OF ORGANIZATION

POMPE GARBARINO S.P.A. conducts and maintains an internal organizational analysis, identifying key factors for strategic business objectives and potential risks and opportunities related to its activities. The analysis includes categories such as environmental, competitive, competitive, cultural, economic, financial, legal, political, organizational, social, territorial, and technological factors.

The company's stakeholders, including partners, customers, suppliers, legal, regulatory, personal, and society, are identified and assessed in relation to the integrated management system. The integrated management system is the tool for identifying and satisfying the interests and expectations of clients and interested parties, ensuring products and services meet customer requirements, applicable requirements, and customer satisfaction. The Senior Management in POMPE GARBARINO S.p.A monitors these evaluations and works towards improving the system.

POMPE GARBARINO defines the application of its integrated management system in compliance with UNI EN ISO 9001, UNI EN ISO 14001, and NATO AQAP 2110 standards, evaluating external and internal factors, relevant parties' requirements, legislative obligations, organizational units, activities, products, and services, and its authority and ability to exercise control and influence. The application is defined as “the design and implementation of centrifugal, self-priming, volumetric, and packaging pumps for industrial, naval, petroleum, and military sectors, including post-vendor assistance" (Pompe Garbarino, 2024).

The System of Quality and Environment Management implemented by POMPE GARBARINO includes business processes, active management of processes, roles and responsibilities, risk and opportunity assessments, continuous improvement audits, and documentation and support.

The organization manages all business processes, including external ones as thermal and/or superficial treatments, according to management procedures, and ensures control according to management procedures and flow diagrams.

3.1.2 LEADERSHIP

POMPE GARBARINO S.P.A. aims to provide high quality products to customers while ensuring high standards of safety and environmental protection. The company aims to consolidate its leadership in the naval, merchant, and military sectors and to attempt a continuous penetration of the market for pumps for industrial uses with the goal to increase customer satisfaction with products that exceed customer expectations while promoting environmental consciousness.

The company's management focuses on establishing coherent strategies and policies, clear objectives, ensuring that quality and environmental policies are established and compatible with the company's strategy and environment, integrating the System of Quality and Environment Management requirements into business processes, promoting awareness of the focus on processes, ensuring adequate resources, and communicating the importance of an effective system.

Therefore, periodic revisions of the System of Quality and Environment Management are conducted to verify the capacity and appropriateness of human and technical resources, in line with policy and objectives for quality and environmental management. This periodic control is performed by the company's management through the Review of Management, while continuous control by the Integrated System Management.

POMPE GARBARINO S.p.A, through its marketing department, plans sales strategies, campaigns, and communication methods for products and services, monitoring market and market evolution needs, and directing and controlling customer analysis companies.

To make the commitment clear and concrete, the management communicates and reports the results of the management's work transparently, motivating employees to participate in the continuous improvement process.

The Functional Organigram, which describes the lines of responsibility between the different functions that influence the management for Quality and Environment of POMPE GARBARINO S.p.A is shown below:

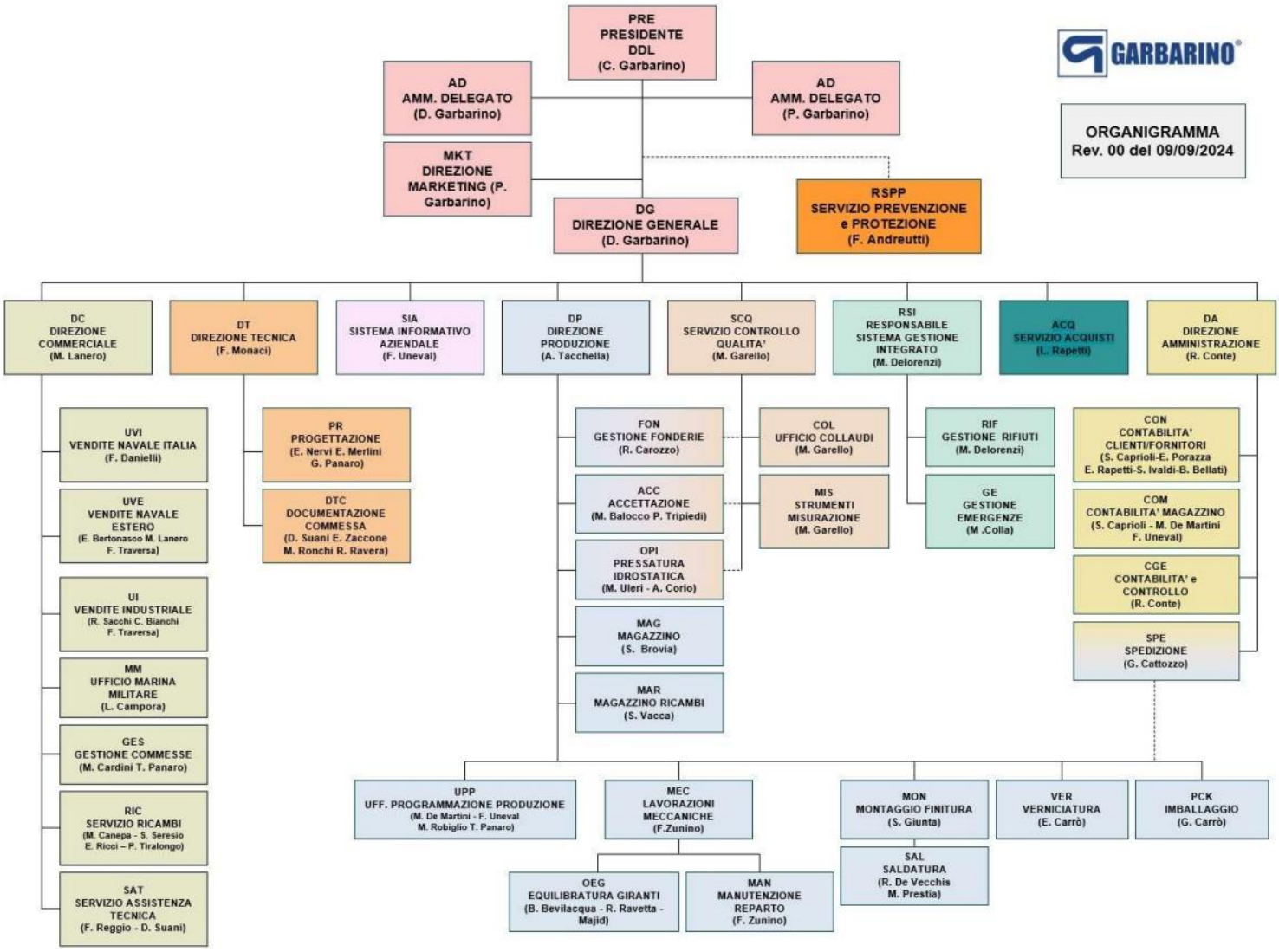

Figure 15. Functional Organigram (Pompe Garbarino, 2024).

3.1.2.1 POLICY

The management system has been established, implemented, maintained, and enhanced by POMPE GARBARINO S.p.A. in a way that respects the environment and ensures a product based on the highest customer satisfaction, more generally of all stakeholders.

The POMPE GARBARINO S.p.A quality policy, approved by senior management in conjunction with the integrated system manager, associates with some clauses of

ISO 9001:2015 the action lines to achieve the quality objectives associated with the integrated quality management system.

The quality policy, included in the company's integrated manual and disseminated internally and externally to all employees of the company and all interested parties, is reported below:

- ❖ Focus on the customer, stakeholders and environmental aspects

  POMPE GARBARINO S.p.A is committed to understanding the needs of stakeholders, compliance obligations and plans its activities to fully meet them. Likewise, it operates in compliance with the following requirements:

- Of the target market.
- Of the country where it operates, complying with laws and regulations.
- Of all parties involved in the processes.
- Improve awareness of the product life cycle, from design to disposal.
- Improving environmental performance and preventing pollution.

- ❖ Process approach

POMPE GARBARINO S.p.A identifies the different activities of its organization as processes to be planned, controlled and constantly improve the best active resources for their realization.

POMPE GARBARINO S.p.A manages its processes and defines objectives, indicators and monitoring plan and measurements.

- ❖ Leadership

POMPE GARBARINO S.p.A assumes responsibility for the effectiveness of its integrated management system, ensuring necessary resources and monitoring that the planned objectives are compatible with the context and strategic directions. Pompe Garbarino S.p.A communicates, internally and made available to interested parties, the importance of the integrated management system and actively involves all stakeholders, coordinating and supporting them.

- Assessment of risks and opportunities

POMPE GARBARINO S.P.A. has decided to use the methodology adopted by the ISO 31000 standard, which provides guidelines for the implementation of the Risk-Based Thinking approach. Risk Based Thinking allows the organization to determine the factors that could cause its processes and its Integrated Management System to deviate from planned results, implement preventive controls to minimize adverse effects and maximize opportunities when they arise.

- Involvement of staff and stakeholders

POMPE GARBARINO S.p.A is aware that the involvement of staff and all stakeholders, together with the active participation of all employees, is a primary strategic element. It promotes the development of internal professionalism and the careful selection of external collaborations to acquire competent and motivated human resources.

- Improvement

POMPE GARBARINO S.p.A is committed to continuously improving the suitability, adequacy and effectiveness of the integrated management system. The preliminary assessment of risks and opportunities related to business processes, internal and external audit activities, and management review are the tools used by POMPE GARBARINO S.p.A to constantly improve.

3.1.3 PLANNING

At least once a year, POMPE GARBARINO S.p.A makes evaluations of the possibles risks and opportunities identified related to external and internal contextual factors, stakeholder needs and expectations, environmental aspects and compliance obligations and discusses if there are notable changes to the organizational environment or business procedures, as part of the management reviews. It allows to increase the desired effects and prevent or reduce undesirable effects that will affect the organization.

In the planning stage, prior to the production of the pump, the document related to the Management Plan of the Contract Risk, which is contractually required for supplies to the Defense and in compliance with the requirements of the standard NATO AQAP-2110, identifies and analyzes the associated risks to the order, both internal and external to the organization, including those of any sub-suppliers, and how to control and mitigate them.

To fulfill its compliance requirements, address and mitigate its environmental impacts, and prevent the negative effects resulting from risks and opportunities, POMPE GARBARINO S.p.A also develops the proper activities to take.

The management of POMPE GARBARINO S.p.A sets environmental and quality objectives considering important environmental issues, related compliance obligations and risks and opportunities. These objectives are in line with the mission of Management and with the environmental and quality policy and regularly updated, measurable and communicated by management at all levels of the organization to maximize communication of objectives in accordance with the Quality and Environment Policy.

POMPE GARBARINO S.p.A identify all the business processes that interfere with the production of its goods and services, planning their execution through monitoring the identification of requirements governing them. Also, it defines the records necessary to keep track of operations that have been carried out according to forecasts.

If it is found that changes need to be made to the Management System, they will be assessed and weighted according to the purpose, possible impact, integrity of the management system, availability of resources, allocation or reallocation of responsibilities and authorities.

3.1.4 SUPPORT

The Integrated Management System can be established, implemented, maintained, and continuously improved by POMPE GARBARINO S.p.A based on the adequacy and capacity of the resources made available by management.

To achieve customer and stakeholder satisfaction, the management supports that the business processes are implemented using sufficient resources as appropriate infrastructures that compliance with legal requirements. The machines and tools present in the various stages of the company, as part of the infrastructure resource, are identified and repaired, either ordinarily (carried out by internal or external personnel) or extraordinary (carried out on breakage and/ or based on the needs reported). They also make sure that personnel are properly trained and prepared to ensure the implementation, updating, and improvement of the Integrated Management System in terms of effectiveness.

The general management defines the profiles of the personnel who fill a specific job within the organization and annually identifies the training needs and draws up the training program; In addition to promoting awareness of the value derived from the contribution of each personnel.

POMPE GARBARINO S.p.A adopts information and communication technologies adapted to its structure to ensure the effective functioning of its processes as its website for communication to external stakeholders. It also offers an environment that supports productivity, operability, comfort and integrability considering the effectiveness and infrastructure functionality, in full compliance with current regulations related to safety and the environment. The computer equipment is controlled by routine checks by the manager of the Company Information System with the third-party company and verifies the reports in which it records the operations carried out.

Likewise, the conformity of the products and services provided is guaranteed by POMPE GARBARINO S.p.A thanks to the implementation of organizational knowledge as specific knowledge of the organization on the operation of its processes, acquired internally through experience or externally through standards and regulations.

POMPE GARBARINO S.p.A transmits information to interested parties on the quality of the products manufactured, through an internal communication system via intranet to transmit the operational information necessary for the different phases of

the production and the effectiveness of the management system, and external communication to customers / Suppliers, such as complaints from customers and interested parties, through channels such as e-mail, company website or guided visits to the production unit.

The Integrated Quality Management System documentation includes the integrated manual, the procedures in reference to the ISO 9001, ISO 14001 standards and the NATO AQAP-2110 publication and the registration forms and templates suitable for suppliers to demonstrate the functioning of the system, as internal origin, and the applicable technical standards, laws and regulations as external origin.

3.1.5 OPERATION

The processes related to the realization of products and the provision of services are defined through a planning system, based on the evaluation of the potential and adequacy of the available resources as represented in the following diagram:

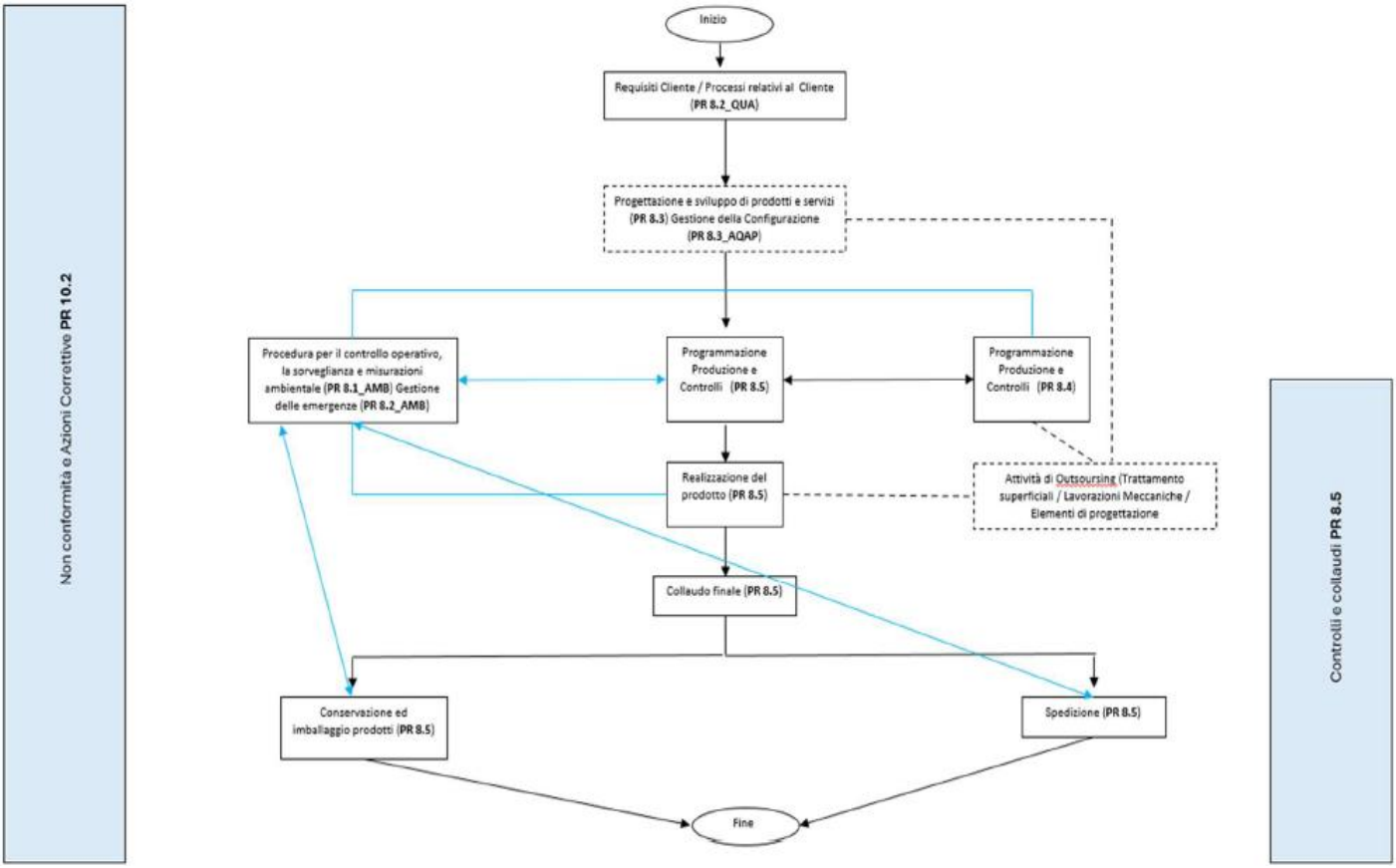

Figure 16. Process planning system (Pompe Garbarino, 2024).

POMPE GARBARINO S.p.A identifies potential accidents and/or environmental emergency situations that may occur on the Via Marenco n° 44 - Acqui Terme site and prepares instructions to respond to such events and to prevent and/or mitigate the environmental impacts that may result and promote periodic activities on environmental emergencies that involve its personnel.

The offer and contract activities, including post-delivery activities, are all managed by the Sales Management (DC) through the following specific steps:

- Acquisition of the Client's bid request and risk analysis (Market, Customer, Project).
- Analysis of the requirements specified by the Client, including those referring to critical features such as safety, performance and reliability (AQAP 5.4.3).
- Definition of delivery and post-delivery activities.
- Analysis of the requirements specified by the Customer and those applicable to products and services.
- Preparation and issuance of the offer/quote.
- Review of the offer before sending it to the Client.
- Follow-up of the bid and negotiation for the award.
- Formal review of the contract/order, to verify that the contractual requirements have been considered and, for contracts intended for Defense where required, transmitted throughout the entire sub-supply chain.
- Management of any changes to the tender and/or contract.
- Management of the customer's technical assistance/advice activities before and after sales.

