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Ensuring lifecycle requirements and feedback flow to Engine Power Plants Technology

School of Technology and Innovations
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Tiivistelmä:

Elinkaaripalvelut ovat nousseet keskeiseksi kilpailuedun lähteeksi energiateknologiayrityksille, minkä myötä elinkaaritietojen tehokas viestintä on yhä tärkeämpää. Tässä tutkimuksessa tarkastellaan elinkaarivaatimusten ja palautteen kulun nykytilaa Energy Services ja Engine Power Plants Technologyn välillä Wärtsilä Energy organisaation sisällä, tunnistetaan keskeiset haasteet ja kehitetään konkreettinen parannusehdotus.

Tutkimus toteutettiin monimenetelmäisenä yksittäistapaustutkimuksena yhdistämällä kyselyjä, puolistrukturoituja haastatteluja ja yhteistyöllisen työpajan. Yhteensä 36 henkilöä 11 eri osastosta osallistui tutkimukseen. Aineisto osoittaa, että yksiköiden välinen viestintä on pitkälti epävirallista ja perustuu yksilölliseen aloitteellisuuteen eikä mihinkään määriteltyyn rakenteeseen. Kolme keskeistä haastetta tunnistettiin: määritellyn rakenteen ja vastuiden puute, elinkaaripalautteiden järjestelmällisen huomioimisen puuttuminen Engine Power Plants tuotekehitysprosesseista sekä erillisen palautetyökalun puuttuminen.

Näiden haasteiden pohjalta kehitettiin ehdotus, joka koostuu nelivaiheisesta palautesilmukasta, elinkaaripalautteen integroimisesta Engine Power Plants tuotekehitysprosesseihin sekä strukturoidun palautetyökalun vaatimusten määrittelystä.

AVAINSANAT: Product Life Cycle, Knowledge Management, Feedback, Product Development, Communication, Engine Power Plant, Energy Industry

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ABSTRACT:

Lifecycle services have become a key source of competitive advantage for energy technology companies, which makes the effective communication of lifecycle knowledge increasingly important. This study looks at the current state of the lifecycle requirement and feedback flow between Energy Services and Engine Power Plants Technology within Wärtsilä Energy, identifies the key challenges, and develops a concrete proposal for improvement.

The research was conducted as a mixed-methods single case study, combining surveys, semi-structured interviews, and a collaborative workshop. In total 36 participants from 11 departments took part in the research. The data shows that communication between the two units is largely informal and driven by individual initiative rather than any defined structure. Three key challenges were identified: the lack of defined structure and responsibilities, the absence of systematic consideration of lifecycle feedback in EPPT's product development processes, and the lack of a dedicated feedback tool.

Based on these challenges, a proposal was developed consisting of a four-stage feedback loop, integration of lifecycle feedback into EPPT's product development processes, and the specification of requirements for a structured feedback tool.

KEYWORDS: Product Life Cycle, Knowledge Management, Feedback, Product Development, Communication, Engine Power Plant, Energy Industry

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Abbreviations

EPP = Engine Power Plants
EPPT = Engine Power Plants Technology
ES = Energy Services
KM = Knowledge Management
PLM = Product Lifecycle Management
SECI = Socialisation, Externalisation, Combination, Internalisation
QEHS = Quality, Environment, Health and Safety
EPC = Engineering, Procurement and Construction

1 Introduction

This research is conducted for Wärtsilä, a global leader in innovative technologies and services shaping the decarbonisation of marine and energy (Wärtsilä, n.d.). Lifecycle services form a key part of Wärtsilä's Energy business, and their strategic importance has continued to grow in recent times. This has made the effective communication and utilisation of insights gathered throughout the lifecycle increasingly important for ensuring that power plant designs and concepts are developed in a way that supports long-term lifecycle performance (Wärtsilä, 2025).

This study looks at the current lifecycle requirement and feedback flow between Energy Services (ES) and Engine Power Plants Technology (EPPT) within Wärtsilä Energy. The focus is on how lifecycle knowledge is communicated between the two units and how it is considered in the development. The study is conducted as a mixed-methods single case study, combining surveys, interviews and a workshop. The outcome of this research aims to benefit both organisational units by providing a structured proposal for improving the feedback flow, which would help integrating lifecycle insights better into product development.

1.1 Background

The energy sector is going through a period of significant change, driven by the global push towards decarbonisation, and growing demand for flexible and sustainable power generation (Babatunde et al., 2020). In this environment, the ability to deliver not only competitive new build projects, but also high-performing lifecycle services has become a key differentiator, as service-driven business models have long been seen as more valuable than those focused solely on technology or price (Loock, 2012).

Wärtsilä's Energy business operates in this context. The company provides engine power plant solutions and lifecycle services to customers around the globe, with a clear ambition to grow agreements coverage and expand performance- and outcome-based service offerings. For this to work, power plant designs and concepts need to be developed with lifecycle performance in mind. In other words, lifecycle knowledge and experience must feed the product development and engineering phases at an early stage (Wärtsilä, 2025).

Within Wärtsilä, EPPT and ES are units within the broader Energy organisation. EPPT is part of Engine Power Plants (EPP), which together with ES forms the two main organisational units within Wärtsilä Energy. EPPT is responsible for the technology and design development of power plants, while ES manages the lifecycle after delivery. The ability of these two units to communicate and exchange lifecycle knowledge is therefore important for the business. However, the current practices and structures supporting this communication have not been clearly examined. This study fills that gap.

1.2 Research problem and scope

The strategic importance of lifecycle knowledge for product development has been recognised within Wärtsilä Energy, but the flow of lifecycle requirements and feedback from ES to EPPT has not been formally structured or systematically managed. It has been recognised that important lessons are accumulated during the lifecycle phase, but there is room for improvement in their communication and utilisation in development and engineering decisions. The key challenges identified relate to undefined ways of working and responsibilities, and the lack of a dedicated feedback tool.

This study focuses specifically on the lifecycle feedback and requirement flow between ES and EPPT within Wärtsilä. The scope does not extend to other organisational units or feedback flows within the company.

1.3 Research objective and questions

The main objective of this study is to develop a concrete proposal for improving the lifecycle feedback and requirement flow between ES and EPPT, which has been found limited. In order to reach this objective, the current state of the feedback flow must first be understood, and the key challenges identified. The study therefore seeks to answer the following research questions:

1. What is the current state of the lifecycle feedback and requirement flow between ES and EPPT?
2. What are the key challenges regarding the flow of lifecycle feedback and requirements between ES and EPPT?
3. How could the lifecycle feedback and requirement flow be improved?