All the phases related to the relations with the Customers are managed by the sale management, always in a written and documented manner.
Customer communication is carried out on contract management, feedback information, claims and products/ services through a commercial and technical function and during the support service.

POMPE GARBARINO S.p.A performs overall detailed design activities related to the construction of hydraulic pumps. The process is managed through:

- Definition of the planning phases of product design or re-design and development.
- Definition of design choices following requirements, technical product standards and/or legislation.
- Evaluation of design choices that allow, where possible, to minimize environmental impacts related to:
  - Noise.
  - Consumption of energy resources.
  - Waste generation during processing.
  - Consumption of natural resources.
  - Possibility of recycling and/or re-use of the product at the end of its life cycle.
- Definition of review, verification and validation activities related to the different phases of project development.
- Identification of responsibilities and authorities involved, and the definition of the interfacing and communication modalities of the different actors involved.
- Definition of appropriate ways to modify and update project documents.

For types of processes, where it is not possible to verify the result during the product realization with measurement and monitoring, POMPE GARBARINO S.p.A defines:

- Criteria for the review and approval of such processes.
- Special instructions.
- Requirements for equipment that can be used.
- The relevant personnel qualification requirements.

In particular, the following special processes have been identified:

- Welding processes.
- Non-destructive testing.
- Surface treatment of paint.

Correct management of supply activities and its constant and systematic control allow us to optimize the objective of continuous improvement of product quality and

reduction of environmental impact. The conformity of the products supplied is carried out through acceptance control, which includes quantitative, typological, visual, functional and documentary verification.

Likewise, POMPE GARBARINO S.P.A. identifies its products / components with a specific identification number (Serial Number, Batch, Factory Number, Casting) and has storage facilities for its conservation. Also, performs replacement and/or repair work of its products at the customer/ user and/or in the company, and supervision activities on site during installation and start-up of the system.

The material shipped, where required by the contract, will be accompanied by a Certificate of Conformity (CoC) in accordance with UNI EN 10204 or NATO publication AQAP-2070 for Defense supplies, signed by the top organization or its delegate.

3.1.6 PERFORMANCE EVALUATION

POMPE GARBARINO S.p.A. plans and implements a comprehensive measurement and monitoring system, based on statistical methodologies, to ensure compliance and improvement of the Integrated Management System and the products made, related to the level of satisfaction of the client, internal and external audits and non-conformities, implementing some performance indicators. Through the measurement and monitoring of these performance indicators, POMPE GARBARINO S.p.A in accordance with ISO 9001:2015, defines any corrections or actions necessary to ensure the conformity of the products supplied and services provided.

The quality control system used in the product of POMPRE GARBARINO S.p.A is based on three phases: acceptance, checking that the material is produced in accordance with production, intermediate production and final release with the tests. These final tests are certified according to the contract by the Quality Control Service.

Marketing and commercial management develop a system for measuring customer satisfaction based on the processing of feedback data collected through different

tools such as: questionnaires (Customer Satisfaction), direct surveys (interviews, technical-commercial meetings, trade fairs) and analysis of the number of acquired, retained and lost customers.

Since the application of the Integrated Quality and Environment Management System allows a comprehensive database to be structured, which results from measurement and monitoring activities on processes and products and other relevant sources, the company has structured a system of analysis and evaluation of the same, of compliance with the requirements by statistical techniques.

Thus, for the verification of the consistency of the integrated management system internal audits are carried out periodically that include the following phases:

- Planning.
- Auditor qualification and selection according to the criteria defined in ISO 19011.
- Communication of the audit to the Manager of the area concerned.
- Preparation of the Checklist by the Integrated System Directorate and the designated qualified auditor.
- How the audit is conducted:
  - Report writing.
  - Identification of any Non-conformance and deficiencies.
  - Actions of overcoming and corrective consequence.
  - Verify effectiveness of actions taken and corrective actions taken and closure of the audit.

The Quality and Environment Management System is reviewed periodically, at least annually, by management which assesses its effectiveness, suitability and continued adequacy in reference to UNI IN ISO 9001, UNI IN ISO 14001, NATO publication AQAP-2110, Policy and defined Objectives. This review takes into account relevant customer feedback, economic-financial data, environmental performance and non-conformity, results of internal audits, recommendations for improvement, established indicators and the coherence and adequacy of the strategies and the Policy for Quality and the Environment with the established mission, allowing to generate

corrective actions, changes in the organizational structure and elements of the integrated management system, as well as changes to the quality policy.

Any actions undertaken or proposals regarding the conformity of contractual requirements will be identified and planned, as well as any organizational changes or modifications that may affect the quality of the product supplied or the Quality Management System.

3.1.7 IMPROVEMENT

POMPE GARBARINO S.p.A in achieving the objective of continuous improvement of Quality and Environmental management, determines and selects opportunities for improvement on products and services provided, undesired effects and the effectiveness of integrated management system.

The problem reports are verified by the functional manager who, together with the integrated system management manager, opens a non-conformity report and defines the respective corrective actions. These non-conformities are results of customer claims, audit by the customer or certification entities. The effectiveness of the execution of a corrective action must be verified, according to the time set by the person responsible, who evaluating the results obtained, decides whether they must be closed.

For the continuous improvement of the effectiveness of the integrated management system, POMPE GARBARINO S.p.A identifies and implements opportunities for improvement through:

- Review of the results of internal audits.
- Analysis of data relating to the performance of processes and products.
- Corrective and preventive actions.
- The Management Review.

3.2 SWOT ANALYSIS

To analyze the current situation of POMPE GARBARINO S.p.A and understand how to establish incremental changes that will improve its efficiency and effectiveness, a

SWOT analysis adapted to the company has been developed, based on the implementation and optimization of its quality management system according to ISO 9001:2015.

The SWOT analysis is a tool based on 4 strategies to identify strengths, opportunities, weaknesses and threats of the organization and improve the current situation in which it finds itself, projecting it over time. These strategies are identified to know the real situation of the organization and to be able to establish the strategies based on the CAME tool (correct, adapt, maintain and explore) (Dianelys Nogueira Rivera, 2024).

The strengths for the SWOT analysis are all those differentiating capabilities and resources that the organization must exploit opportunities, they are advantages that the organization have and serve to differentiate the organization in the market. On the other hand, opportunities are external factors that are positive and favorable for the development of the organization including its objectives.

Weaknesses are those factors that cause an unfavorable environment with the competition and must be controlled and overcome so that they cannot affect the strategic objectives of the management system implemented in the organization. While threats are external situations that put at risk the stability of the organization and prevent the development of strategies that help to establish quality objectives and implement quality policy, implemented in accordance with ISO 9001:2015.

It is important to remember that strengths and weaknesses are internal situations, they are within the organization and in a certain way there is some degree of control. In this way, it is possible to maximize the strengths or minimize the weaknesses with strategies that are established in the organization. On the contrary, opportunities and threats are external situations that the organization has little or no control over.

Therefore, it is essential that to understand the context of the organization and to be able to implement the management policy based on the ISO standard established, these aspects are considered to see the reality in which this organization is.

Thus, the SWOT analysis developed in this section for the company POMPE GARBARINO S.p.A was carried out from an organizational reality, being totally objective and realistic; to this end, an exhaustive analysis executed by brainstorming with the multidisciplinary team which is part of the company, including managers and key positions as technical trades, production and quality skills, which allowed to identify the real situation of the company.

Thus, once all the strengths, opportunities, weaknesses and threats of the company were identified, 3 to 5 elements in each category were prioritized so that it was possible to establish and prioritize the strategies that have the most impact on the organization, and in the implementation of the mission, vision, objectives and policy of the quality management system.

Now, for the analysis to be effective and allow correct information in taking actions and thus to establish the appropriate strategies for the system, the following considerations were taken:

- Analysis of resources, as internal factors including capital, human, systems and information and assets.
- Analysis of activities, such as management resources that are available, which strategic reminders need to be developed and operational resources to control or improve.
- Analysis of risks about the resources and activities of the company, whether technical or material.

This analysis helped to identify the context of the organization and the relationship of interested parts, as they have a great influence on management systems based on ISO standards. Therefore, in compliance with requirement 4.2 'Understanding the needs and expectations of interested parts' of ISO 9001:2015, it is necessary to identify relevant interested parts that may be affected by the company’s activities. In this sense, during its development it was also considered:

- The suppliers.

- The distribution channels of suppliers, considering whether they are suitable to help the immediate and proper improvement and delivery of the product with the customer.
- The types of clients.
- The markets and the kind of competition in which the market is located.

It must be established how activities and context can generate risks or opportunities in the management system of the company.

Thus, for the internal factors the following analysis was obtained:

Strengths	Weaknesses
- The wide experience of POMPE GARBARINO S.p.A in the manufacture of centrifugal and volumetric pumps has allowed it to acquire solid technical knowledge in critical sectors such as marine and industrial. - Quality and sustainability are the company's main commitments, supported by the certification and compliance with ISO 9001:2015, ISO 14001 and NATO AQAP 2110 standards, allowing it to acquire a competitive advantage in the market. - Compliance with the specifications of entities such as RINA, ABS and other international regulatory authorities through a high level of technical specification with trained	- Performance indicators are not clearly defined for monitoring the efficiency and quality of the process, thus limiting the taking of strategic decisions based on quantitative data, especially in the production area. - The production processes are carried out mechanically without any systematic control, making the workers work only by memory. - Internal and external perception of the quality, environmental and safety approach is distorted because the quality policy currently implemented does not contain principles and strategies aligned with the company's mission and vision and lacks clear objectives. - The delay in delivery of products is an indicator that during the last

personnel and properly established processes in their production. - To achieve the objective of quality management and strengthen operational efficiency, the company always shows willingness for continuous improvement, driven by the requirements of ISO 9001:2015. - Customization is one of the differentiating factors of POMPE GARBARINO S.p.A in the market, since it does not focus on the production of series pumps, but a customized production according to customer requirements.	years has exceeded the limit of the target established annually. This is due to the overload of the operational capacity of the company, which contributes to the fact that current staff and resources such as foundry cores cannot meet the additional challenges arising from high demand. - The defects in the mergers that the company buys for its production process are signs of the lack of quality control in the acceptance of material.

At the same time, for external factors the analysis was:

Opportunities	**Threats**
- Improving the management of resources such as foundry cores, through the implementation of appropriate performance indicators, would allow the optimization of the production process, increasing efficiency and improving customer satisfaction. - Adopting new software-based planning and control tools would improve production management	- The adaptation of advanced technologies in other companies to optimize production represents a competitive challenge. - The recurrent changes in the regulations governing the company require constant adjustments to production processes and quality control. - The company depends entirely on external suppliers for the casting of parts for its production, generating

and logistics, facilitating decision making and real-time monitoring. - Expansion in the international market thanks to improved processes and certifications in compliance with ISO and NATO standards. - A more robust and transparent quality management system would improve customer perception.	effects in case of delays or problems in the supply chain. - Sustainability expectations require high rigorous control of environmental aspects and compliance with standards such as ISO 14001.

This analysis allowed an overall vision and strategic objectives of the key points, related to competitiveness, areas for improvement, and the impact of the proposed changes in quality management according to ISO 9001, which POMPE GARBARINO S.p.A should focus on to improve its quality system and customer satisfaction, as well as the external and internal challenges that it must address in order to maintain and strengthen its position in the market, whose actions are developed in the following section.

Among these, the absence of clear metrics that limit effective performance monitoring and performance improvement through audits and continuous reviews is highlighted, thus establishing themselves as an indispensable factor for their implementation, allowing them to be effective and conform with quality objectives. The above does not allow a quantitative basis, there is no comparative data to make strategic decisions of the system such as the need for more personnel or expansion in certain specific processes, assess bottlenecks, time or material wastage generated at various stages of the process and make proactive adjustments for lack of trends and patterns over time.

On the other hand, although the workers are familiar with the production process, since the senior management is responsible for ensuring that all the workers in the company have sufficient skills for their job, performing this repetitively and

mechanically, creates a memory and experience dependency on the staff that can lead to unexpected problems or changes in the workflow. Therefore, the focus on processes through management of interrelated and interdependent processes must be emphasized so that overall organizational performance can be improved.

4. IMPLEMENTATION OF THE QUALITY MANAGEMENT SYSTEM

4.1 FORMALIZATION OF PROCESSES

According to ISO 9000, a process is defined as "a set of interrelated or interactive activities that use inputs to deliver an expected outcome, which is called product or service depending on the reference context. Inputs to one process are generally the results of other processes and the results of one process are usually the results of other processes".

In the implementation of a quality management system, understanding and managing interrelated processes as one system contributes to the effectiveness and efficiency of the organization in achieving its expected results. This approach allows the organization to control the interrelationships and interdependencies between all management system processes to enhance the overall performance of the organization.

4.1.1 INTERACTION PROCESS

Integrated management of internal processes and their interactions ensures alignment with quality policy and strategic objectives. Each process is analyzed by inputs and outputs, ensuring an effective response to customer needs and added value as design results become critical inputs for production and testing, ensuring continuity and consistency throughout the value chain.

Similarly, in line with the process approach, there may be controls and checkpoints to track and measure performance in the process. All these controls or checkpoints can be set at the inputs, activities or outputs before the receivers of output receive the product. As mentioned in the regulations, the analysis of risks and opportunities must be done throughout the quality management system, and it is here that each process has its controls to ensure that output really meets the specifications that the process must generate and will also vary depending on the risks involved.

To establish the representation of the processes relating to POMPE GARBARINO S.p.A, its subdivision was first determined as follows:

- Primary processes

These processes, related to the design, realization and assistance regarding centrifuge pumps, self-priming, positive displacement and packages, create a value recognized by the external customer and its operational performance as costs, quality and times, covering all stages up to the final delivery.

- Support processes

Support processes are processes that are complementary to the primary processes, ensuring that they function efficiently and are related to organizational services that provide resources and support in key areas.

- Management processes

The management processes ensure compliance with the strategic quality objectives of POMPE GARBARINO S.p.A managed by the requirements of the international standard ISO 9001:2015, together with system efficiency and continuous improvement.

At the level of detail, the model referring to the main and complementary processes of the company is schematized as follows:

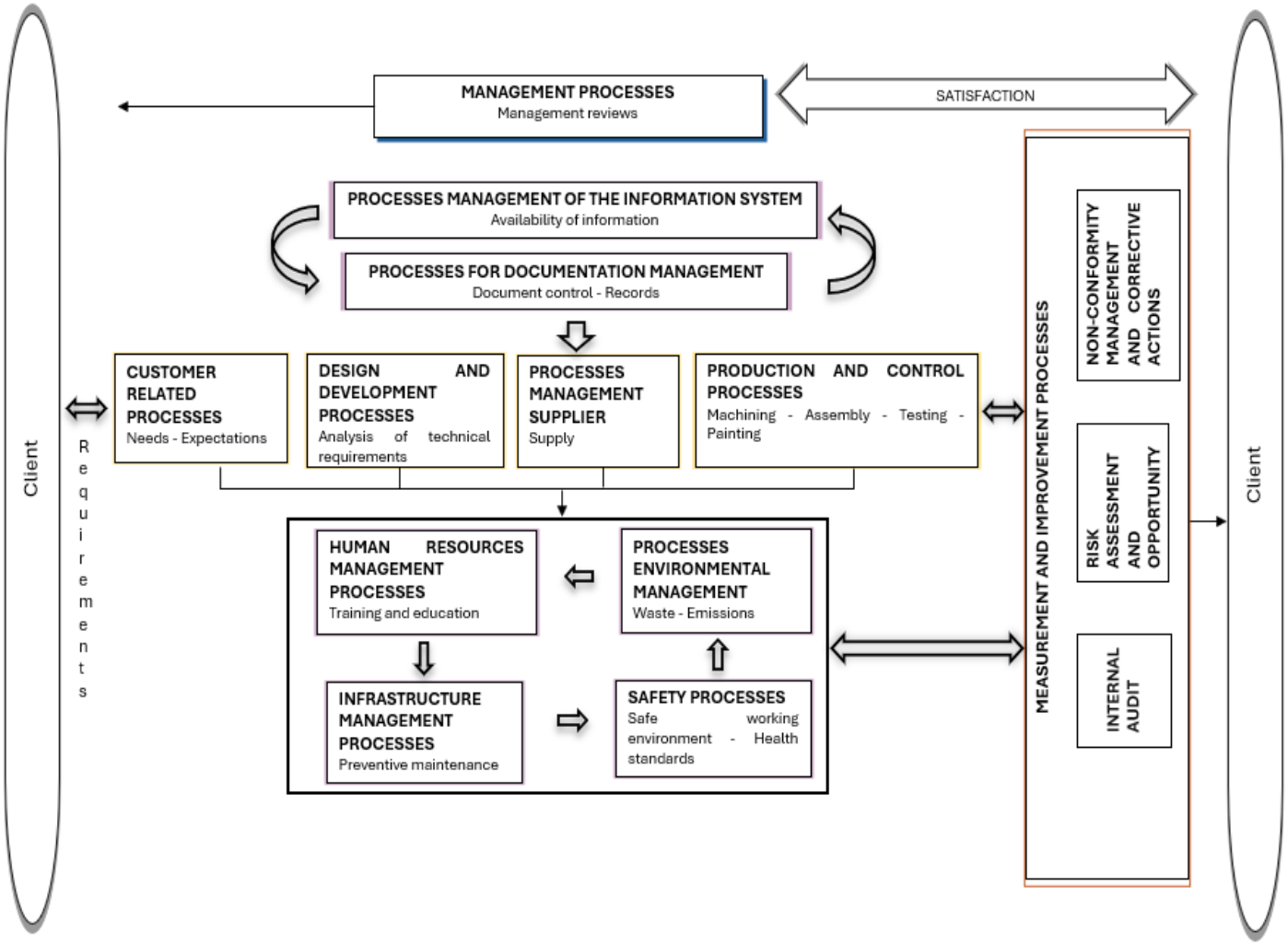

Figure 17. Representation of management processes implemented.

In the process management diagram implemented for the quality management system of POMPE GARBARINO S.p.A, the interaction of processes is represented by arrows, whose sections are organized vertically and horizontally, from support to management and main processes. Each process is identified by a color, the yellow being corresponding to main processes, the orange being to management processes and the pink being to support processes, which allows to improve the legibility of the diagram, highlighting the different processes to facilitate the understanding and retention of information.

The process flows in the direction and ends with the client. The management processes are represented by blue color, as a starting point at the top of the diagram

from which all processes are derived. These management processes represent leadership, making a fundamental part of the coordination and optimization of company activities, defining strategic direction and ensuring quality and continuous improvement in the performance of production processes.

The management review, as a management process, requires the commitment of the senior management to the implementation, maintenance and improvement of the quality management system, evaluating the management of the system from convenience, adaptation, effectiveness and alignment with strategic direction. To this end, POMPE GARBARINO S.p.A must analyze specific inputs ending with conclusions, decisions and actions that will enable it to improve the quality management system from a senior management perspective. These inputs are considered as input for decision-making and conclusions.

To do this, it is necessary in the first instance to analyze critical changes that need to be planned, taking as priority the information about satisfaction of the client and the feedback of the interested parties obtained through requests, complaints or claims. This revision must be carried out by the company during the first month of each year, where it will initially be necessary to evaluate the status of the actions of the revisions previously established by the management, reviewing the commitments generated previously and analyzing their fulfilment. The extent to which the objectives set have been achieved will be analyzed according to results in terms of development of activities, use of resources from these activities, performance of those responsible for these objectives and compliance with management indicators.

The above will allow the organization to establish new indicators with the respective actions planned to be carried out at a specified time during the year, in cooperation with the different main, support and management processes, always focused on customer satisfaction and the effectiveness of the quality management system.

On the other hand, as a central flow of the diagram are the main processes which are related to the customer, design and development, supplier and production and control and whose orientation is towards the customer. The customer feedback

arrows in the diagram towards the main processes ensure the company's commitment to meeting the needs and requirements of the customer, ensuring continuous control and improvement.

❖ Processes related to the customer

Through the integrated management system, the company identifies and meets the needs and expectations of customers and interested parts through procedures according to requirements integrated in the system requirements. The procedures used as methods for carrying out these customer-related processes are broken down below:

- POMPE GARBARINO S.P.A. uses surveys or direct communications as a means of collecting systematic feedback to assess the expectations of customers and interested parts, collecting information on the degree of satisfaction and identifying areas for improvement.
- Through periodic evaluations and environmental impact analysis, POMPE GARBARINO S.p.A monitors the environmental impacts and quality of services ensuring alignment with the expectations of the customer and interested parts.

❖ Design and development processes

POMPE GARBARINO S.p.A rigorously verify compliance with technical, regulatory and legislative requirements in terms of quality of products and services according to customer specifications, ensuring that each process meets the required standards. At the same time, it develops custom designs for pumping products of the counterflow, self-supporting, volumetric or package type, verifying and validating compliance with quality and safety standards.

The main management instrument used for these processes is the Design Plan, which contains all the significant elements of the project phases, including the environmental criteria considered.

- Supplier management processes

To satisfy the customer's requirements, the suppliers must be evaluated, selected and qualified according to criteria of quality and sustainability, ensuring the availability of materials and services in the required time, according to previous experiences of the suppliers. For this, instruments such as informative questionnaires, audits and control in entry are used.

- Production and control processes

The production and control processes of POMPE GARBARINO S.p.A are divided into mechanical working, assembly, testing, painting, shipping and after-sales assistance. Within the mechanical working, the parts are transformed and machined according to the specifications of the design; passing subsequently to the assembly of components that are provided by the operators of the warehouse to construct the final product. Once the operator in charge of the tests receives the pump from the assembly, the pump must be chosen to be tested based on the expiry document that was provided; these tests of operation, safety and efficiency verify compliance with quality standards and customer expectations. Later, when the pump arrives with the passed tests through the forklift, finishes and coatings are applied for protection and durability, being prepared for shipment, always guaranteeing the quality standards.

Also, as a differentiating factor of POMPE GARBARINO S.p.A, it guarantees interventions of replacement or repair after-sales of the product, through management of complaints and feedback from the customer for continuous improvement.

These main processes, besides the customer requirements, have as input and output conditions the support processes, which will allow us to provide support for key activities to ensure their efficiency and effectiveness.

The processes such as information system and documentation, management of resources, management of infrastructure, environment and security are part of the support processes and are represented by arrows connecting the primary processes, demonstrating its support role.

- Information and documentation system processes

Adequate management in the control of documents and records of the integrated management system of POMPE GARBARINO S.p.A will allow to provide a structured and accessible reference as guarantee of the availability of the adequate information for all processes. This document management is in accordance with the integrated management system, regulates the operation and influences the quality of the product manufactured and the services provided.

Among the documented information, it includes contractual and order documents, technical specifications, also including documents relating to relations with suppliers, customers and interested parties regarding the management of the system, environmental aspects identified, and the data managed electronically referred to as computer data.

All the documents for computer support will always be available on the corporate intranet, if paper documents are available, it is necessary to arrange for digitization and archiving in the company intranet area. At the same time, Infor enterprise software is used to align management and accounting data.

Once these computer factors, necessary to initiate the preliminary phases of processes, allow the interaction between themselves of actions for the realization of the result, the following support processes are established:

- Human resources processes

To ensure a safe and compliant working environment, staff are recruited and trained in quality, environmental management and safety to align with the integrated management system, thus allowing the development of skills needed for each job. The effectiveness of the training carried out to ensure the necessary added value connected with the operations will be assessed through specific tests at the end of internal audit courses.

❖ Infrastructure processes

Infrastructure management plays a key role not only in the conformity and suitability of manufactured products but also in the working environment, both in terms of health and safety of workers and in terms of environmental impact.

The buildings and systems belonging to POMPE GARBARINO S.p.A. must allow internal staff to operate with adequate, clean, orderly and comfortable infrastructures, suitable for the correct functioning of processes and conformity of products with air conditioning installations and equipment for fire prevention and response. Preventive and corrective maintenance schedules must be made to ensure the correct functioning of production equipment. This will also allow us to face any challenge that may arise in the workspace due to changes in the production flow caused by increases in demand.

❖ Environmental processes

The processes for identifying and mitigating environmental impacts must be verified in accordance with the regulations applicable to the production place and relating not only to obtaining the authorizations provided by law and carrying out activities and verifications indicated in the same authorizations, to those which have been indicated and inserted by the company. The process of identifying the environmental aspects associated with activities, manufactured products and services includes the following factors:

- Emissions to air, partly quantified in the painting process due to the use of solvents which can evaporate. To do this, the activated carbon of the filters is changed periodically.
- Waste management.
- Use of natural resources, such as water and energy consumption.
- Noise.
- Vibrations of machines used in manufacturing.
- Traffic of vehicles related to the impact on roads available in the company, either by loading material within the establishment or arrival of raw material.
- Impact on the community due to odors and environmental impact.

❖ Safety processes

Safety management includes the aspects of risk prevention in accordance with occupational health and safety regulations, and the creation of a safe environment for workers.

Finally, management processes are in a side column that connects the primary and support processes, representing the control and continuous improvement processes. This includes processes for assessing risks and opportunities, directly linked to the primary processes to provide feedback and analysis, joined internal audits and corrective actions that allow the alignment of the quality management system with the strategic objectives established.

❖ Risk and opportunity assessment

Risk and opportunity management should be based on risk-based thinking, providing a basis for increasing the effectiveness of the quality management system, achieving better results and preventing negative effects. Therefore, once the risks in all key production processes have been identified and evaluated, opportunities must be sought through the implementation of preventive and corrective measures that maximize them.

According to ISO 9001:2015 "a positive deviation arising from a risk may provide an opportunity, but not all the positive effects of the risk result in opportunities" (ISO 9001, 2015).

❖ Non-conformity and corrective actions

The management of non-conformities and their possible treatment by means of corrective action must be implemented through the following procedure, in consecutive order:

- Identification of non-conformity: detection of non-conformity with a defined, implied or mandatory requirement.
- Reporting: staff report problems related to the implementation of the integrated management system to responsible managers.

- Verification: the manager responsible verifies the reported situation to confirm the existence of non-conformity.
- Opening of the non-conformity report: in collaboration with the integrated system manager, the manager responsible formalizes the non-conformity opening.
- Definition of actions: the immediate treatment and the necessary corrective actions are established, involving the affected functions.
- Action monitoring: the progress of corrective actions is recorded and monitored by the integrated system responsible.
- Verification of actions: the implemented actions are verified within a defined period, after which the effectiveness of the corrective action itself is evaluated.
- Reporting to the management: the results of actions are made available to the management for periodic review.

❖ Internal audit

Internal audits should be carried out periodically, verifying the consistency of the integrated management system with the laws and regulations applied, the critical processes and all contractual requirements and the actions to face risks and opportunities defined by the management. To do this, it should establish a plan of internal audits where these are planned at least once a year but also can be implemented during the year with unscheduled audits, prioritizing decision making on improvements and adjustments in the system.

The management processes are finally linked to the customers as output receivers, since they are the ones who must have satisfied their needs, exceeding their expectations regarding the product and these are linked by bidirectional arrows to the directional processes, showing that the management reviews and makes decisions based on the results of the performance evaluation of all the processes.

4.1.2 FOUNDRY MANAGEMENT

All the elements that are part of a pump built by POMPE GARBARINO S.p.A, whether bodies, impellers and covers are managed by external suppliers related to crude metal foundries, to be processed further during the machining process phase within the firm and finally assembled. This requires the construction of models and cores of the different elements, managed also externally through model companies, according to the designs and drawings provided by the company's technical office according to customer requirements.

POMPE GARBARINO S.p.A collaborates with specialized foundries of sand-molded objects according to the required material, whether bronze, stainless steel, aluminium or cast iron, among which Santa Caterina, Fondinox, Caglioni and FVB. For each foundry selected to produce the objects in grey, the company moves the required equipment, being the only company that moves it whenever necessary.

Although each foundry has its own production time, provided with a variability of time in case of inconsistencies in the planning, the need for external suppliers to supply the pump components give the necessity to insert additional variables in the planning and control of production at POMPE GARBARINO S.p.A because delays may occur in the delivery of the castings, directly affecting manufacturing times and thus final delivery to the customer. In addition, once the parts are processed within the company, some of them may require specific adjustments during mechanical processing or even when used during assembly generating bottlenecks on the production line if not managed properly.

Thus, the management of foundries cannot be seen as a cut-off process but rather as an integral part of the quality management system of POMPE GARBARINO S.p.A, fulfilling a fundamental role in the system as it directly impacts production efficiency and the company's responsibility to meet delivery times to customers. The quality and delivery time of pumps depend mostly on the delivery time and quality of castings.

However, this has led to the need for experience and expertise of the quality control service manager who carries out the foundry process, since the smelting process is

managed externally and has therefore created operational dependencies that may represent risks to the workflow in the processes.

The company now depends on only one person to coordinate the management of the foundry, thus identifying the lack of integration between the different areas of the company such as production and planning, due to the lack of knowledge about how casting orders are managed, creating an information bottleneck. The production area, for example, often does not know the actual delivery times of the smelted parts, making it difficult to efficiently plan assembly to assess compliance in the timeline of the lead time in production. There are no formal guidelines or written protocols for the transfer of knowledge. This also makes it difficult to make strategic decisions and optimize the workflow.

Thus, because without a documented process the company loses agility to make quick decisions in unexpected situations, it has been carried out by means of a mapping of the management of foundries, how the interaction between the production management and the quality control service should be for a clearer management of the process.

Their representation is shown below:

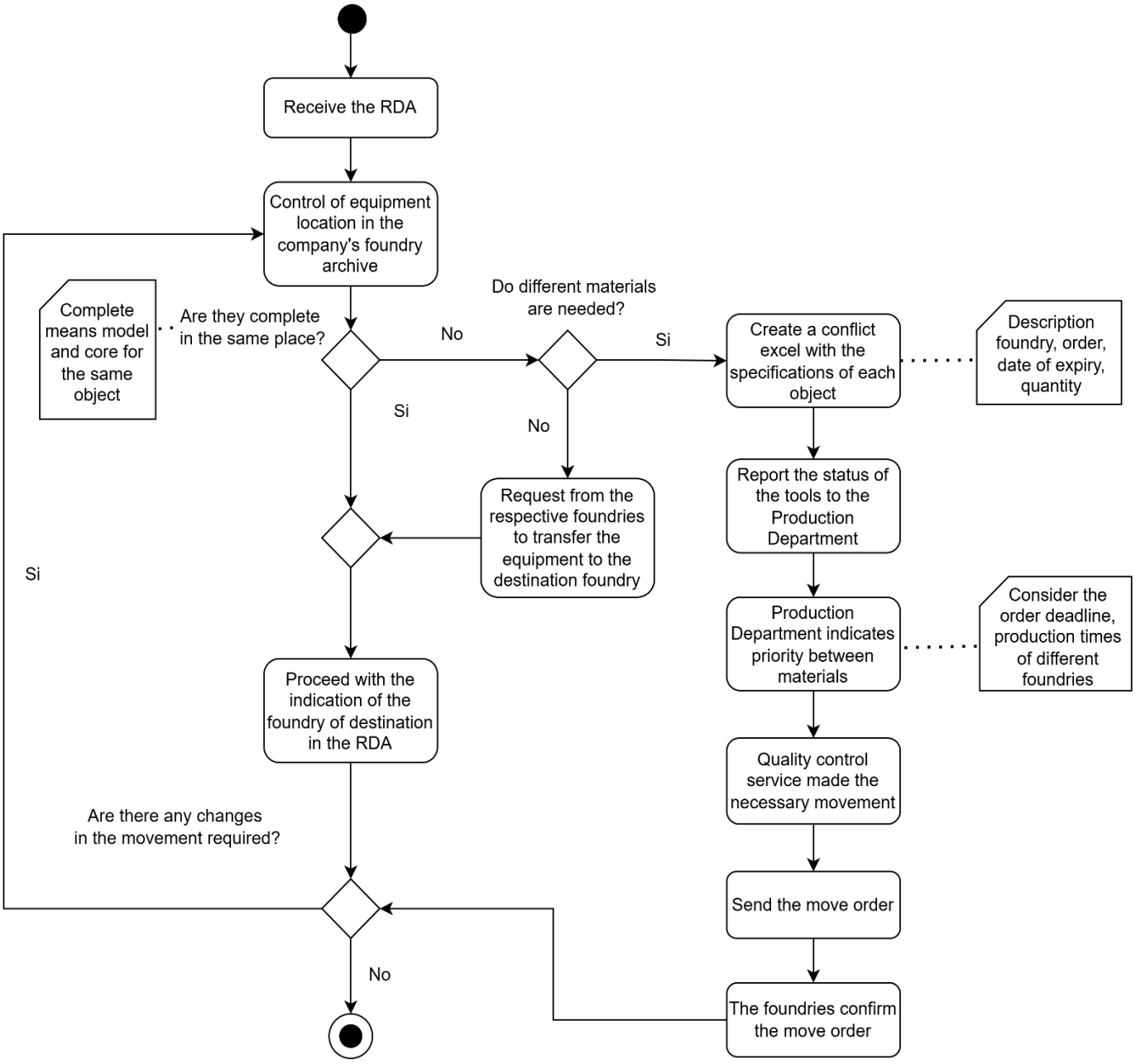

Figure 18. Foundry management

The process of managing foundries begins with the receipt of a request for purchase from the quality control department, where the materials required are established, the items required for the type of pump specifying whether they are in the warehouse

or must be purchased by means of a purchase order from the respective foundries and the dates of request by the customer.

It is important to mention that the company POMPE GARBARINO S.p.A has several models and cores to smelt the large number of types of pumps in its production line. However, for the same object, the firm may have three cases:

- One model and some cores.
- One model and one core.
- Some models and some cores.
- Some models and one core.

For a foundry to be able to start working on the smelt part, it must have the complete equipment, that is the core and the model of the part together; without the core it cannot begin working on the required part.

Therefore, to make the respective decisions on the management of foundries, the company must analyze the demand for purchases and establish whether the equipment required according to the customer's request is in the same foundry or not. If the equipment is in the same factory, the production order is carried out according to the requirements of the purchase order, considering the quantity and date established. If, on the other hand, the equipment is not in the same foundry it must be analyzed in the request for purchase the material required by the customer and identify in which foundries are the model and the core.

If the model or the core is in the foundry where the material is required, the other foundry must be requested to move the part to the required foundry. For example, if the piece to be made is in stainless steel, the model is located in Fondinox, and the core in Santa Caterina that produces in bronze, it must be requested to Santa Caterina the transfer of the core to Fondinox, because it is the foundry that works with stainless steel and again proceeds with the production order according to the request of purchase. If neither the model nor the core are in the foundry of the required material, a conflict of order is generated by creating in excel a table with the specifications of each object, describing the foundry where it is located, the order

date, the delivery deadline and the required quantity, since there would be a need to smelt the same object in different materials.

The conflict situation must subsequently be communicated to the production management, which must indicate priority of the production order according to the materials required for the same part; the customer's order schedule and the foundry's production time must be considered. This priority is communicated to the quality control department responsible, who sends the order for the model or the core to the required foundry and waits for confirmation from the respective foundries.

Finally, if any change of transfer is required due to the arrival of another customer order with a date closer to that of other orders for which management of the parts of smelting has already begun, the location of the equipment should be analyzed again and the process described above should be repeated. If no modification is needed, the foundry management process ends. At this point it is important to make a shared follow-up plan for the orders of the foundry developing a real time monitoring system, where it is analyzed at what stage they are to compare the established production timeline and make a pre-analysis of delivery compliance to the customer.

This will enable the company to reduce uncertainty in production planning by having greater visibility of risks associated with delays or failures of foundries, ensuring operational continuity in the case of staff absence by documenting and standardizing the process of managing orders for the foundries, improving the efficiency and sustainability of the POMPE GARBARINO S.p.A quality management system over the long term.

4.2 INTEGRATED MANAGEMENT POLICY

During the study of the current management system of POMPE GARBARINO S.p.A, as established in the SWOT analysis, the lack of formalization of the quality policy is one of the main weaknesses of the company. The ISO 9001:2015 standard in requirement 5.2 states that an organization must establish a quality policy that can be materialized with the help of the company's staff.