1.4 Structure of the thesis

This thesis is structured as follows. Chapter 1 introduces the research background, problem and scope, research objective and questions, and the structure of the thesis. Chapter 2 reviews the theoretical background relevant to the study. Chapter 3 describes the research methodology and covers the research design, data collection methods and data analysis approach. Chapter 4 addresses the first two research questions by presenting the as-is analysis of the current state of lifecycle feedback and requirement flow between ES and EPPT, and identifies the key challenges. Chapter 5 addresses the third research question by building on these findings and the collaborative workshop to present a proposed way forward. Chapter 6 concludes the thesis with a summary of key findings and suggestions for future research.

2 Literature review

This chapter covers the theoretical background for this study. The review covers four themes that together build the foundation for understanding the research problem. The chapter opens by introducing Product Lifecycle Management as a concept and framework within which the study operates. Second, Knowledge Management theory is explained to understand the nature of knowledge and the challenges of sharing it within organisations. The review then moves to more practical topics and examines cross-functional communication and the difficulties that rise when knowledge fails to flow effectively between units. Finally, feedback loops are introduced as a mechanism for enabling systematic knowledge transfer. These themes together provide the theoretical basis for understanding the challenges identified in this study and for evaluating the proposed improvement.

2.1 Product lifecycle management

A classic in the field, Stark (2011) describes Product Lifecycle Management (PLM) as the business activity of managing a company's products across their entire lifecycle in the most effective way. Ameri and Dutta (2005) further define PLM as a business solution that aims to streamline the flow of information about the product and related processes throughout the lifecycle, ensuring that the right information is available in the right context at the right time. The importance of PLM for organisations lies in its ability to support competitive differentiation. According to Ameri and Dutta (2005), product innovation, customer intimacy and operations excellence have become the most important areas of focus for organisations seeking competitive advantage, and PLM enables competitiveness by promoting knowledge management across all three.

According to Stark (2011), a product's lifecycle consists of five distinct phases: imagination, definition, realisation, use and support, and disposal. In each phase, the product exists in a different state and requires different management activities. During the imagination phase, the product exists only as an idea. During the definition phase, these ideas are converted into a detailed description. By the end of the realisation phase, the product exists in its final form and is ready for customer use. During the use and support phase, the product is with the customer, being operated and maintained in real-world conditions. Finally, in the disposal phase, the product is retired and no longer in use. These five phases are commonly grouped into three broader categories — Beginning of Life, Middle of Life, and End of Life — as illustrated in Table 1 below.

Table 1. Product lifecycle stages (Stark, 2011).

Beginning of Life	*Middle of Life*	*End of Life*
Imagine/Define/Realise	Support/Maintain/Use	Retire/Dispose

Of these five phases, the use and support phase is especially relevant to this study. It is during this phase that the product is in the hands of the customer, being operated and maintained. In the case of power plants, this phase is especially important, as power plants typically operate for several decades, which means that the use and support phase represents the vast majority of the product's total lifecycle. This is also where a significant amount of operational knowledge and experience is accumulated, and effectively feeding this knowledge back to product development can significantly improve the performance of future product generations (Igba et al., 2015). However, as Meyer et al. (2022) note, insights from the use phase are often insufficiently identified and documented in practice, leaving product planners to rely on assumptions and speculations rather than reliable data.

As Ameri and Dutta (2005) elaborate, PLM plays a central role as a knowledge management system, where capturing, storing and making available the knowledge generated across all lifecycle phases is considered important. PLM also seeks to enhance an organisation's ability to manage product development activities and support collaboration across organisational functions and business units (MacCarthy & Pasley, 2021). This connection between PLM and knowledge management is particularly relevant in the context of this study, as the central challenge lies not in the absence of lifecycle knowledge, but in how that knowledge is managed and communicated across organisational boundaries. The following section examines knowledge management theory in more detail.

2.2 Knowledge management

Gupta et al. (2000, p. 17) define Knowledge Management (KM) as "a process that helps organizations find, select, organize, disseminate, and transfer important information and expertise necessary for activities such as problem solving, dynamic learning, strategic planning and decision making." In today's competitive environment, knowledge has been identified as the most important strategic resource. Bergh et al. (2025) conducted a meta-analysis of 348 samples and found that knowledge resources have the highest positive association with organisational performance across all dimensions, which includes financial performance, stock market returns and growth. This confirms that knowledge offers superior strategic value compared to other resource types. Organisations that are able to effectively capture, manage and utilise their knowledge have therefore better chances to have competitive advantage over time.

In KM theory, knowledge is often divided into two types of knowledge: explicit and tacit. Explicit knowledge is easy to document and record. It can be found in manuals, reports, databases and formal procedures, and is relatively straightforward to share and transfer across an organisation. On the other hand, tacit knowledge is personal, experience-based and deeply rooted in individual practice, which makes it difficult to articulate or transfer (Nonaka, 1994). Nonaka (1994, p. 13) also states that tacit knowledge is “deeply rooted in action, commitment, and involvement in a specific context”. Tacit knowledge can be further understood through two dimensions. First is a cognitive element consisting of mental models, beliefs and perspectives that shape how individuals perceive the world, and second a technical element covering concrete know-how, skills and crafts that apply to specific contexts (Nonaka, 1994).

Even though tacit knowledge has enormous strategic value, it is difficult to transfer between individuals and organisational units. The key challenges regarding it include organisational culture, trust, leadership, and the absence of structured systems and processes for knowledge sharing (Lartey et al., 2022). Unlike explicit knowledge, tacit knowledge resides within individuals and is not easily captured or documented, which makes it challenging to share and utilise more broadly within the organisation. One widely recognised approach to address this challenge is the SECI model proposed by Nonaka et al. (2000), which explains how tacit and explicit knowledge interact and convert into one another through four processes: socialisation, externalisation, combination and internalisation. Of these, externalisation is particularly relevant for organisations seeking to capture experiential knowledge, as it converts tacit insights into explicit documented form, which makes the knowledge accessible beyond the individuals who hold them.

In the context of this study, the lifecycle knowledge gathered by ES is mostly tacit knowledge. It is based on field observations and practical insights that are not systematically documented. This makes its transfer to EPPT challenging, as the externalisation of such knowledge requires structured processes, clear responsibilities and dedicated tools through which tacit insights can be converted into explicit and actionable information. The following sections explore the more practical organisational factors that further complicate this transfer and the mechanisms that could better support it.