The quality policy is the most important document within an organization, since it sets out a series of commitments which the organization has made with the different interested parts whether they are customers, partners or shareholders. Through senior management, this quality policy must be maintained throughout the process of designing, establishing and improving the quality management system, being appropriate to the purpose and context of the organization. It should indicate what the organization is dedicated to, what it wants to achieve, what the working method is and what commitment it has, this implies what, how, for what, and the commitment that the organization has.

However, there are other standards that establish the need to implement environmental and health and safety policies such as ISO 14001:2015 (ISO 14001, 2015) and ISO 45001 (ISO 45001, 2018) respectively. Although a main approach has been established towards a system of quality management in accordance with ISO 9001:2015, during the study it was identified that the company does not have a standard health and safety policy, document constantly requested by companies interested in having business dealings with POMPE GARBARINO S.p.A as is SBM Offshore by BV Brazil in its "Product Manufacturers Questionnaire" to know more about the company and its strategic direction. On the other hand, in order to refer to the policy of safety and health at work, the company refers to the “risk assessment” document, a document provided for by article 28 of legislative decree 81/08 of the Italian standard on safety and health, which establishes the obligation of employers to train and inform their workers about risks and management of safety at work (Alteredu, 2024).

A section of the questionnaire showing the request for the safety and health at work policy is shown below:

Instructions to complete the Qualification Questionnaire

011	Checklist for documentation to be attached to this Questionnaire (as applicable)	
	Supply Chain Charter signed	X
	Annual Report for the last 3 years	NO
	Financial Report for the last 3 years	X
	Evidence of Registration (Trade Registry or Tax Registry or VAT Registration)	X
	Evidence of clean tax situation	X
	Evidence of Bank Credit rating	NO
	Evidence of commercial registration/authorization for the country of operation	Trade License
	Quality Management Plan	(*)
	Management of Change Plan	(*)
	Supplier/Subcontractor qualification procedure	X
	Product catalog/brochure	X
	Quality Management System Certificate	X
	For Authorised Distributors/Stockists/Agents - evidence of authorisation	NO
	Sustainabiliy Policy or Standards	NO
	Human Rights Policy or Standards	NO
	Type approval certificates	X
	NCR register for the past 3 years	(**)
	Quality Policy	X
	HSSE Certification	(***)
	HSSE policy/Safety Manual	(***)
	Drug and Alcohol Policy	NO
012	Any other relevant/appicable documents attached? If yes - please provide details below	

(***) Compliance with legal requirements relating to worker health and safety	
are mandatory to carry out any production activity in Italy and Europe	
Reference must be made to the legal authorizations and the attached DVR (Healt and Safety Manual).	

Figure 19. SBM Offshore Questionnaire (OFFSHORE, 2022).

Therefore, to implement these three policies required in international regulations, an integrated management policy was developed, as a reference to meeting not only customer requirements but also legal and regulatory requirements such as the commitment to generate continuous improvement. Management must start with an initial strategy, the organization must know what it is that one wants to achieve, what are the weaknesses and opportunities that wants to take advantage of or what wants to improve.

The importance of systems that ensure the care and health of the environment around us is becoming increasingly visible today, Therefore, implementing an environmental policy is one of the first steps to generate the commitment of people

and employees towards a culture of responsibility in the face of the care we must have for our planet.

In addition, it is important to provide a reference framework for setting safety at work objectives through commitments to eliminate hazards and reduce risks to labor safety and health, preventing injury and deterioration of workers' health, and providing safe and healthy workplaces.

This integrated management policy is a reference for setting the company’s objectives, supporting its strategic direction and is aligned with the company’s mission and vision.

The policy implemented and formalized by POMPE GARBARINO S.p.A contains principles, strategies and actions as shown below:

4.2.1 DECLARATION OF INTENT

POMPE GARBARINO S.p.A incorporates quality and environmental protection in every strategic and operational decision, providing innovative and high-performance solutions in the design and manufacture of centrifugal and volumetric pumps for the marine, industrial and oil sectors.

Its commitment is to become a trusted ally in the pump industry, ensuring products and services that meet the highest standards of quality, safety and sustainability. Its objective is to promote the sustainable development and competitiveness of the marine and industrial sectors, contributing to their growth with reliable and durable solutions.

POMPE GARBARINO S.p.A carefully selects, trains and evaluates its personnel to meet the needs and requirements of customers and technical standards at a national and international level.

In addition, POMPE GARBARINO S.p.A is committed to ensuring a safe and healthy working environment for its workers, visitors and interested parts involved in training activities related to prevention and safety at work. Health and safety protection is

part of the strategic direction which meets the highest regulatory requirements and international laws.

4.2.2 QUALITY AND ENVIRONMENT

4.2.2.1 PRINCIPLES OF QUALITY

- Customers and stakeholders: understand the needs of interested parts, compliance obligations and plan their activities to fully meet them.
- Legal regulation: ensure compliance with ISO 9001, ISO 14001 and NATO AQAP 2110 standards and maintain certification of classification entities such as RINA, ABS, BV, LR, DNV, GL and NKK on all products.
- Environment: minimize the environmental impact through resource optimization and waste control in line with ISO 14001.
- Processes: identify and manage the different activities of the organization as processes to be planned, controlled and constantly improved to activate the best resources for their realization.
- Risks and improvement: implement preventive controls of the factors that deviate strategic directions to minimize negative effects and maximize opportunities for improvement, when they arise.
- Staff and stakeholders: Promote the development of internal professionalism and careful selection of external collaborations to provide itself with competent and motivated human resources.

4.2.2.2 DEVELOPMENT OF QUALITY AND ENVIRONMENT POLICY

This policy creates the fundamental reference framework for defining the objectives and directives of POMPE GARBARINO S.p.A regarding quality and environmental management, promoting their implementation in all phases of growth and operation of the company.

Likewise, POMPE GARBARINO S.p.A provide services to customers both nationally and internationally who demand high performance standards and reliability. Commercial success and satisfaction with customer and stakeholder requirements are mostly based on the quality assured in the products and services provided.

The quality and environmental policy includes:

- Provide services that reply effectively and competitively to the requirements and expectations of the customers and stakeholders, respecting the highest standards of efficiency, in addition to the regulations in force.
- Proactively adapt to market dynamics, maintaining a strong relationship with suppliers and stakeholders for a reliable supply chain ensuring the availability of the most suitable centrifugal and volumetric pumps to the customers.
- Identify targets, indicators and monitoring plans for continuous improvement in product life cycle performance from design to disposal.
- Promote leadership through a proactive leadership culture, aimed at effectively directing the efforts of all personnel, ensuring careful selection, continuing training and internal promotion to create positive customer experience from product design to after-sales service
- Incorporate the environmental component into decision-making, ensuring the use of materials that are not classified as prohibited substances, thus promoting a sustainable approach at each stage of the production process.
- Ensure responsible and compliant management of the hazardous waste and non-processed waste using dedicated temporary storage facilities which are carefully individualized and organized to ensure the proper conservation of waste awaiting disposal, under company rules and procedures.
- Working with companies that specialize in the recovery of the waste, ensuring that waste materials are handled responsibly. Although the company does not generate derivative products, it works exclusively with suppliers that comply with all the requirements required by current environmental regulations.

Compliance with the established principles is mandatory for all staff of the company and is fully spread through the management system, ensuring that each member of the organization participates actively in the commitment to excellence and sustainability.

4.2.3 HEALTH AND SAFETY

4.2.3.1 HEALTH AND SAFETY PRINCIPLES

- Hazards and risks: identify, assess and manage risks to mitigate hazardous situations.
- Awareness: ensure adequate training of company staff to adopt a systematic way of developing safe and responsible behavior at work.
- Resources: analysis of the risks to which operators are exposed to help improve health and safety conditions.
- Monitoring and improvement: perform regular health and safety audits for continuous performance improvement.

4.2.3.2 DEVELOPMENT OF HEALTH AND SAFETY POLICY

POMPE GARBARINO S.p.A, through this policy, develops a healthy and safety culture, allowing zero injuries within the company to be a real possibility, monitoring emerging problems, changes and innovations adapted to production processes to respond to global opportunities.

The health and safety policy includes:

- Provide the necessary personal protective equipment, including protective gloves, reinforced toe-cap safety footwear and safety glasses, suitable for the activities to be carried out, ensure protection against specific risks and comply with current regulations, promote a safe working environment.
- Ensure areas equipped with electrical installations by the standards and equipped with safety and fire-fighting devices provided by current law, ensuring a safe space and in line with regulatory standards.
- Plan the number, reference period and type of training courses, external or internal, to be attended by company staff and certificates obtained.
- Prepare emergency plans, ensuring operational agility to respond in time to unforeseen situations, including health issues, first aid and prevention of risks at work.

4.3 IMPLEMENTATION OF KEY PERFORMANCE INDICATORS

4.3.1 INDICATORS

In an organization, defining a KPI "Key Performance Indicator" as a key metric allows implement the actions that will define what is going to be done in the future, maintaining a balance between what has happened and what is going to happen within the company. It is a measure of the performance of a process and its value is directly related to a pre-set target.

POMPE GARBARINO S.p.A has as its weakness in the integrated management system the lack of a clear definition of KPIs, establishing quantitative metrics that do not establish a clear objective for continuous improvement of processes, especially in the production department. The current system uses the “Improvement plan and monitoring” to refer to existing KPIs, but its content does not precisely establish objectives and procedures through actions to achieve traceability of these but rather the actions taken to improve processes following compliance obligations.

The evidence of this improvement plan and monitoring model is shown below:

GARBARINO	SISTEMA GESTIONE INTEGRATO QUALITA' E AMBIENTE						
	PIANO DI MIGLIORAMENTO E MONITORAGGIO						
	6.2.1 - 6.2.2					9.1.1 / 9.1.3	
PROCESSO ASPETTO AMBIENTALE OBBLIGO DI CONFORMITA'	OBIETTIVO	AZIONE (Cosa sarà fatto)	RISORSE (Cosa mi serve)	RESPONSABILE DELL'AZIONE	TEMPISTISTICHE DI COMPLETAMENTO DELL'AZIONE	COSA MONITORARE E MISURARE	INDICATORE (Metodo per monitoraggio, misurazione, l'analisi e la valutazione
Produzione	Garantire il fatturato, l'affidabilità e la consegna in tempo del prodotto dell'organizzazione	Monitoraggio KPI produzione	Tutti i processi	DP	Anno	Monitoraggio Fatturato	Fatturato Vendita (escluso SAT)
						Monitoraggio e aggiornamento dell'indicatore.	Affidabilità
						Monitoraggio e aggiornamento dell'indicatore	Consegna in tempo

Figure 20. Improvement plan and monitoring model (Pompe Garbarino, 2024)

Although it may be measuring many metrics that are available within a company, just a few are considered key and if they are followed regularly and if they are managed to improve them, the organization and actions will grow and progress. Having a clear objective will make it easier to find variables to follow that allow POMPE

GARBARINO S.p.A to assess whether the objective wanted to achieve will be achieved.

For this reason, the most representative performance indicators have been structured for each department of the organization, which allows a follow-up in the evolution of the company, evaluating the weakest points of the system to make informed strategic decisions. To structure these indicators, first, the department or area in which work is going to be done was identified, the logistic or methodological process for measuring was defined, the objective was defined, then the information and results were collected to update the indicators gradually.

The methodology was as follows:

1. Write the goal according to what the company wants to measure.
2. Start the evaluation, analyzing which variables were held, the components that were being handled, and their structure during the whole development.
3. Evince what was needed to achieve this process, how it could be improved, or how it could be optimized. As personnel evolve and know the process, optimization helps to structure it and have it in a better way.
4. Establish the strategy to be able to adjust and achieve the indicator at a higher compliance rate due to the optimization process.
5. After the strategy was defined, a phase of implementation was undertaken, which included the identification of all tasks necessary to achieve the indicators in a higher percentage of compliance; time becomes important within this phase.
6. Finally, the evaluation of indicators was established, where subsequently it was necessary to find actions that would allow us to improve and structure the development being managed.

The most representative indicators selected by each department of the company are described below:

❖ Purchasing department

- Spare parts delivery time

Measurement: Days between receipt of a spare parts order and delivery to the customer.

Objective: To reduce the delivery time of spare parts to improve customer service.

Frequency time: Annual.

❖ Sales department

- Customer satisfaction

Measure: Total survey score/ Total survey responses

Objective: Monitor customer perception regarding product quality and service.

Frequency time: annual

❖ Quality department

- Quality test (such as vibration, noise, leak test) approved in inspection.

Measurement: Percentage of pumps that pass all tests required by internal and customer specifications (e.g., NATO standards) without the need for further adjustments.

Objective: Increase the percentage of pumps that meet all requirements in the first test to reduce non-conformities and regeneration costs.

Frequency time: 6 months.

❖ Technical department

- Issue of contract documents

Measure: Percentage of documents issued on time compared to the total.

Objective: Monitoring the issuance of contract documents.

Frequency time: 6 months.

- Drawings issued on time

Measurement: Percentage of drawings issued on time of the total.

Objective: Control of documentation issued for the contract, including drawings.

Frequency time: annual.

❖ Office integrated system

- Compliance with international standards (ISO 9001 and NATO AQAP 2110)

Measure: Percentage of successful audits without non-conformities.

Objective: Maintain a high success rate in all quality audits.

Frequency time: annual.

- Accidents or incidents at work

Measure: Number of accidents or incidents.

Objective: To improve safety at work by reducing the accident rate.

Frequency time: annual.

- Percentage of product non-conformity

Measurement: Quantity of pieces or products/total pieces, which do not work in each of the stages.

Objective: To identify quality problems with finished products.

Frequency time: 6 months.

- Waste management

Measure: Average percentage of waste reductions over previous months.

Objective: To control the production of types of non-hazardous waste from the production process to increase recycling and thus reduce the impact on natural and/or energy resources (ferrous and non-ferrous scrap)

Frequency time: 3 months.

❖ Production department

- Delay in delivery

Measurement: Time required - Time shipping (<0)

Objective: To reduce the delivery time of the pumps required by the customer.

Frequency time: 6 months.

- Delivery on time

Measurement: Time required - Time shipping (=0)

Objective: To increase the delivery time of the pump within the time requested by the customer.

Frequency time: 6 months.

- Production cycle time

  Measurement: Total production time/units produced.

  Objective: To reduce cycle times by optimizing production processes without compromising the quality of the final product.

  Frequency time: 3 months.

- Percentage of customer rejection

  Measurement: Number of returns divided by the total number of pumps delivered.

  Objective: Keep this rate as low as possible to improve customer satisfaction and the company's reputation.

  Frequency time: annual.

This type of indicator was helpful to analyze and make decisions in an objective way in some scenarios, allowing us to see the rate of compliance and establishing which tasks must be structured.

4.3.2 OTIF: "ON TIME IN FULL"

POMPE GARBARINO S.p.A presents its great challenge in the fulfillment of deliveries to the customer because its production depends entirely on smelted raw material, managed externally as mentioned in section 4.1.2 of this work. Over the past 5 years, this indicator has always been below the required target, however a follow-up approach to grey castings as required by the customer has not been established, to identify the root cause and main aspect that is causing effects on delivery compliance to the customer and to be able to establish new strategies that herald the beginning of managerial improvement.

To analyze this delivery time to the customer, whether late or on time, the OTIF concept was used, meaning "On time In full", established as a supply chain metric for measuring the efficiency with which deliveries are carried out, checking that orders have arrived within the agreed time (OT) and confirming that the quantity delivered is correct according to the order (IF). This indicator is useful in manufacturing and distribution operations to establish the level of service and quality with which customer requirements are being met (Alan Davies, 2019) .

OTIF monitoring has the potential to help all actors involved, from raw material suppliers to distributors allowing them to improve their processes for their own and the whole chain's long-term benefit (Alan Davies, 2019). For its implementation, the days of delay or advance with which each delivery has been made have been evaluated to know how accurate it is being with the objective of reducing delays, considering the delivery date and the order date in calendar days.

This analysis goes together with the lead time referred to an order cycle time, as the time that runs from an order placed with a supplier until it is delivered to the customer from any point of view, whether it be from the sales department, purchasing department, production department and distribution department (Reid, 2023).

The lead time is present in all areas of the company; for sales, the production lead time must be known to be able to compromise delivery times with customers; for purchases, the lead time of suppliers is indispensable to commit to production in the time when the materials necessary for the manufacture of the pumps will arrive; for production, the lead time of processes is required to commit to sales and delivery dates; for the distribution area, knowing all the lead times allows it to know at which moment the products will arrive at the company, how much time the production process will take to develop so that can be known when start the process of distributing the products to customers. The lead time for the product to reach the customer's warehouse depends on the sum of all cycle times, suppliers, who is producing and the distribution center or warehouse that sends the products (Paul, 2024).

For this purpose, the most critical material required to produce pump bodies, impellers and covers was analyzed in conjunction with the quality control department responsible for managing mergers and the production department. Thus, it was established that stainless steel is the most difficult material to handle by foundries for its elaboration and that it requires a longer production time in comparison with bronze, aluminum and cast iron.

Stainless steel is one of the most difficult materials to smelt because it requires powerful and controlled furnaces at more than 1600°C due to its high melting point

and presents greater reactivity with oxygen during the process requiring special coatings to avoid impurities. In addition, it requires more time in the cooling cycle to avoid warping and longer machining time as it wears out cutting tools faster due to their hardness (Fuquan Chen, 2024)

Also, due to its high use in marine, industrial and offshore applications for its high corrosion resistance, durability and chemical compatibility, strict dimensional tolerances are required as any defect may affect the tightness and strength of the pump and a higher requirement in the control of impurities because any contamination affects the quality of the material (SCI The Steel Construction Institute, 2021).

An analysis of compliance with the delivery time of products was carried out using the software "Minitab" which allowed us to make a statistical analysis, evaluating the behavior of the distributions for each category of pump mentioned in section 1.1 of this work. For this, the order data during the last 3 years has been used, considering the date of request by the customer and the date of actual shipment of the product; these data were provided by the personnel in charge of the company's computer system.

Initially, the origin of outliers presents in delivery times for each type of pump was identified and understood. Subsequently, these outliers were not considered in the statistical analysis as they could distort results and lead to erroneous conclusions. It is also important to note that the results approximate data, since in some categories of pumps there were not sufficient sampling data available (N >30).