2.3 Cross functional communication

Cross-functional communication refers to the exchange of information, knowledge and expertise between different departments or functional units within an organisation. The focus is on aligning activities and achieving shared organisational goals by reducing barriers to communication. It involves collaboration and coordination across organisational boundaries, enabling different functions to work together rather than in isolation. Tucker et al. (1996) argue that an organisation's capability for creating and communicating knowledge across functions can serve as a source of strategic competitive advantage.

Despite its importance, effective cross-functional communication is difficult to achieve in practice. When departments develop their own priorities and ways of working, knowledge and information do not flow freely across organisational boundaries. Research on cross-departmental collaboration has identified factors such as insufficient communication, lack of shared goals, time pressure, and limited trust between units as key obstacles to effective knowledge transfer (Sunnemark et al., 2024). These barriers can make it difficult to establish a common understanding across functions, even when the willingness to collaborate exists.

One of the most persistent barriers to effective cross-functional communication is the formation of organisational silos. Silos refer to the tendency of departments or functional units to focus on their own objectives and operate with limited interaction with other parts of the organisation. In siloed environments, knowledge tends to remain within the unit that generates it, which weakens internal collaboration and organisational learning (Waal et al., 2019). When knowledge fails to cross functional boundaries, valuable insights that exist within one part of the organisation often go unnoticed by those who could benefit from them most.

In the context of this study, ES and EPPT represent two functionally distinct units with different priorities and ways of working. While communication between the two units does take place, the structural separation means that there are lack of defined processes or channels to support it. The challenges described above, including differing priorities, insufficient communication structures and siloed ways of working, are therefore directly relevant to understanding why lifecycle knowledge does not flow effectively between the two units, even though both could benefit from closer collaboration.

2.4 Feedback loops

A feedback loop is a process in which the output of an action is fed back as input to influence and improve future actions. This creates a cyclical flow of information between experience and development. Rather than acting in isolation, each action generates information that shapes the next, which allows systems and organisations to continuously learn. In organisational contexts, feedback loops are instrumental in the knowledge creation process, enabling organisations to learn from experience and refine their activities based on new information (Akbar et al., 2018). Akbar et al. (2018) describe feedback loops as dynamic processes that move through stages of generation, evaluation, expansion, refinement and crystallisation, illustrating how knowledge is continuously built upon and refined over time.

When feedback loops are absent or poorly structured, the connection between experience and development breaks down. Feedback is essential in the design and development process, as it enables adaptation to emerging information and supports learning across the development cycle (Wynn & Maier, 2022). This is particularly important when the knowledge at stake is tacit in nature. Goffin and Koners (2011) found that companies often fail to capture lessons learned related to tacit knowledge for dissemination, meaning that valuable experiential knowledge generated in practice never reaches those responsible for future development.

Organisational learning theory recognises two types of feedback-driven learning. Single-loop learning occurs when problems are identified and corrected without questioning the underlying assumptions or processes that caused them (Argyris & Schön, 1978). It is a corrective mechanism that aims to close the gap between expected and actual outcomes within existing frameworks. Double-loop learning goes further. It not only addresses the problem but also questions and potentially changes the underlying assumptions, policies and structures that led to it (Argyris & Schön, 1978).

In the context of this study, the goal is not to fundamentally change EPPT's development, but to ensure that lifecycle knowledge accumulated by ES is systematically captured and fed back into it. This aligns with the principles of single-loop learning, where the focus is on closing the gap between what is known in practice and what informs development decisions. The feedback loop proposed in this thesis, which moves from issue identification through feedback and evaluation to implementation and follow-up, provides a structured mechanism for enabling this kind of systematic knowledge transfer between the two units.

3 Research methodology

In this chapter, the methodology and research approach are explained and justified. First, the research design and approach will be outlined, followed by a description of stakeholder identification and selection, which emphasises the critical role of stakeholders' involvement throughout the research. Finally, the used data is discussed from data collection, analysis, and data quality perspectives. The purpose of this chapter is to provide transparency regarding how the research was conducted.

3.1 Research design and approach

This research was conducted as a mixed-methods single case study for Wärtsilä. Mixed methods research combines quantitative and qualitative approaches, allowing the researcher to draw on the strengths of both methods (Östlund et al., 2011). This is why it suits a case study, where a single topic is explored through multiple perspectives.

Quantitative data was gathered through structured survey questions with predefined response options, which provided a general overview of the current situation. Qualitative data was collected through open-ended survey questions, semi-structured interviews, and a workshop, which enabled a better understanding of the current situation, identified challenges, and improvement opportunities. As Gaya and Smith (2016, p. 536) state, "qualitative research and case studies share the same objective: uncovering complexity in a natural context," which aligns well with the aims of this study, where the goal is to understand and improve the requirement and feedback flow between ES and EPPT.

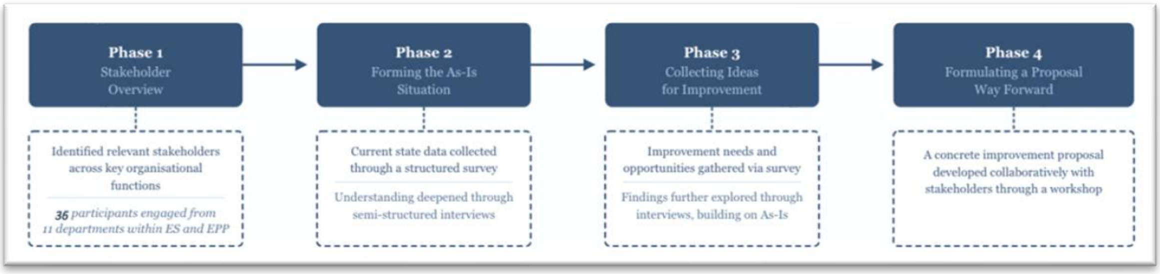

Figure 1. Research structure.

As illustrated in figure 1 above, the research followed a development-oriented, four-phase structure. The process began with a stakeholder overview, during which 36 participants across 11 departments were identified within ES and EPP. This was followed by forming an understanding of the current (As-Is) situation through surveys and interviews. The third phase focused on collecting ideas and needs for improvement, building on the findings from the As-Is analysis. Finally, in the fourth phase, a concrete proposal way forward was formulated through a collaborative workshop with stakeholders. This approach aligns with widely applied process improvement methods, which commonly begin with an analysis of the current state, followed by the identification of challenges and the development of concrete improvement proposals (Malinova et al., 2022)

3.2 Stakeholder identification and selection

As the research was development oriented and closely connected to everyday practices, the stakeholder involvement was a central part throughout all phases of the research. The involvement of stakeholders is increasingly recognised as essential to producing impactful research (Chung, 2024). After the relevant stakeholders were identified, they contributed on picturing the current situation, identifying the challenges and developing the potential solutions.

Given the central role of stakeholder involvement, the identification and selection process was conducted carefully to ensure that all relevant perspectives were represented. As the study examines the feedback and requirement flow between two organizational departments, from ES to EPPT, it was essential to include representatives from both organisational units.

The identification and selection process was carried out in collaboration with company supervisor using a preliminary list of potential stakeholders at director and general management level as a starting point. Some agreed to participate directly, and others nominated team members with roles relevant to the topic. This resulted in 36 participants engaged across 11 departments within ES and EPP.

3.3 Data collection

The data for this research was collected across three phases using surveys, semi-structured interviews, and a workshop. The combination of quantitative and qualitative methods enabled a comprehensive understanding of the current situation, and at the same time collected more detailed insights into the identified challenges and improvement opportunities. This phased approach enabled a flexible research process in which findings from earlier phases was used an input and guided the next phases of the study.

3.3.1 Survey data collection

Once the relevant stakeholders had been identified, the data collection for the As-Is analysis started with two cross sectional surveys, one targeting ES and the other EPPT. Maier et al. (2023) argue that cross-sectional surveys provide baseline information and help lay a foundation for more sophisticated follow-up studies, which aligns well with the purpose of this study. The purpose of the surveys was to gather insights from multiple departments within both units regarding the current feedback and requirement flow, and preliminary ideas for improvement. The surveys were conducted using Microsoft Forms and resulted in a total of 33 answers, of which 18 were from ES and 15 from EPPT.

The survey followed a funnel structure toward more detailed questions about current practices and improvement opportunities. They consisted of a combination of open-ended questions, and questions with predefined response options. This enabled a quantitative overview of the current situation through percentage-based results, and open-ended questions allowed respondents to express their views more freely and provide more detailed insights (Saunders, 2023). The surveys also played as an initial step in the research process encouraging stakeholders to reflect on and engage with the topic.

3.3.2 Interview data collection

The surveys were followed by five semi-structured interviews to deepen the understanding of the current situation and gathering ideas for potential improvements. Semi-structured interviews were chosen because they allow the researcher to explore topics in depth while enabling follow-up questions and probing of responses (Saunders, 2023). The interviewees were selected based on their experience and involvement in the feedback and requirement flow, as well as the relevance and depth of their survey responses.

The interviews were conducted during the autumn 2025 using Microsoft Teams, which enabled the discussions to be recorded and later reviewed during the analysis phase. The participants were informed that their identities would remain confidential and that the collected data would be handled in a way that prevents individual responses from being linked to them.

3.3.3 Workshop data collection

To further develop the ideas and challenges identified through the surveys and interviews into more concrete proposals, a workshop was organised where stakeholders could collectively discuss and refine potential solutions. Workshops are particularly valuable as a research method in studies related to organisational change and development, as they aim to produce reliable and valid data while enabling participants to actively contribute based on their own domain knowledge and interests (Ørngreen & Levinsen, 2017).

The workshop was held at Wärtsilä's Powergate office during December 2025 and lasted 1.5 hours. All involved stakeholders were invited, and 13 participants from 9 different departments attended the session. The workshop started with a short introduction presenting the current situation and identified challenges. After that, the participants were divided into two groups. One group focused on feedback related to already established products, while the other discussed feedback needs from the perspective of new product development. The discussions aimed to refine the improvement ideas identified earlier and to develop suggestions from both perspectives, which were later summarized as input for the final proposal.

3.4 Data analysis

The data analysis followed an iterative thematic approach throughout the study. Thematic analysis is a method for identifying, analysing, organising, and reporting themes found within a dataset, and it provides a highly flexible approach that can be modified to meet the needs of many studies (Nowell et al., 2017).

The survey data was first analysed to build an overall picture of the current situation and to spot preliminary themes and challenges. The interview analysis then took these themes further, which allowed the most usual themes to be examined in more depth. Finally, the workshop outputs were summarised together into a concrete proposal way forward. The iterative nature of the research ensured that each phase built on the findings of the previous one. This progressively guided the analysis toward the concrete proposal way forward.

3.4.1 Survey data analysis

The survey data was analysed to develop an overall understanding of the current requirement and feedback flow from ES to EPPT. The analysis was based on both the percentage-based results generated from the structured questions and the summarised views of the open-ended responses. The focus was on identifying common themes, challenges, and preliminary solutions across the 33 responses from different departments. The key insights and recurring themes served as a foundation for the interviews and were used to guide the formulation of interview themes and questions.

3.4.2 Interview data analysis

The interview analysis focused on deepening the understanding of the current situation, key challenges, and preliminary potential solutions. The insights from the survey analysis allowed the interview questions to be tailored to each interviewee, enabling discussions to go beyond first-level observations and explain how the challenges appear in practice across different organisational contexts. Through the interviews, a better understanding of how the identified challenges play out in practice was gained, as the interviewees were able to draw on their own day-to-day experiences. In addition, the analysis captured concrete ideas and suggestions for potential improvements, which served as key inputs and themes for the workshop.

3.4.3 Workshop data analysis

The key challenges had already been clearly identified through the surveys and interviews, and the workshop therefore focused on developing concrete solutions to these challenges. The two groups produced their suggestions to a PowerPoint template, one approaching the topic from the perspective of already established products, and the other from the perspective of new product development, which were reviewed and synthesised together. The analysis aimed to identify common and complementary approaches between the two perspectives. Solutions that were raised by both groups and across multiple departments were given more weight, and these were ultimately integrated into a single proposal way forward.

3.5 Reliability and validity

The reliability and validity of this research were ensured throughout the research process. As Zohrabi (2013) notes, reliability in qualitative research deals with the consistency and dependability of the findings and can be enhanced through key techniques such as the investigator's position and triangulation.

Both techniques were applied in this study. Regarding the investigator's position, the research process was communicated to the involved stakeholders openly throughout all phases. This included sharing of analysis findings at each stage, and clear communication of the research process. The continuous communication with stakeholders also increased transparency and lowered the risk of misunderstandings. Triangulation was achieved through multiple data collection methods: surveys, semi-structured interviews, and a workshop. This allowed the findings to be cross validated across different sources and perspectives, strengthening the dependability of the results (Zohrabi, 2013).