The following results were obtained for advance/on-time delivery:

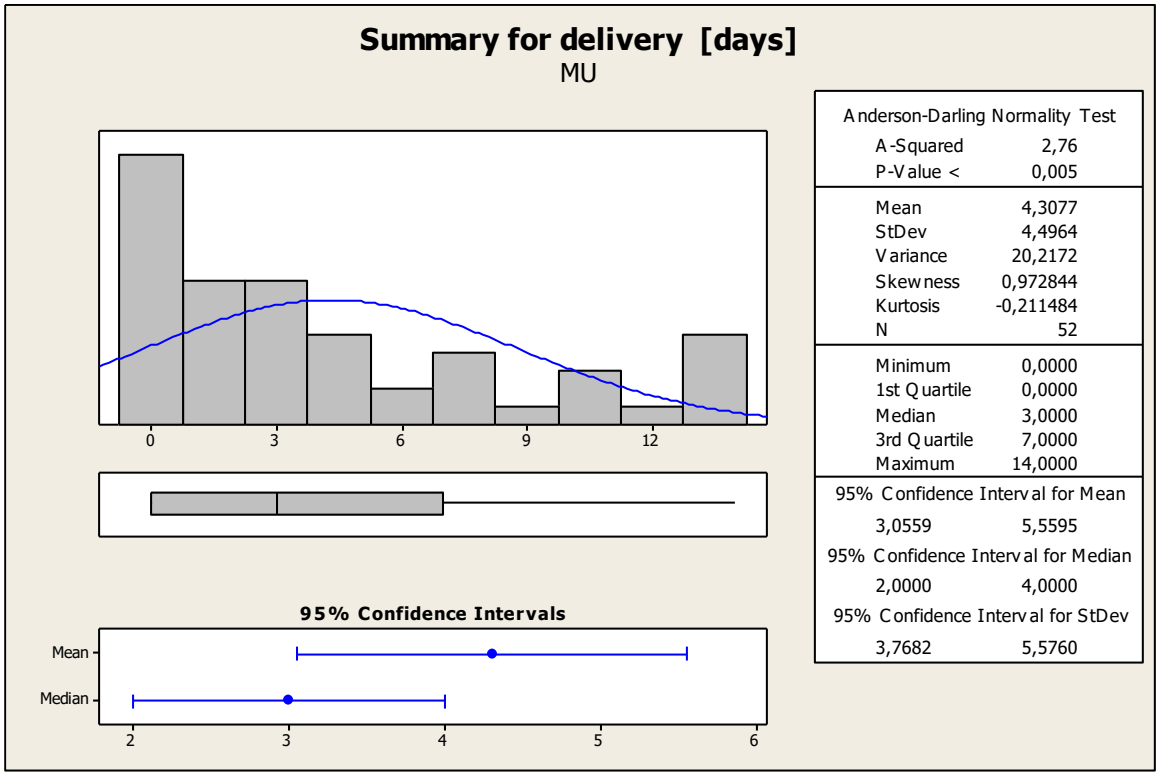

Figure 21. Delivery in advance/on time pump MU

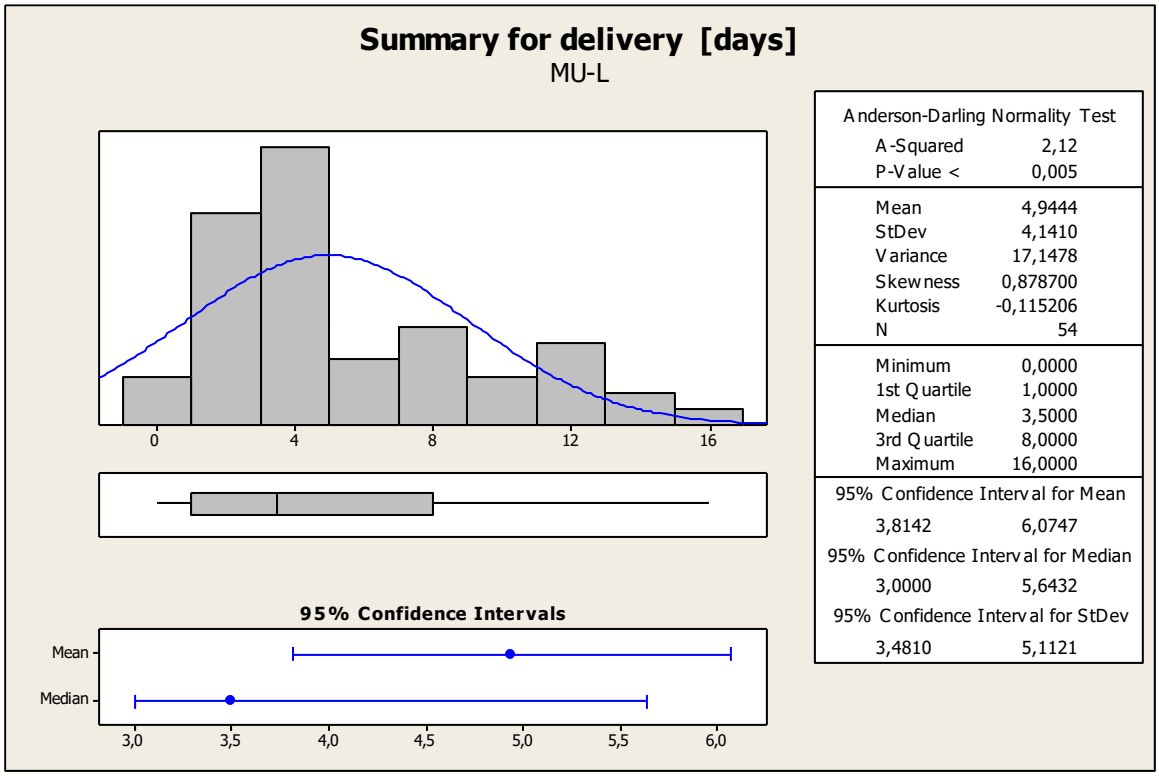

Figure 22. Delivery in advance/on time pump MU-L

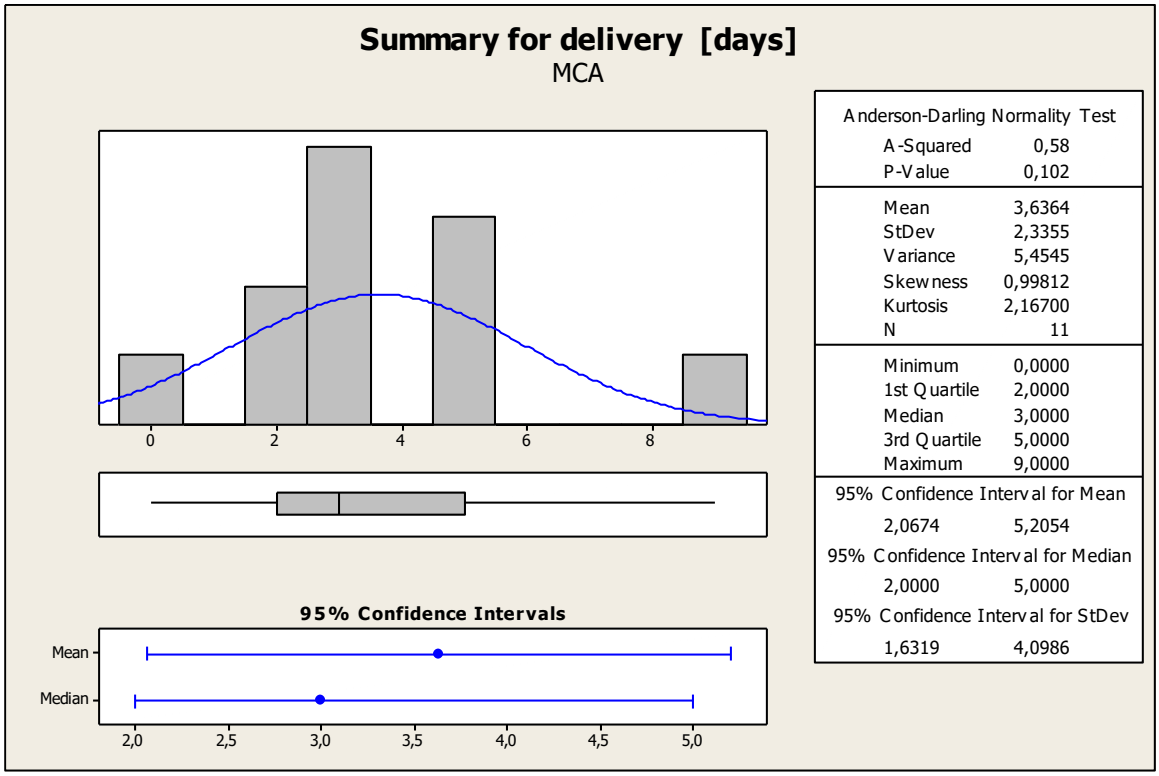

Figure 23. Delivery in advance/on time pump MCA

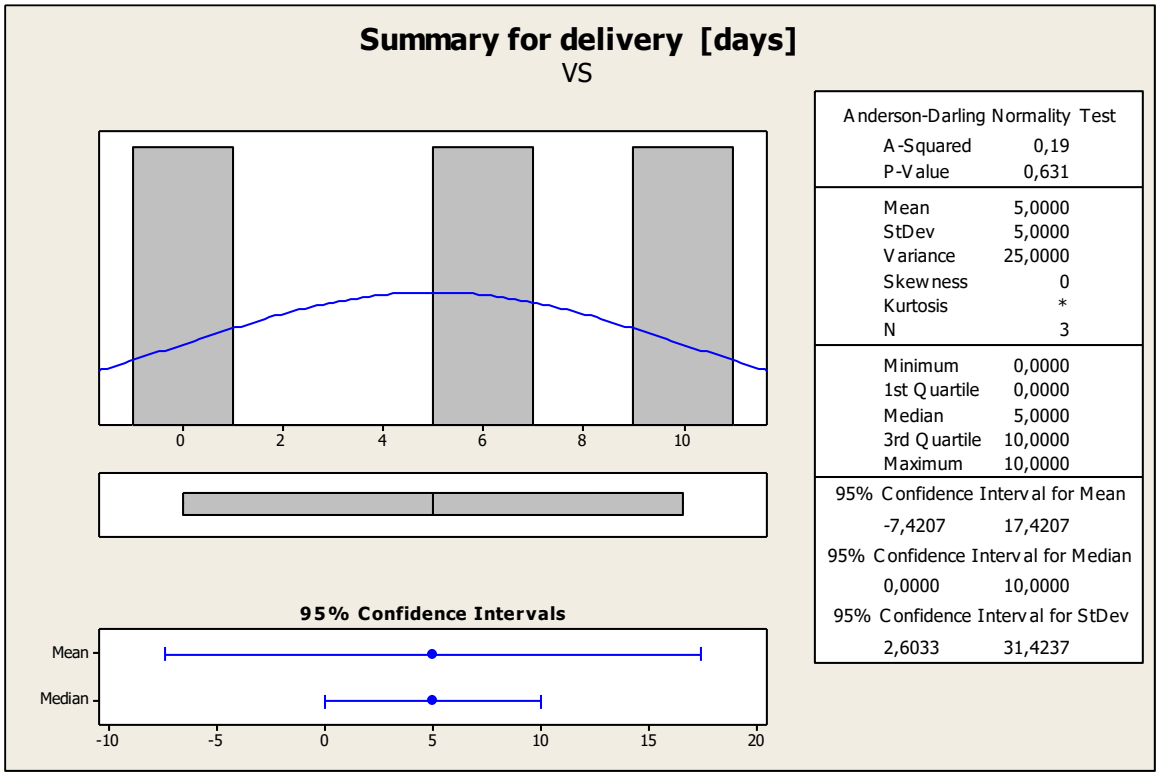

Figure 24. Delivery in advance/on time pump VS

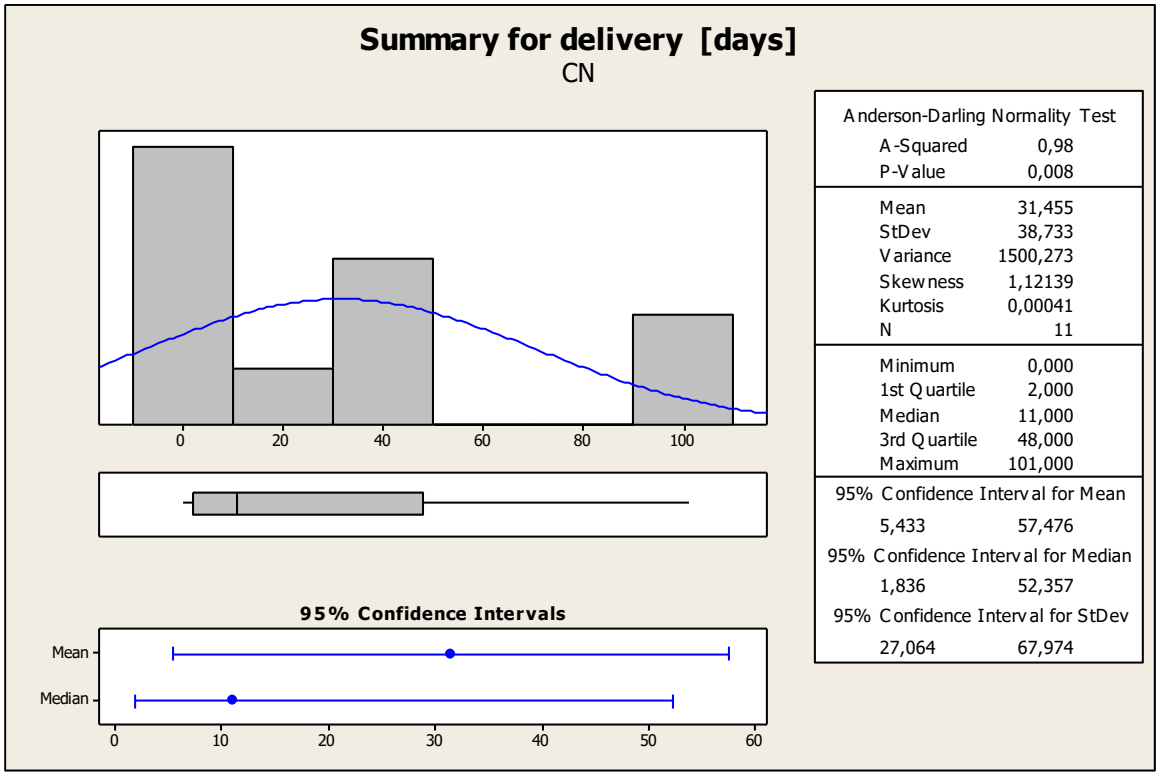

Figure 25. Delivery in advance/on time pump CN

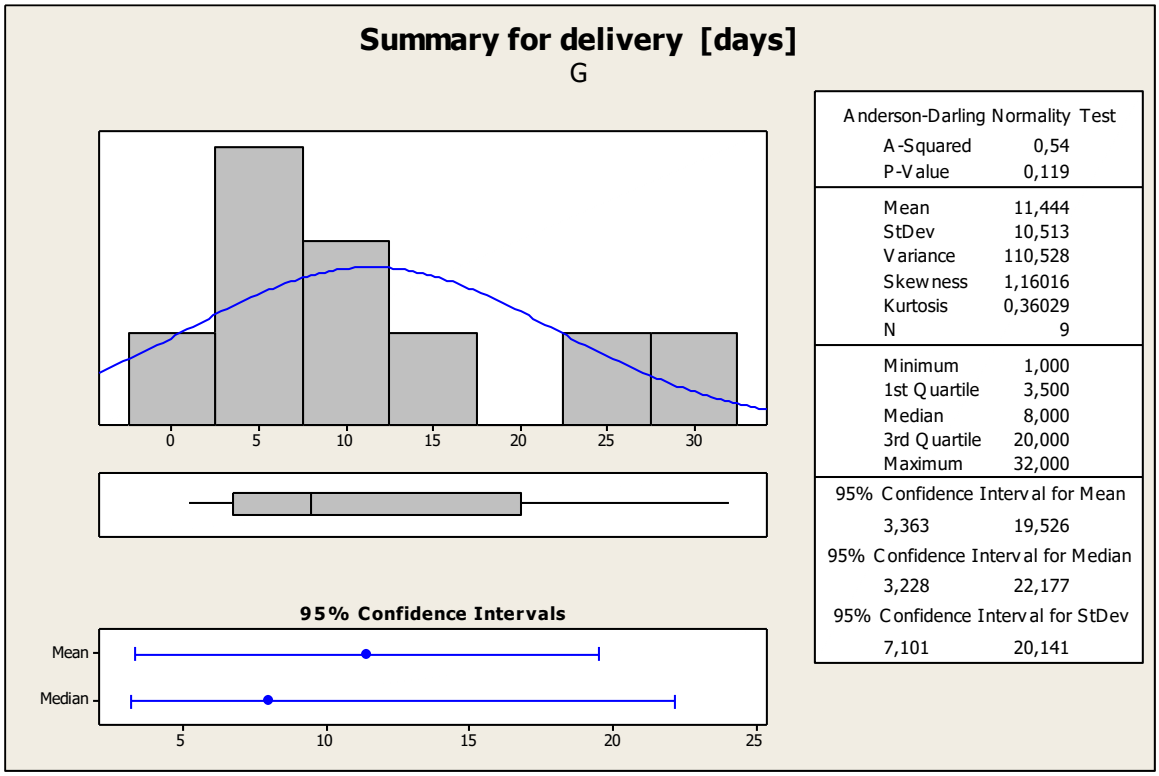

Figure 26. Delivery in advance/on time pump G

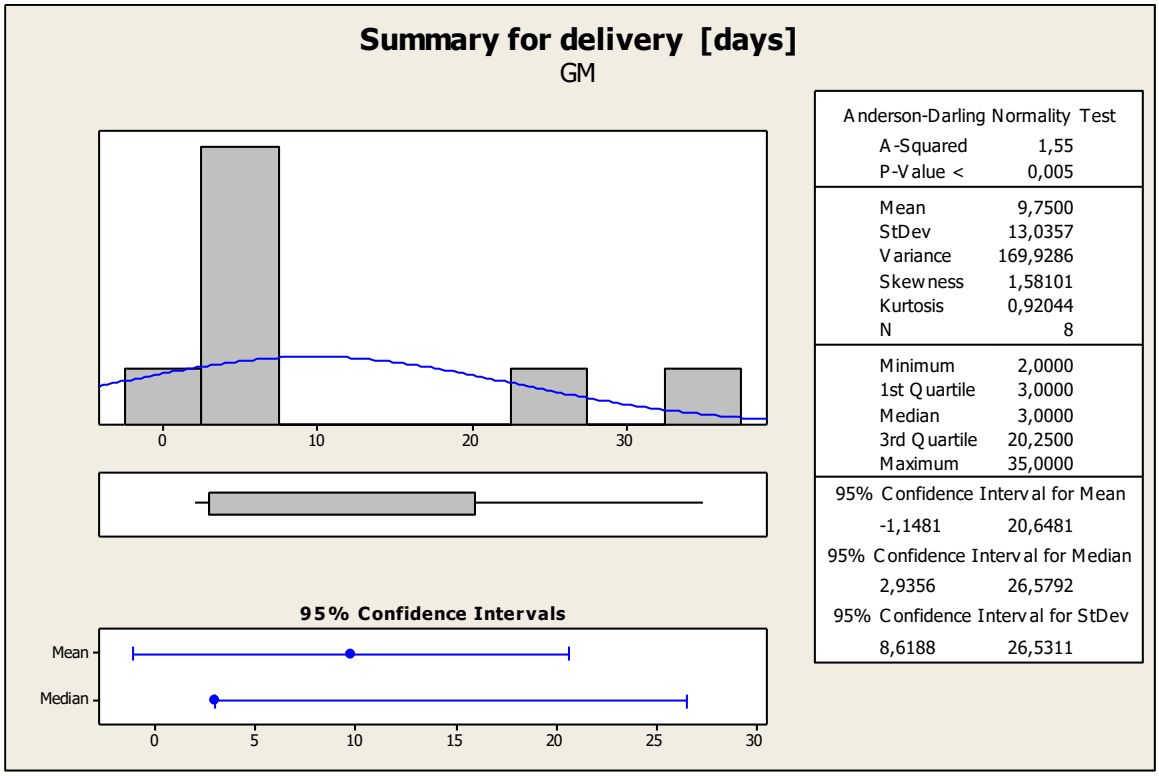

Figure 27. Delivery in advance/on time pump GM

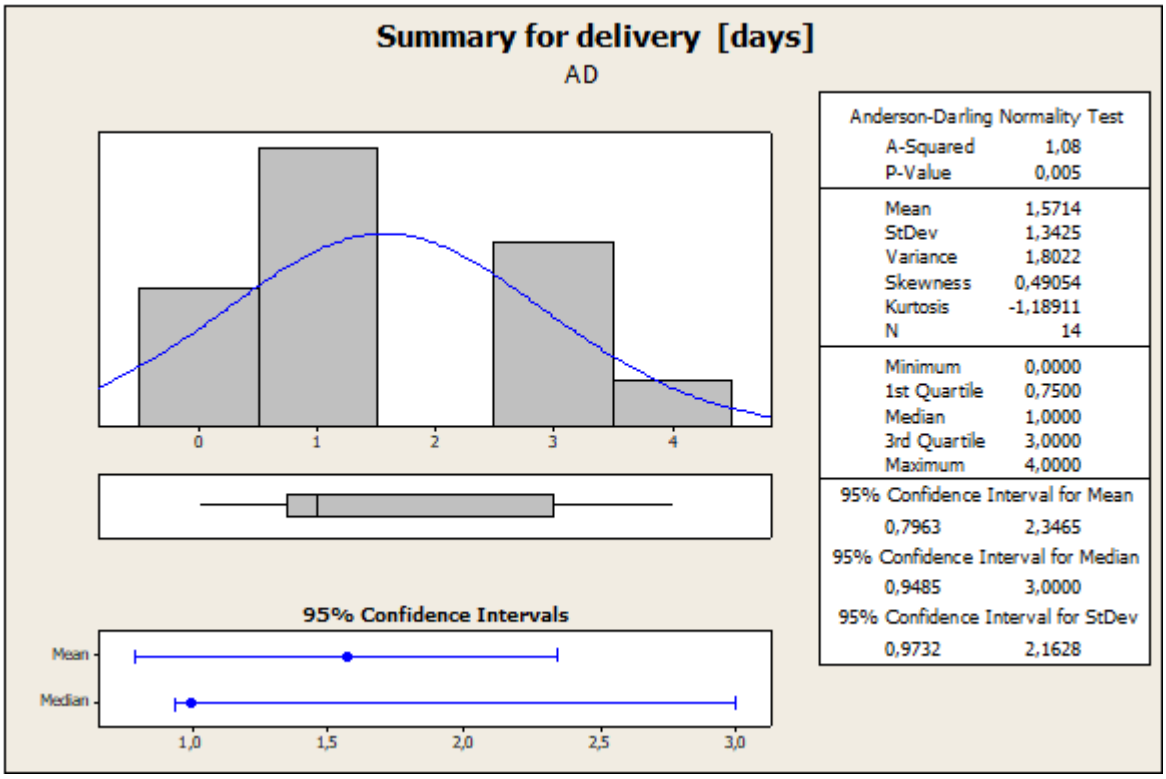

Figure 28. Delivery in advance/on time pump AD

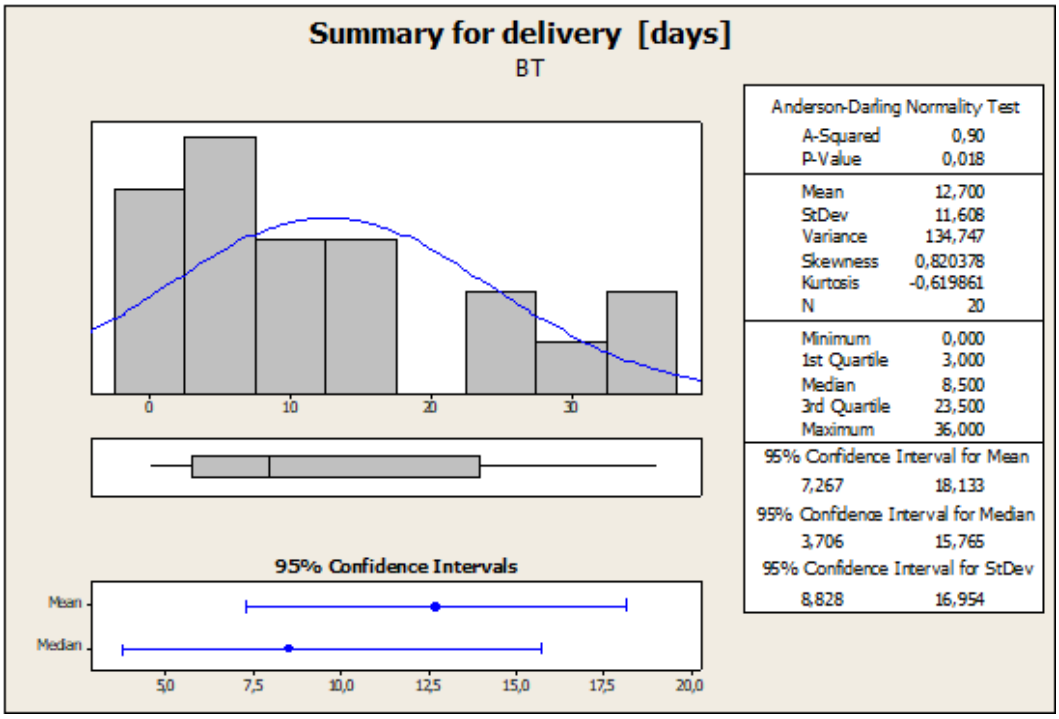

Figure 29. Delivery in advance/on time pump BT

For delayed delivery times the following results were obtained, where the (-) sign in the mean and quartile means that it refers to a delayed time.