The constant involvement of stakeholders further strengthened the credibility of the findings, as participants were motivated to contribute honestly due to the direct relevance of the challenges to their daily work. However, mixed-methods research poses challenges to validity, as the shifting assumptions between qualitative and quantitative components can result in methodological incoherence if not carefully managed (Morse et al., 2006). To overcome this challenge, the quantitative survey data was used to provide a general overview of the current situation, while the qualitative methods were used to deepen and contextualise these findings.

However, the research also had certain limitations. Firstly, the research was conducted as a single case study within a specific organisational context, which limits the generalizability beyond this case. Secondly, the highly specific nature of the challenge and the need for tailored solutions limited the application of existing theoretical frameworks to generate actual improvements. Nevertheless, the primary objective of the research was to address a specific organisational problem rather than to produce broadly generalisable results.

4 As-Is analysis: Current requirement and feedback flow

This chapter presents the empirical analysis of the current lifecycle requirement and feedback flow between ES and EPPT. The goal of this chapter is to understand which lifecycle aspects are important for Service performance and how these are currently communicated and utilized within EPPT. The analysis is based on the data collected through surveys and interviews, as described in Chapter 3.

The chapter begins with a brief overview of the organizational context and the key stakeholder groups involved in the study. This is followed by an analysis of lifecycle considerations told by service stakeholders and the current feedback practices between the two units. Finally, the main challenges in the existing feedback flow are described to provide a basis for the Chapter 5, where future state and recommendations are presented.

4.1 Organizational context and stakeholder overview

As outlined in Chapter 1, EPPT is responsible for the technology and design development of power plants, while ES manages the lifecycle after delivery. ES therefore accumulates a wide range of operational and strategic insights from the lifecycle phase. While some feedback already flows between the two units, more effective and better managed communication could unlock the full potential of this knowledge and provide significant advantage for EPPT's product development decisions. With the breadth of functions involved in the feedback flow, the study involved stakeholders from a wide range of departments across both units, as illustrated in Figure 2 below.

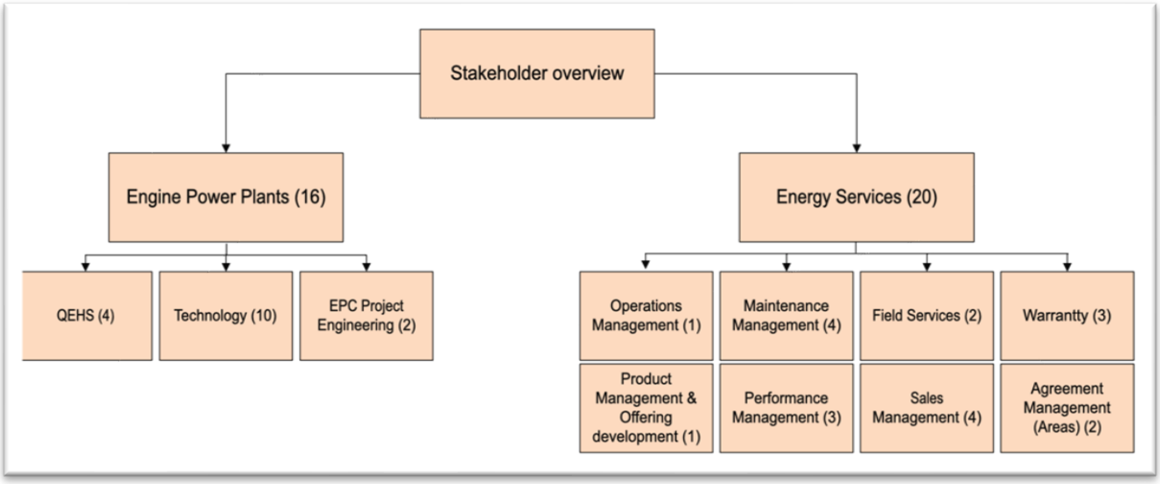

Figure 2. Stakeholder overview, numbers indicate participants per department.

On the EPP side, stakeholders included representatives from Technology, QEHS, and EPC Project Engineering. On the ES side, participants covered a broad range of lifecycle-related functions, including Maintenance Management, Agreement Management, Sales Management, Performance Management, Field Services, Warranty, and Operations Management. This cross-functional stakeholder representation ensures that the findings capture perspectives from across all relevant functions involved in the feedback flow.

4.2 Lifecycle insights from the service perspective

The survey responses from ES highlighted many different lifecycle aspects that are considered important when operating, maintaining and optimizing power plants after delivery. The responses indicate that service stakeholders possess large amount of knowledge of considerations that could improve lifecycle performance, if taken into account already during the design and development phases.

One of the most frequently raised themes was reliability and operational performance. Ensuring safe and reliable operation with high availability and efficiency was emphasised across multiple departments and was considered critical for the customer's business case, as one respondent noted: "ensuring the highest reliability means that the plant will be operational whenever there is an opportunity, thereby generating more revenue for the customer."

Maintainability and serviceability were also widely highlighted. Respondents pointed out that design decisions significantly influence maintenance efficiency and total lifecycle cost. One respondent described this in practical terms: "loading spaces for parts, easy access to units, storage for parts, site workshop, cranes", which illustrates how specific design choices directly affect day-to-day service operations. Another respondent summarised the broader concern: "total lifecycle cost may not be taken into sufficient consideration when developing new solutions."

Documentation and data accuracy emerged as another theme, with several respondents highlighting gaps in available information that directly affect lifecycle operations. Finally, digitalisation and evolving operational models were recognised as areas where lifecycle requirements should be better considered already in the design phase.

Overall, the survey responses reflected a broad and detailed base of lifecycle knowledge within ES. While the analysis presented here focuses on the key recurring themes, the responses contained significantly more detailed observations that are not fully disclosed due to the confidential nature of the topics. Nevertheless, the depth of the responses makes clear that ES stakeholders possess valuable lifecycle knowledge, and that more effective communication of this knowledge could improve its impact on product development and future power plant design.

4.3 As-Is findings

The following sections present the key findings from the As-Is analysis, based on data collected through surveys and interviews. The analysis covers the current state of communication between ES and EPPT, the existence of standardised processes, and the tools and mechanisms currently in use.

4.3.1 Current communication

The survey data from both units reveals that some communication of lifecycle requirements and feedback takes place between ES and EPPT, but it is largely partial and unsystematic.

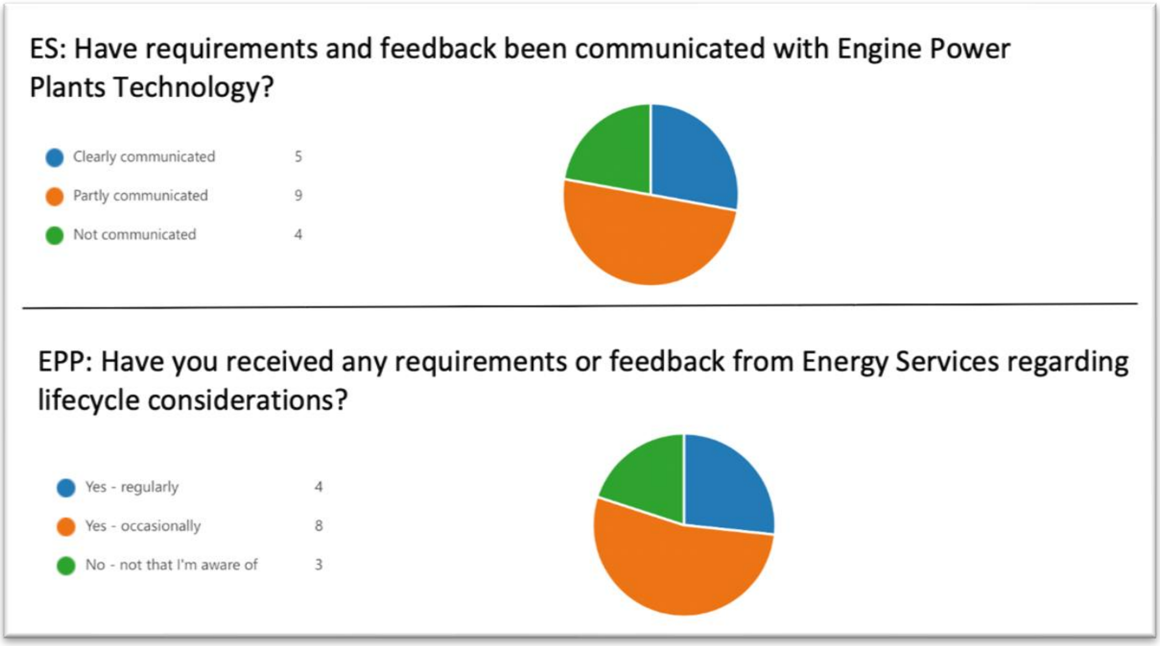

Figure 3. Communication of lifecycle requirements and feedback (Wärtsilä, 2025).

As illustrated in Figure 3, the majority of ES respondents reported that requirements have been only partly communicated to EPPT, while four respondents answered that no communication had taken place at all. This is highly consistent with the EPPT perspective, where most respondents reported receiving feedback only occasionally, and three respondents were not aware of having received any feedback related to lifecycle considerations. These insights were further supported by the interviews, where one interviewee summarised the situation as follows: "Dialogue occurs sporadically when deficiencies or improvements are identified. There are no regular meetings or a clear feedback process."

4.3.2 Process and standardization

The survey data also reveals that no clearly defined process or standardised way exists for communicating lifecycle requirements and feedback between the two units.

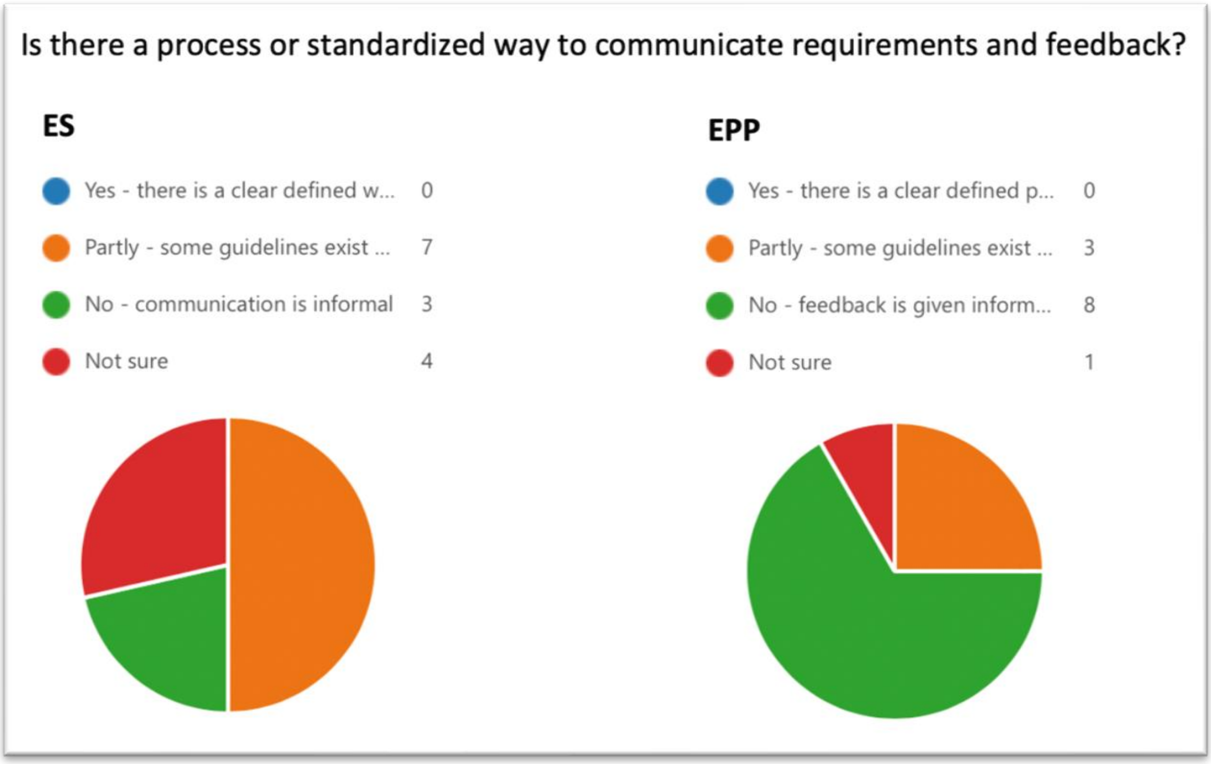

Figure 4. Existence of a standardised process (Wärtsilä, 2025).

As shown in Figure 4, the majority on ES side indicated that only some guidelines exist but are not consistently followed, while a significant share reported communication as entirely informal or was unsure of any process. The picture is even clearer on the EPPT side, where the majority reported that feedback is given informally with no structured process in place. These survey findings were also supported by the interviews. One interviewee noted that communication largely relies on individual initiative rather than any formal structure, which is consistent with the survey results and strengthens the reliability of the findings.