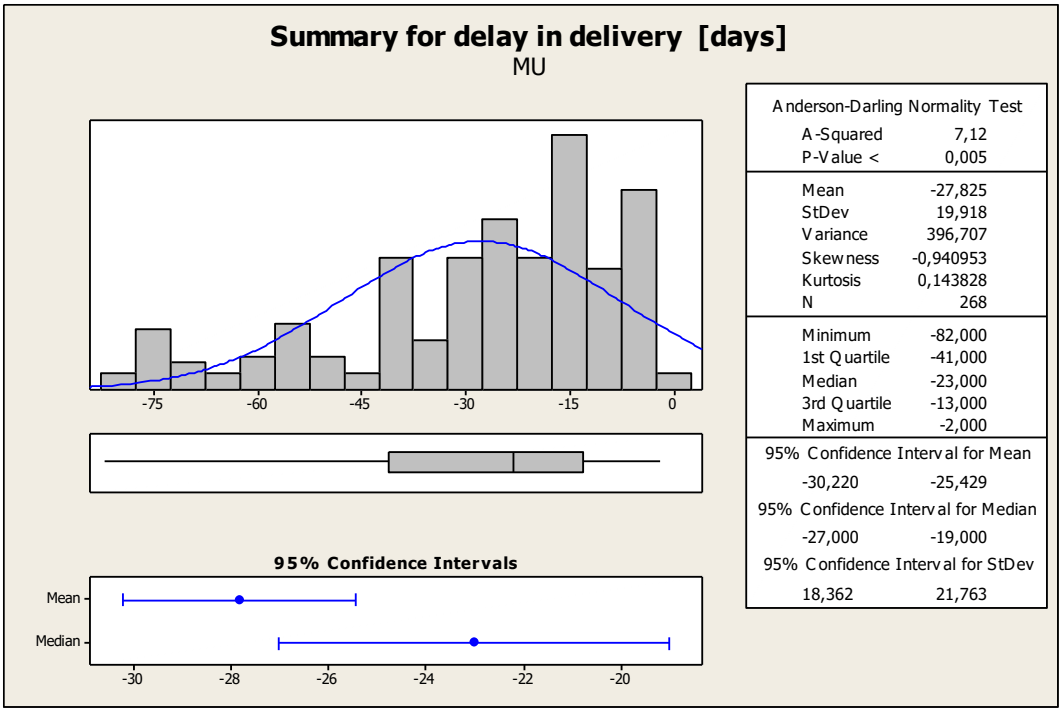

Figure 30. Late delivery pump MU

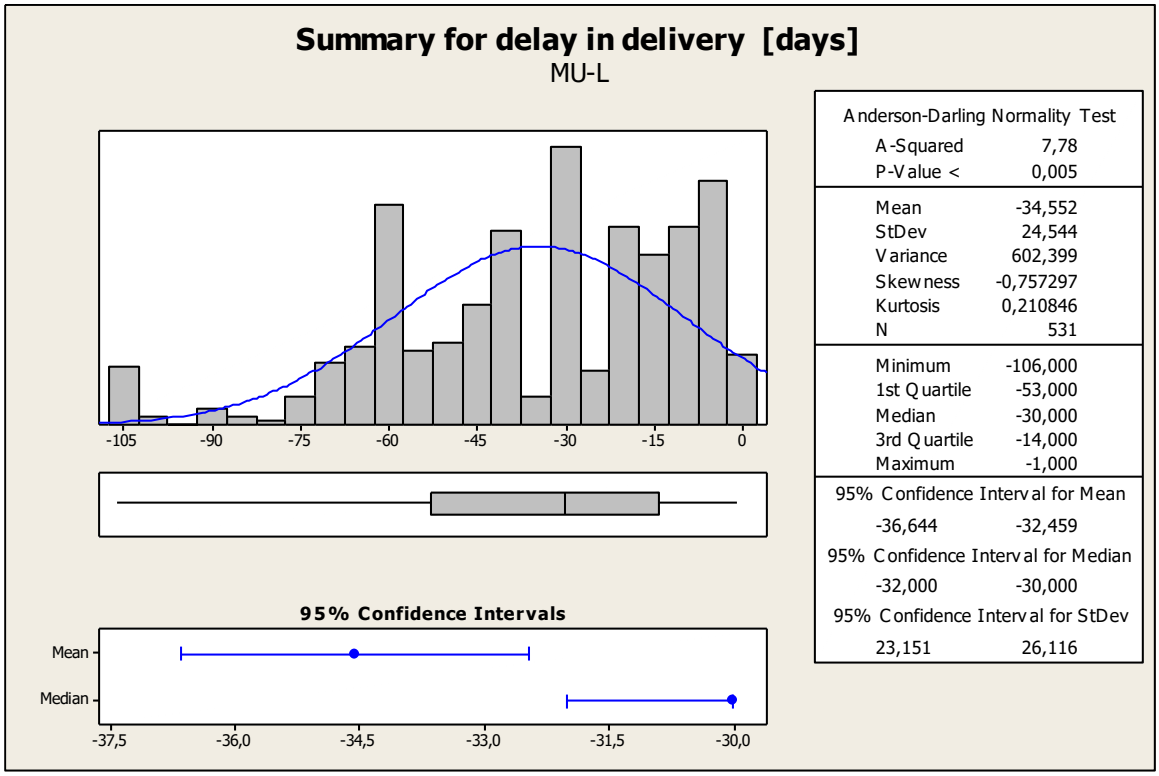

Figure 31. Late delivery pump MU-L

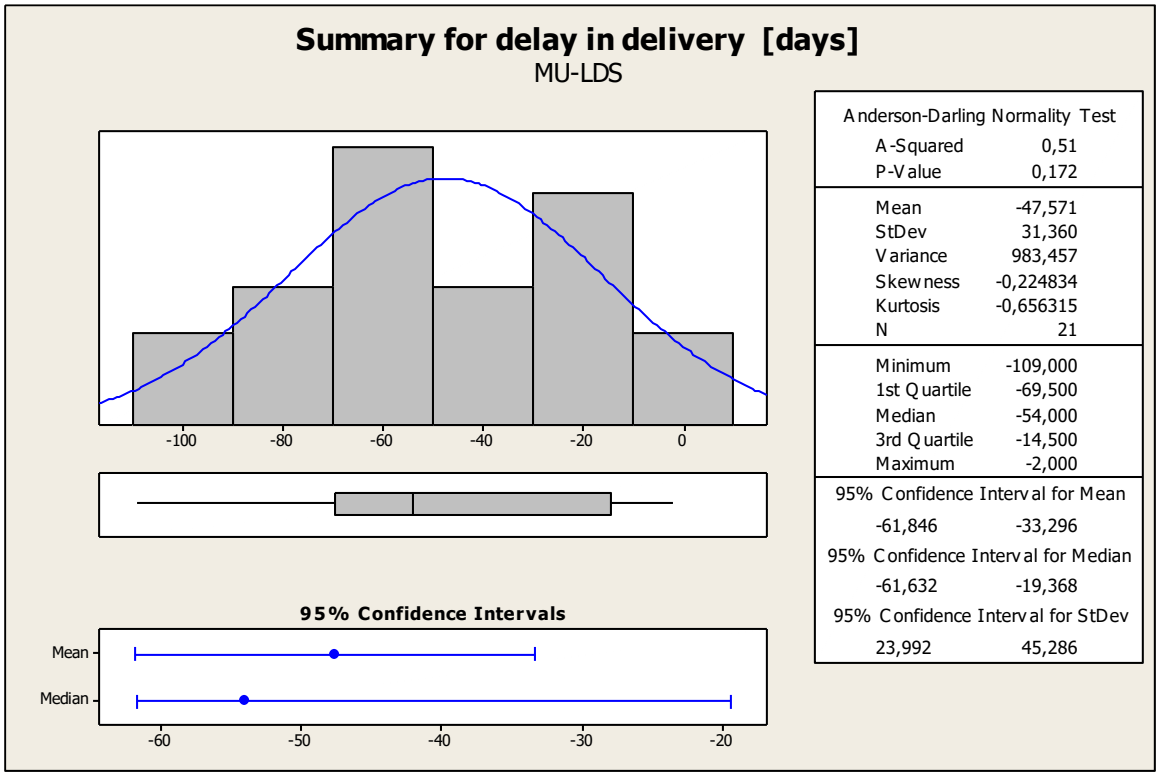

Figure 32. Late delivery pump MU-LDS

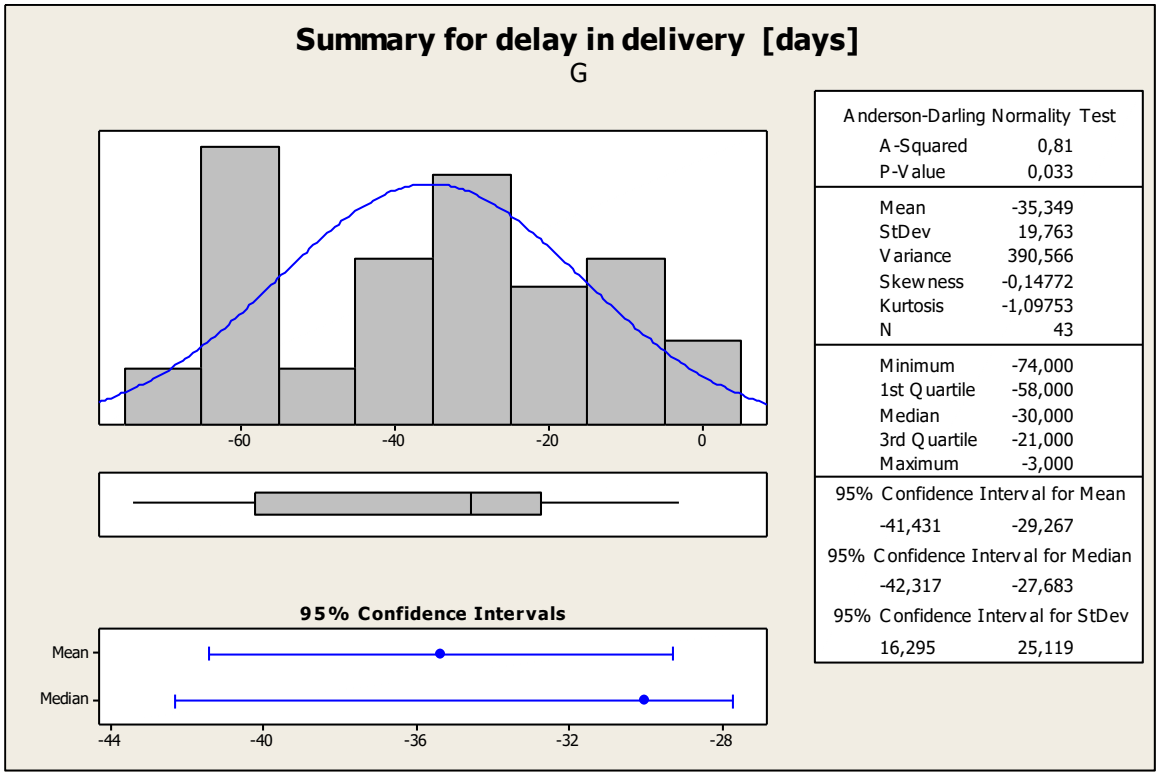

Figure 33. Late delivery pump G

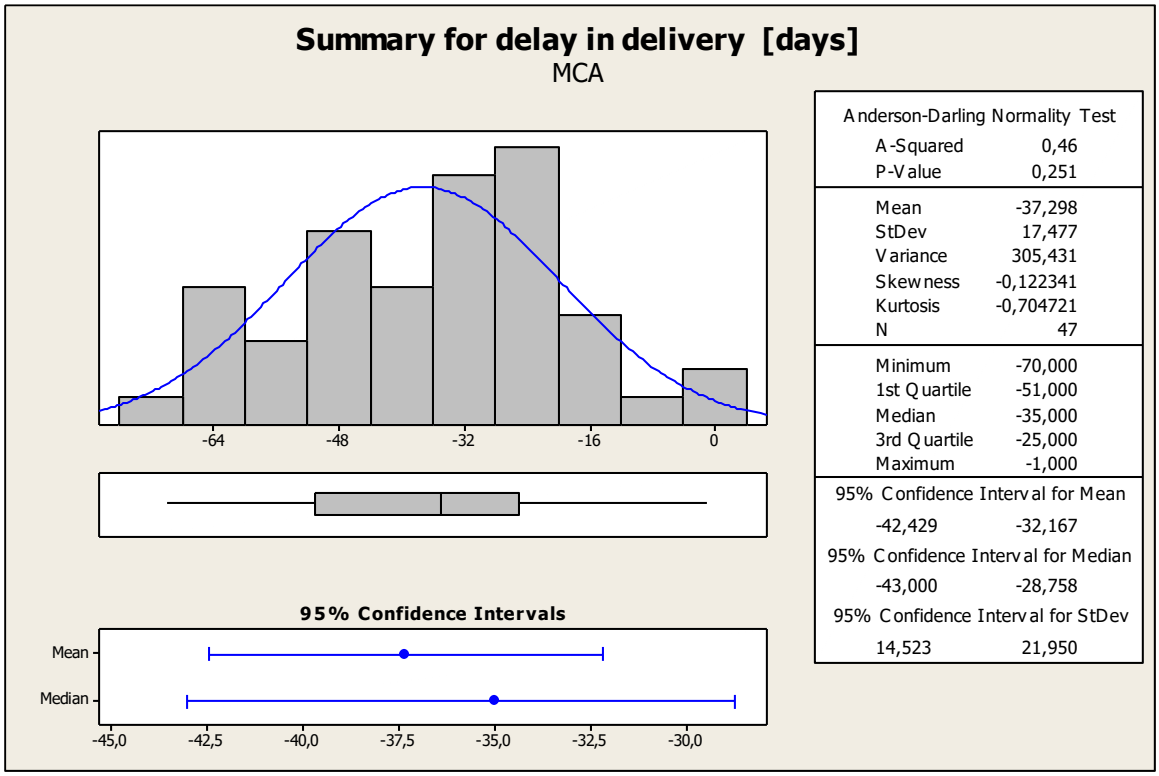

Figure 34. Late delivery pump MCA

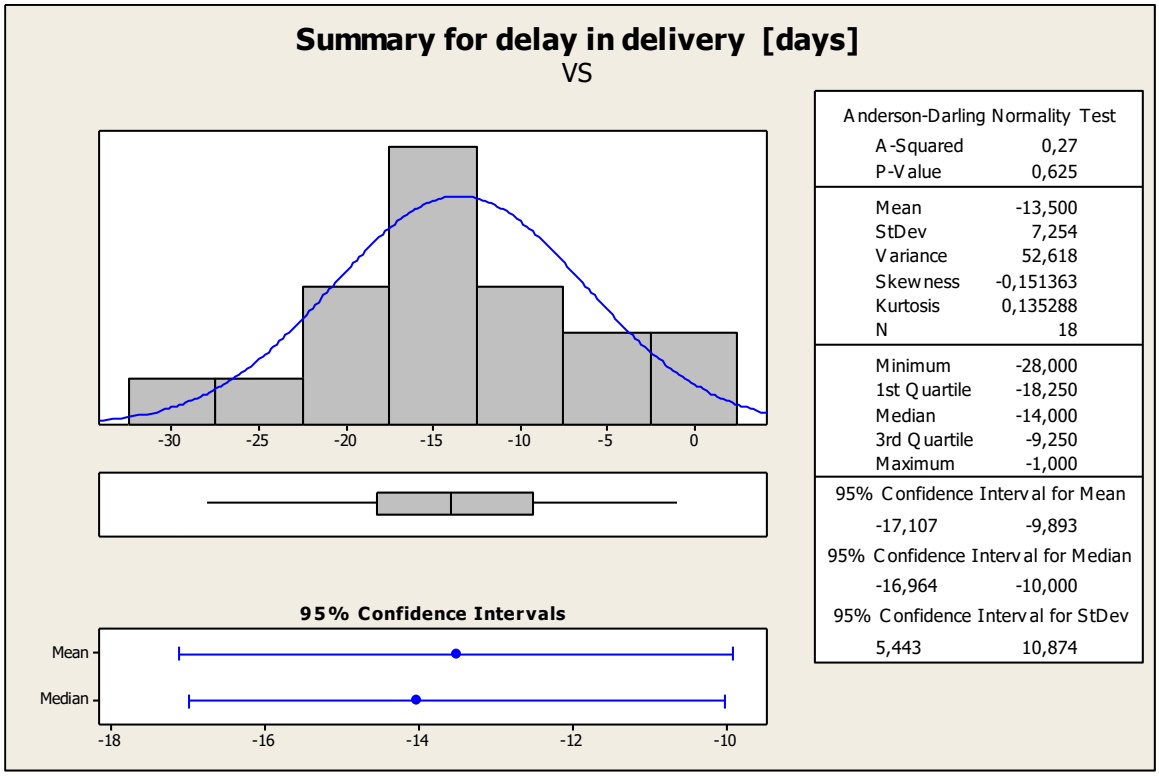

Figure 35. Late delivery pump VS

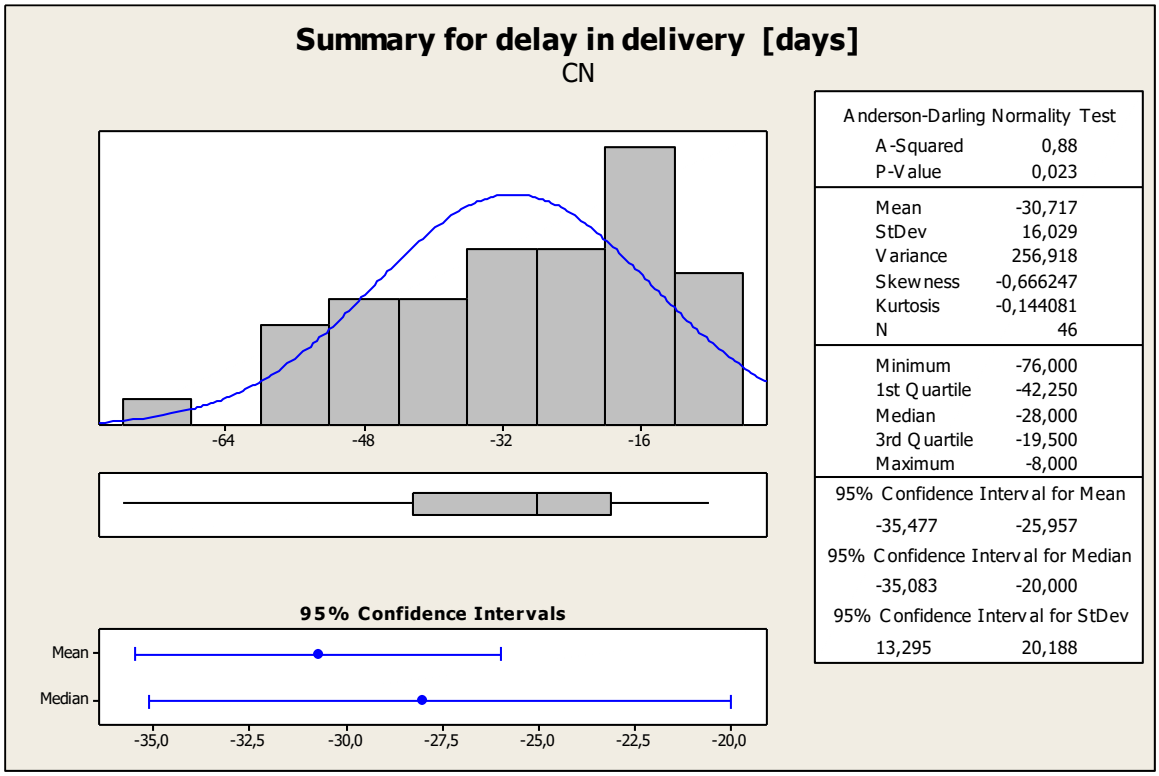

Figure 36. Late delivery pump CN

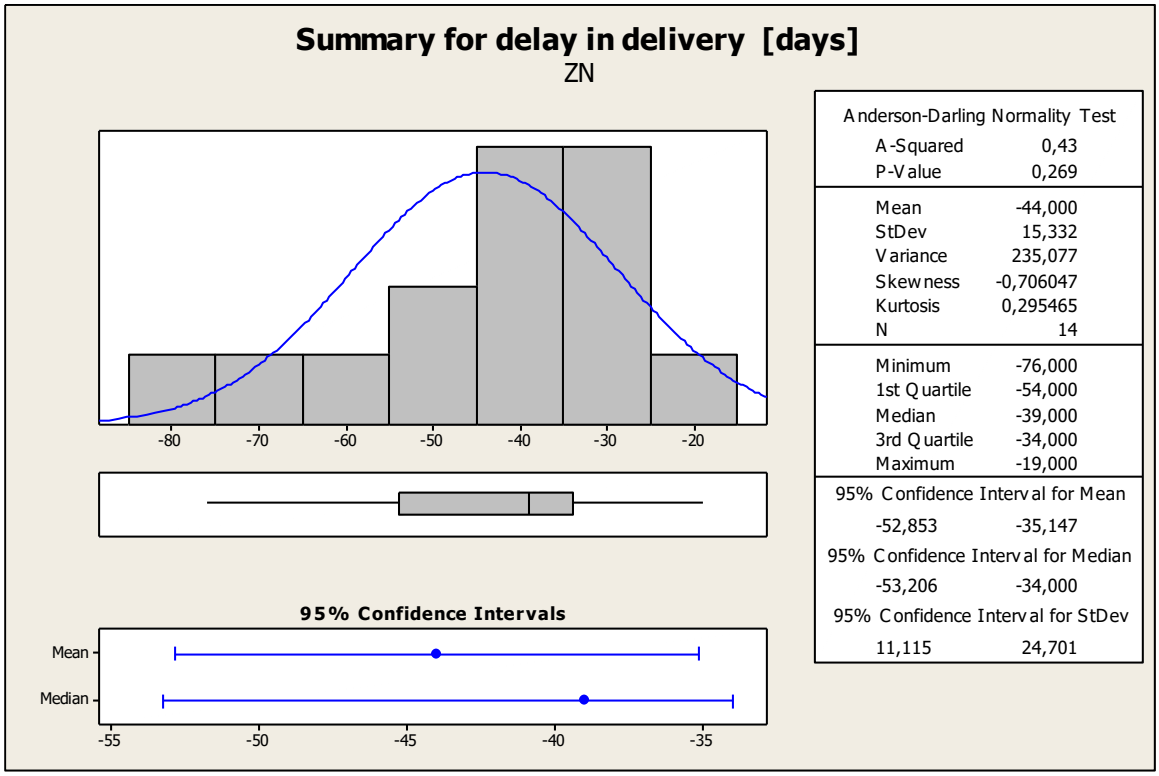

Figure 37. Late delivery pump ZN

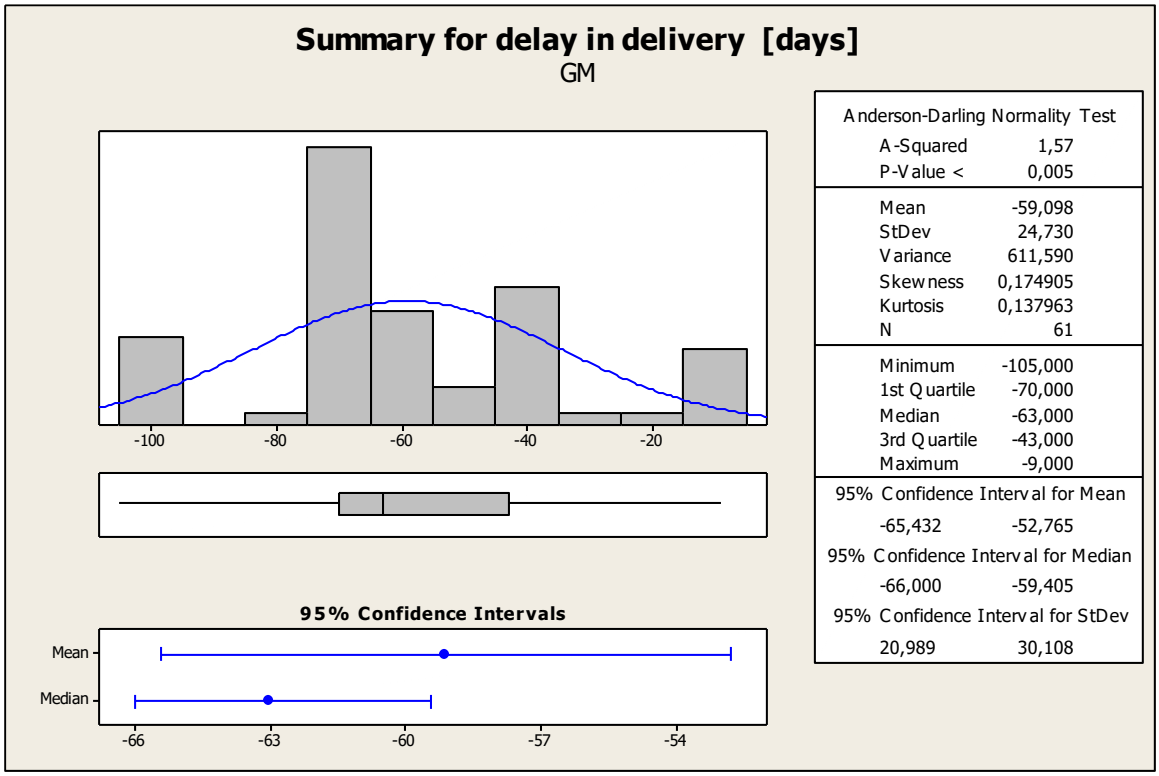

Figure 38. Late delivery pump GM

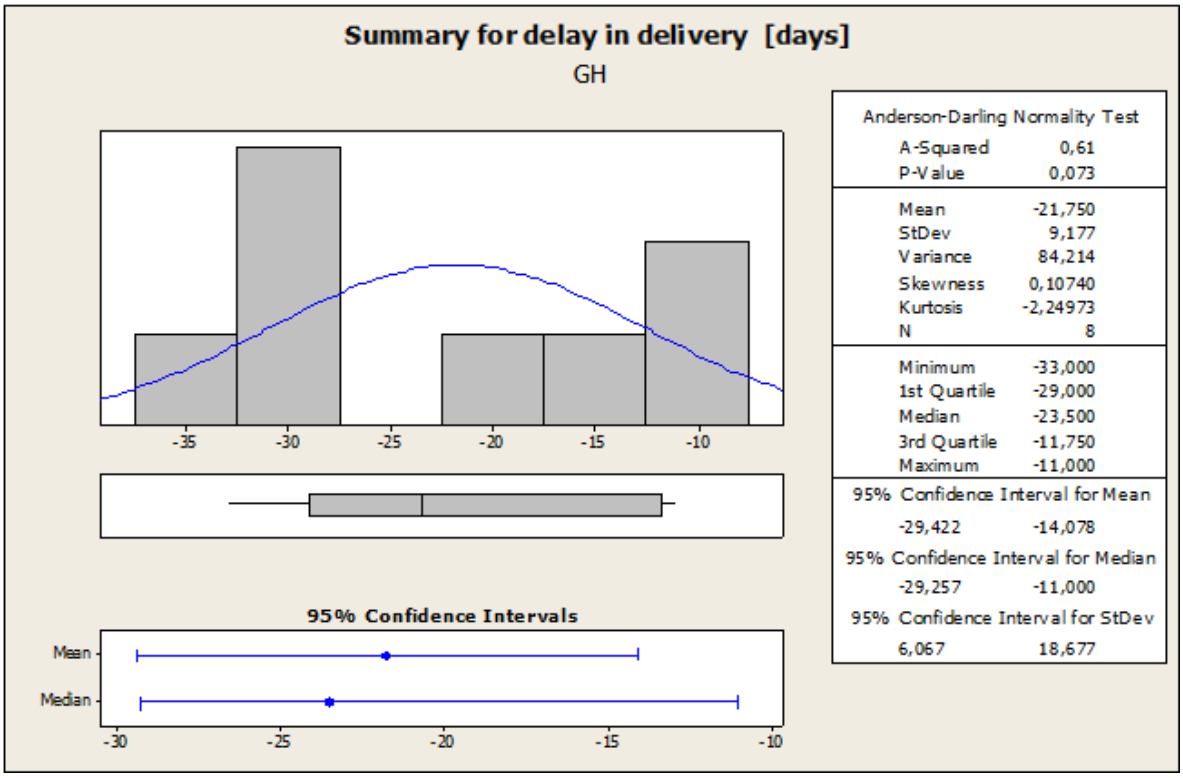

Figure 39. Late delivery pump GH

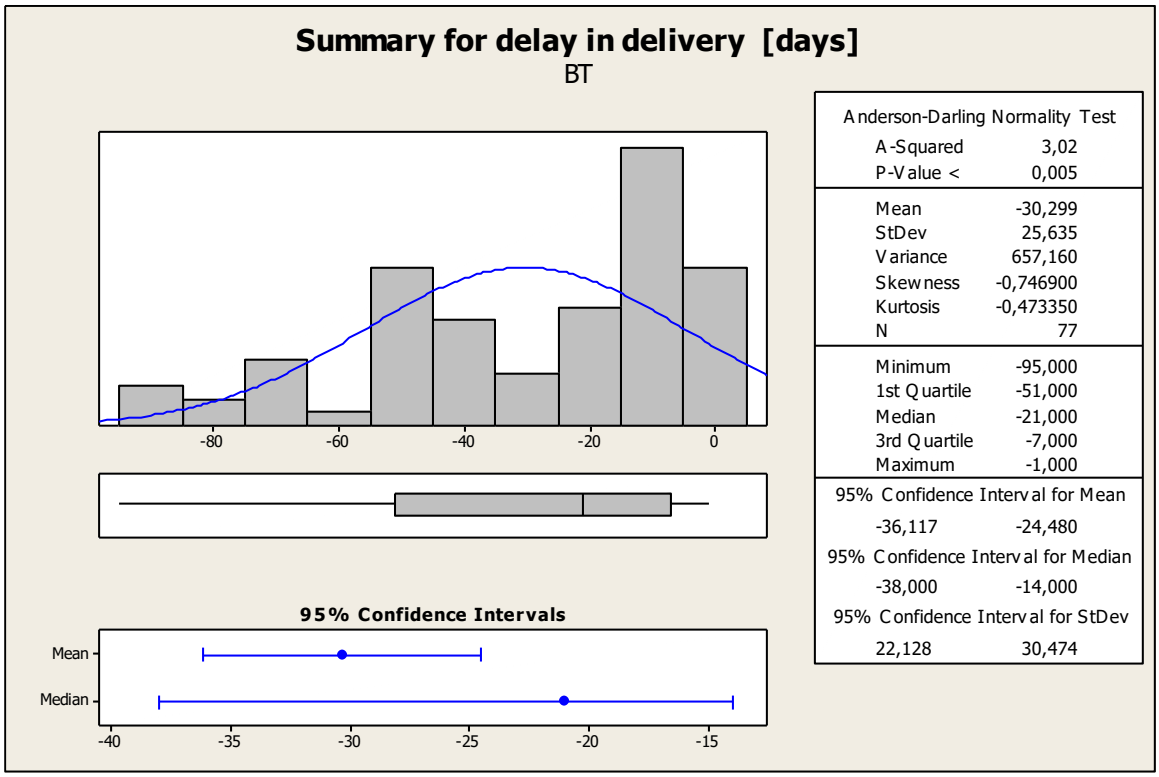

Figure 40. Late delivery pump BT

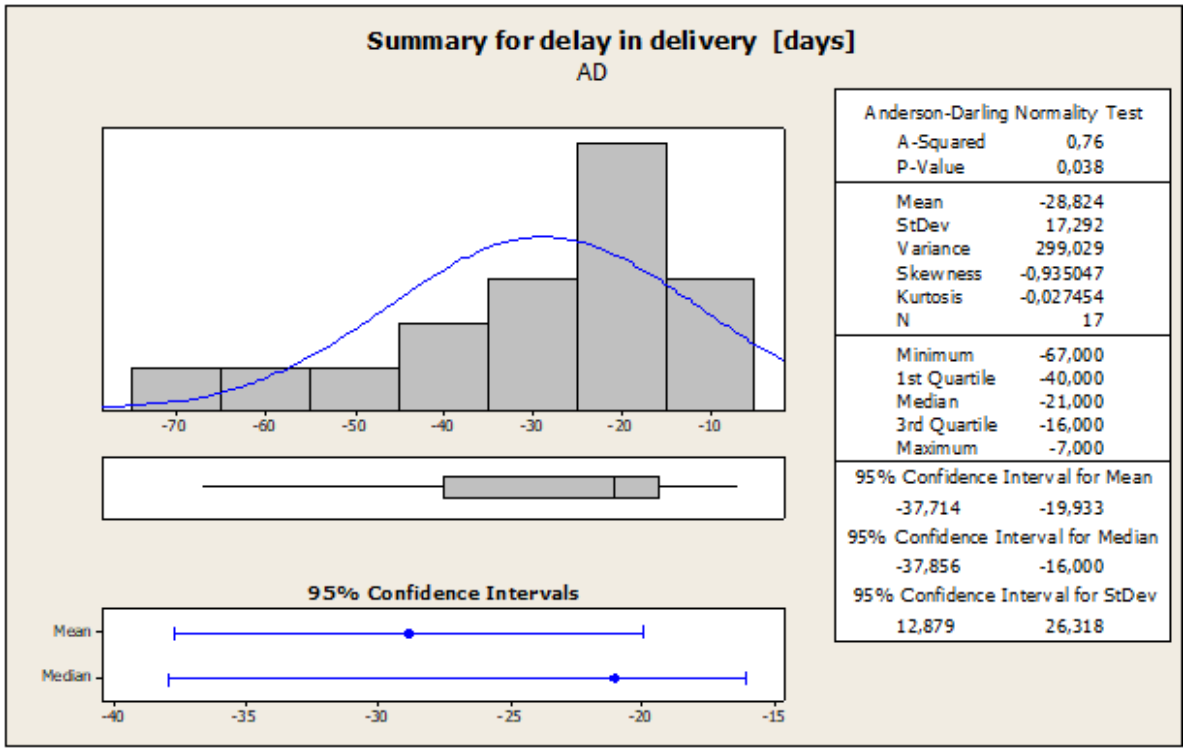

Figure 41. Late delivery pump AD

The above graphs have allowed us to identify that, for stainless steel material:

- The categories with the highest average delay are:
  GM: 59 days
  MU-LDS: 47 days
  ZN: 44 days
- The categories with the least average delay are:
  VS: 13 days
  GH: 21 days
  MU: 27 days
- The categories with normal distributions are VS, GH, AD, CN, G, MCA y ZN.

The categories with normal distribution are allowed to establish stability for tracking delivery delays. Therefore, because these statistics are given with a history of years ago, and customers, on average, already know the variability in delivery time that they expect from POMPE GARBARINO S.p.A, it has been proposed, together with the production area, that these average delays in the different categories of pumps

produced will be the new starting point for identifying the true cause of delays in delivery, that is, these values will be counted as the zero time of the new tracking in the customer delivery time indicator.

In addition, to assess the influence of the smelted parts on the pump delay, a statistical analysis was carried out using a pareto chart of the delay times of the foundries. To this end, a time-delay average has been calculated for the fusing of pump bodies and impellers, which are the most critical elements for the assembly of pumps; and an average of the time that the customer provides for delivery of the product in the different types of stainless steel worked in foundries as are WCB (AC), CF-3M (AS), Saf2205 (CE) and Saf2507 (SD). These averages were used as data to establish the effective time available, that is, the real time to manufacture the pump and deliver it to the customer.

The graphs are shown below:

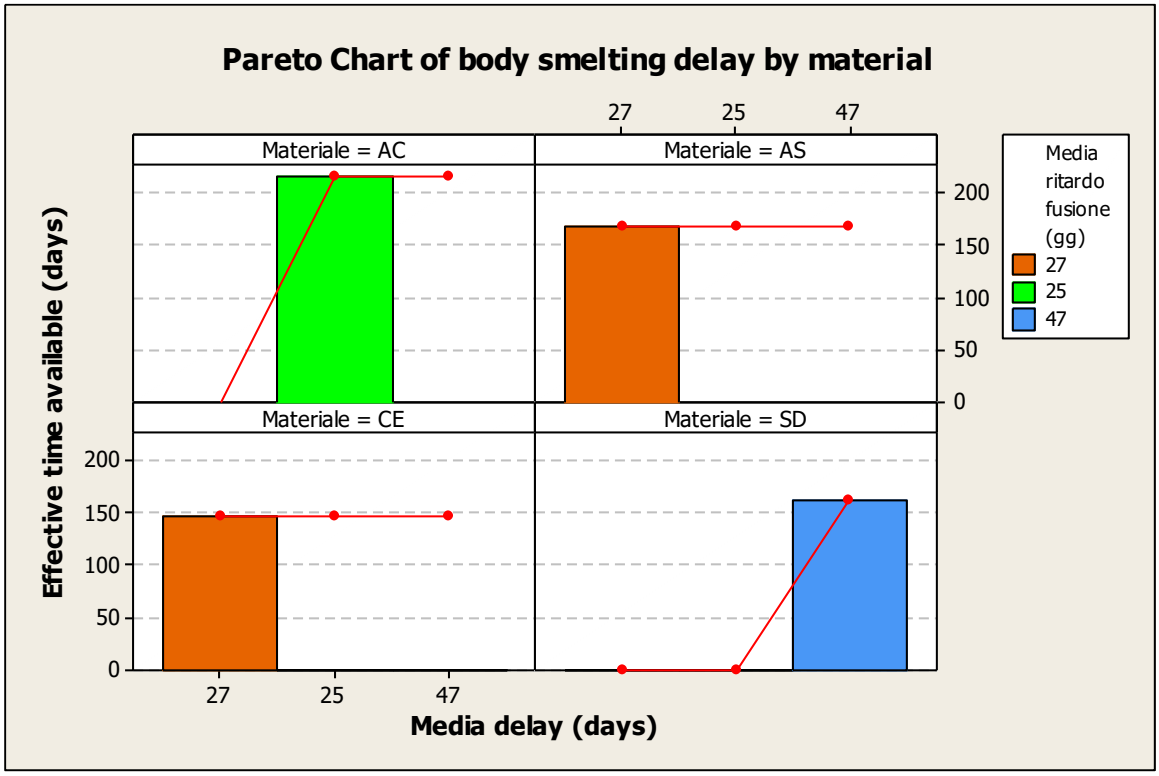

Figure 42. Body fusion delay

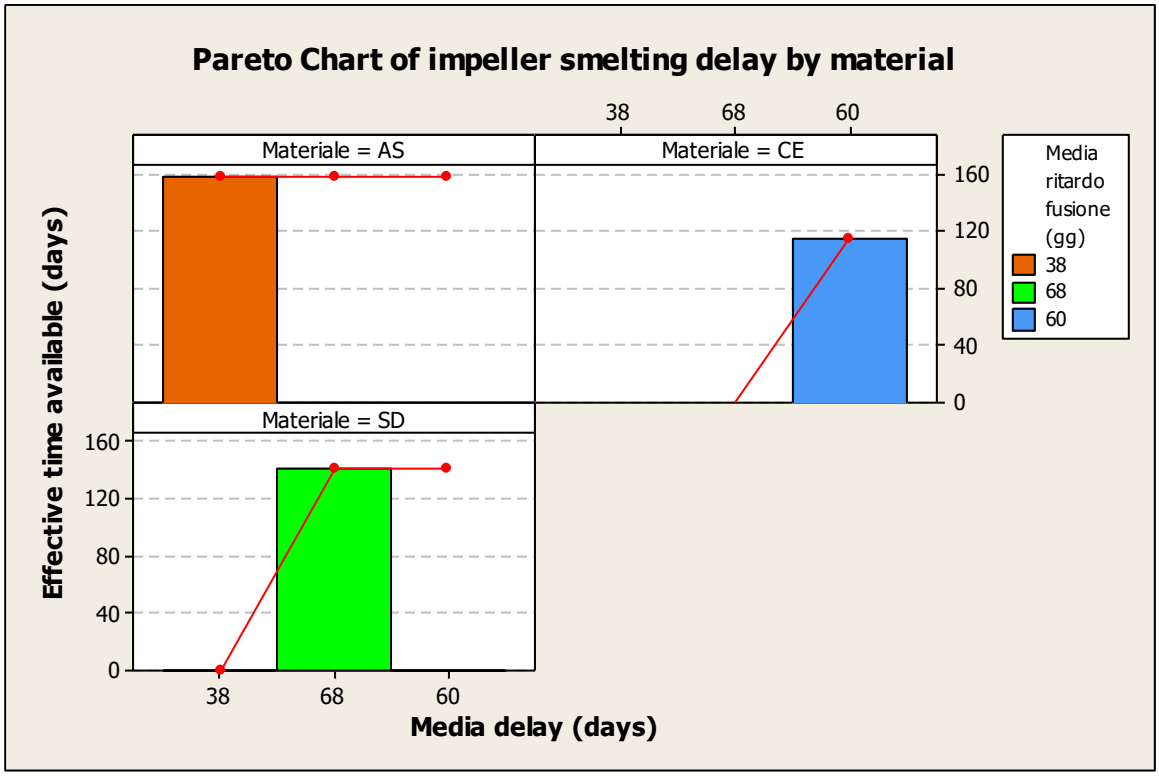

Figure 43. Impeller fusion delay

Thus, for the body of the pumps, the SD material has a higher average delay in fusion (47 days) since it is located more to the right according to figure 42 and a lower effective time (163 days), indicating that it is the most likely material to create bottlenecks in the supply chain and the most critical for planning. It is considered the material with highest priority to intervene since a delay in fusion directly affects the ability to keep to the customer. On the other hand, for impellers of pumps, the most critical material is CE according to figure 43.

On the other hand, material like AC in pump bodies has an average delay but a higher effective time, meaning it has a greater margin to handle the problems that can be triggered, considering not priority material to intervene. For impellers, AS is the material with the lowest risk of causing delays in delivery of pumps to customers.

This analysis will enable POMPE GARBARINO S.p.A to implement new actions relating to the foundries, such as integration between the production department and the quality control service in order to improve the manufacture of elements in this type of materials, identify the points of these objects which show the highest

frequency of non-conformities at the time of pressure tests on pumps to inform to the foundries and enable them to act against them, for example, leak in the side of the pump and pay more attention to this specific point of the pump body in its smelting process to avoid any further delay, besides that generated during its processing, for returns to be repaired and so optimize the process and meet the customer.

5. CONCLUSIONS

Implementing a quality management system based on ISO 9001:2015 enables a company to have greater commercial, operational and organizational advantage within the competitive market as it allows to seek the efficiency of the processes increasing customer satisfaction and compliance with legal and regulatory requirements. Having worldwide recognition of a management system certificate increases the possibility of accessing new customers with a guarantee of good practice and increased loyalty to existing customers.

Organizational advantages mean improving the definition of the company, specifying the processes and their managers through the process diagram. The application of the process approach in the quality management system of POMPE GARBARINO S.p.A allowed for understanding and consistency in meeting customer requirements, establishing appropriate inputs to the process such as materials and resources, and the implementation of respective adjustments in favor of continuous improvement. In this sense, changes to the company's integrated manual allowed complementarity to the quality management system, ensuring the system's efficiency in the process and its improvement based on the evaluation of data and information, clarifying the objective sought, the inputs and activities to be developed with their start and end times, and the receivers of outputs of this process with the client as the main actor to meet their needs and exceed their expectations. Amon these changes is the need for greater standardization and documentation in foundry management, which poses a risk to business continuity. Structuring processes in more detail by means of flow diagrams will ensure that all steps taken are clearly and visually documented, making it easier to understand and identify critical control points.