4.3.3 Current Tools and Communication Channels

The survey data reveals that a wide range of tools and communication channels are currently used for sharing lifecycle feedback and requirements. However, no single dedicated or integrated tool exists for this purpose.

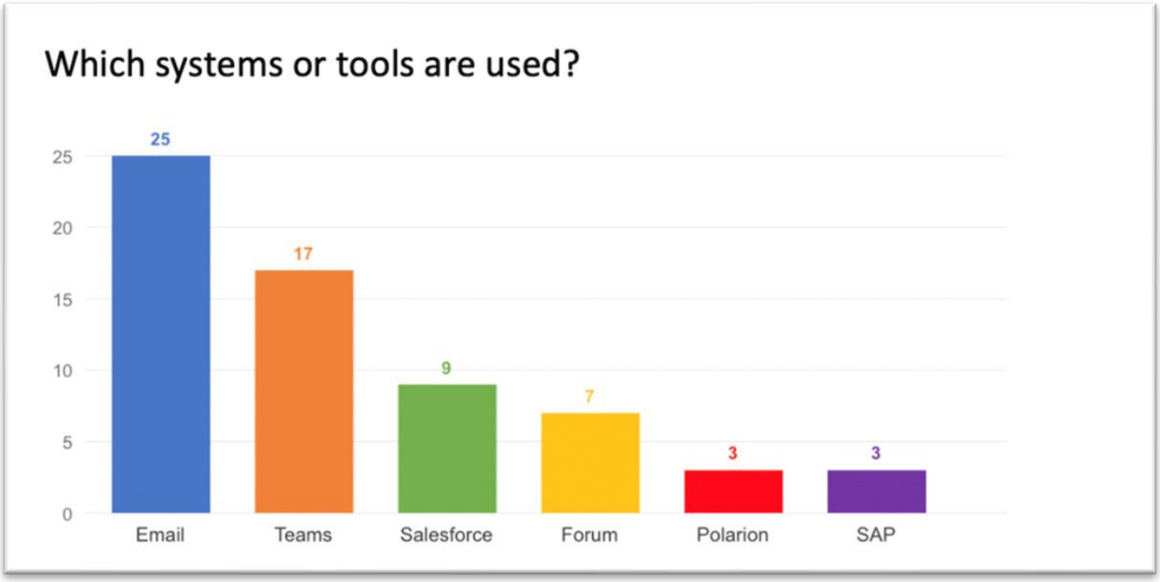

Figure 5. Communication tools used between ES and EPPT (Wärtsilä, 2025).

As illustrated in Figure 5 above, email and Teams are by far the most commonly used channels, which aligns with the open responses where one respondent summarised the situation as: "mainly coming from personal contacts." The next most frequently mentioned tools were Salesforce and various internal forums. While several tools are in use, they serve different purposes and are used inconsistently across departments, resulting in a fragmented communication landscape with no single point of contact for lifecycle feedback.

This was also backed by the interviews, which further confirmed that no dedicated or integrated tool exists for lifecycle feedback, which leaves the communication dependent on informal channels and individual initiative. As one interviewee stated: "there is a lack of a centralised location where feedback and requirements from all relevant functions could be systematically documented and accessed."

4.4 Is there a problem?

The findings presented in the previous sections describe the current state of lifecycle feedback and communication between ES and EPPT. While the data reveals that communication is partial and no standardised process or dedicated tool exists, these observations alone do not necessarily confirm that a significant problem exists. However, the data presented below points to a clear problem.

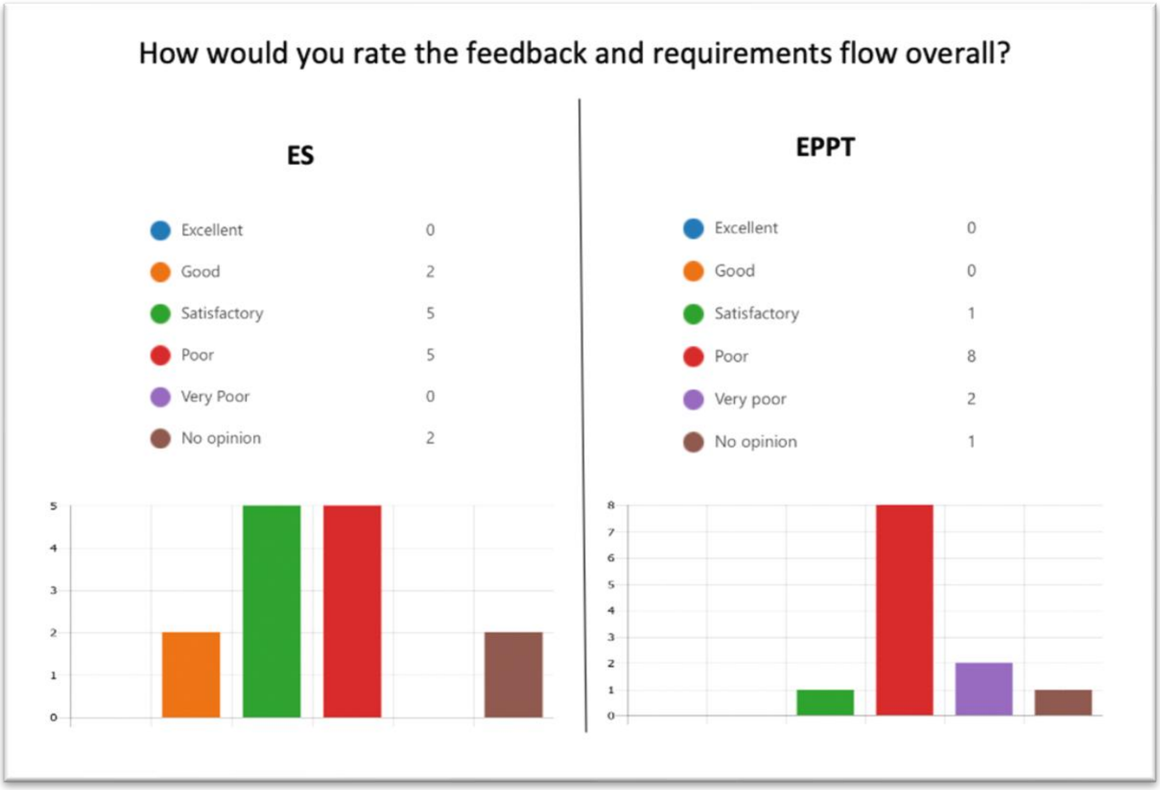

Figure 6. Overall rating of lifecycle feedback and requirement flow (Wärtsilä, 2025).