On the other hand, having key indicators in an organization like POMPE GARBARINO S.p.A allowed made decisions to see their evolution as well as the delivery times of the pumps together with the study of the impact of delays in the foundries. This is why real-time visibility platforms have become indispensable tools to ensure consistency in the performance of a company, encouraged by the OTIF "On time In full". These platforms keep the process transparent from beginning to

end of the supply chain and help the logistics department identify where delays are causing OTIF problems.

Finally, the application of statistical analysis tools in Minitab, such as the Pareto chart, was established as a key aspect for identifying patterns in production and delivery data. The elimination of outliers allowed a clearer view of actual trends and made better decisions for process optimization.

Within an organization, ensuring a quality culture becomes a key aspect of process development where continuous training and feedback make it easier to reduce non-conformities and optimize production times.

BIBLIOGRPHY

Alan Davies, S. L. (2019, June 13). Defining "on time, in full" in the consumer sector.

Alteredu. (2024). Retrieved from DOCUMENTO DI VALUTAZIONE DEI RISCHI (DVR): https://www.alteredu.it/documento-valutazione-rischi-dvr-faq/

Dianelys Nogueira Rivera, A. M. (2024, Abril). *Swot matrix and CAMA analysis, Management Control tools: application case*. Retrieved from http://scielo.sld.cu/scielo.php?script=sci_arttext&pid=S2218-36202024000200034

Fuquan Chen, B. t. (2024, July 30). What You Need to Know About Stainless Steel Melting Point.

ISO 14001. (2015). *Environmental management system*.

ISO 45001. (2018). *Occupational health and safety management systems*.

ISO 9001. (2015). *Quality management systems - requirements, 5*.

OFFSHORE. (2022). Qualification Questionnaire Product Manufacturer.

Paul, B. (2024). Lead Time Explained: How It Works, Types, and Examples. Andrew Latham.

Pome Garbarino. (2022). Retrieved from Quality sistem: https://www.pompegarbarino.com/it/chi-siamo/sistema-qualita/

Pompe Garbarino. (2020). Retrieved from Prodotti: https://www.pompegarbarino.com/it/produzione/prodotti/

Pompe Garbarino. (2024, September 09). Integrated quality and environment manual. Italy: Manuela Delorenzi.

Reid, H. (2023, September 22). Lead Time: Definition, Examples, and Formula. Retrieved from https://dclcorp.com/blog/inventory/lead-time/

SCI The Steel Construction Institute. (2021). Design of stainless steel offshore structures.

UNE 66177. (2005). *Management systems*. Retrieved from Management systems.