Figure 6 shows that the overall ratings of the feedback flow are mostly negative across both units. Neither ES nor EPPT respondents rated the flow as Excellent, and the vast majority of responses fall in the Poor category. This provides a clear indication that the current state of lifecycle feedback and requirement communication is widely recognised as insufficient across the organisation.

Looking at the two units separately, a notable difference can be seen. On the ES side, responses are divided between Satisfactory and Poor, which suggests a mixed but largely critical view of the current situation. The EPPT perspective is considerably more negative, as Poor dominates with eight responses and two respondents rated the flow as Very poor.

This difference suggests that the inefficiencies of the current feedback flow are seen more by those receiving the feedback than by those providing it. This points to a disconnect between what is communicated and what is actually received and utilised, suggesting that the current tools and practices fall short of supporting an effective and meaningful feedback flow.

4.5 Key challenges in the current feedback and requirement flow

The evidence presented in the previous section confirms that the current feedback and requirement flow between ES and EPPT is widely recognised as insufficient. When combined with the insights gathered through the interviews and open responses, the findings can be summarised into three fundamental issues from which the other issues arise.

4.5.1 Issue 1: Lack of defined structure for providing feedback

The survey and interview data consistently emphasise that ES stakeholders lack a clearly defined structure for providing lifecycle feedback to EPPT. Communication currently relies on individual initiative and personal contacts rather than any agreed way of working. This leads to feedback that is provided sporadically and inconsistently across departments, meaning that valuable lifecycle insights often fail to reach EPPT in a systematic way. This was reflected in both the open responses, where one respondent noted: "both responsibility and flow unclear, need more structure to report lifecycle feedback to newbuild", and the interviews, where one interviewee highlighted the need for clear communication points and defined responsibilities for who takes ownership of feedback and improvement ideas.

4.5.2 Issue 2: Lifecycle feedback not systematically considered in product development

The second key issue relates to how lifecycle feedback is considered within EPPT’s product development activities. While the first challenge focuses on the ES side, this gap concerns the receiving end. Lifecycle requirements and feedback are not systematically built into EPPT's product development processes, meaning that even when feedback is provided, there is no defined mechanism to ensure it is evaluated and acted upon. This was also supported by the interviews, where one interviewee highlighted that without a structured way to document and follow up on feedback, valuable lifecycle insights risk being lost, and another answer acknowledged that informal feedback received in meetings is easily forgotten.

4.5.3 Issue 3: Lack of a defined feedback tool

The third key gap concerns the absence of a defined tool for providing and managing lifecycle feedback. As seen in the earlier findings, the tools currently in use are primarily email and Teams, which are general communication channels not designed for systematic feedback collection, storage or follow-up. This means that feedback is scattered across multiple platforms, which makes it difficult to manage. This issue directly contributes to both previously identified issues. Without a structured platform, ES stakeholders have no clear channel through which to provide feedback, and EPPT has no mechanism to systematically capture and act on it.

These three key gaps formed the foundation for the improvement work carried out in the next phase of the research. The identified challenges were explored further through the workshop, where the findings were discussed and developed into a concrete proposal way forward, which is presented in the following chapter.

5 The proposal

This chapter presents the proposal way forward, developed collaboratively during the workshop where stakeholders from both units discussed and refined potential solutions from two complementary perspectives. The resulting proposal responds to the three key issues identified in the previous chapter through a structured feedback loop with defined responsibilities, an integrated tool, and clearly defined touchpoints in the existing processes.

5.1 From challenges to solutions

The three key issues identified in the previous chapter — the lack of a defined structure for providing feedback, the absence of systematic consideration of lifecycle input in EPPT's product development activities, and the missing dedicated tool — formed the basis for the improvement work done in the workshop. The goal was to build a solution that would tackle all three issues at the same time with a structured feedback loop. The outputs from both groups were combined into one cohesive proposal, presented in the following section.

5.2 Proposed way forward

The proposed way forward consists of three key elements, each targeting one of the key issues identified in Chapter 4. The feedback loop itself, which is built on the idea of single-loop learning, establishes the defined structure and responsibilities that were previously missing. The loop is described in more detail below. Alongside it, lifecycle feedback is integrated as a defined step in EPPT's existing product development processes, so it is not overlooked or left to individual initiative. Finally, detailed requirements for a dedicated feedback tool were specified during the workshop to provide the missing mechanism for capturing and communicating lifecycle knowledge across the two units. The more detailed definitions of each element are not disclosed in this thesis due to their confidential nature.

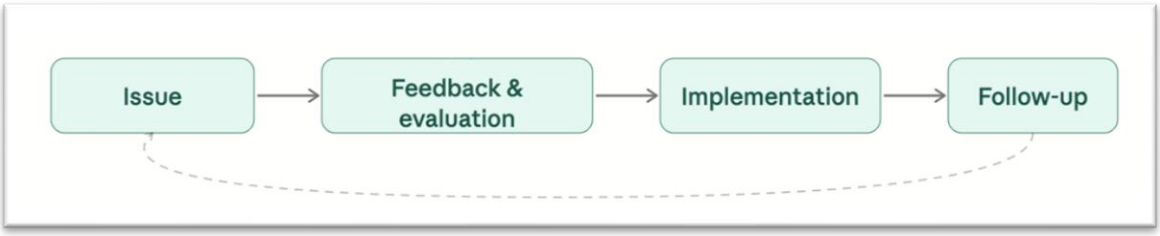

Figure 7. Feedback loop.

Figure 7 illustrates the four stages of the proposed loop. In the first stage, issue identification, lifecycle observations are collected and documented in a dedicated system using clear categories and clearly defined responsibilities for each type of feedback. In the second stage, feedback and evaluation, the collected feedback is reviewed together by representatives from ES and EPPT, who assess feedback relevance and decide on concrete action points. In the implementation stage, agreed actions are translated into clearly defined work tasks, each with assigned ownership, and the issue is resolved according to its nature and scope. When tasks are completed, they are formally closed during the follow-up stage, and the outcome is communicated back to ES. This confirms that the feedback has been addressed.

These three improvements — the four-stage feedback loop, the integration of lifecycle feedback into EPPT's product development processes, and the dedicated tool — each tackle one of the key issues identified in Chapter 4. Together these improvements create a clear structure and fill the gap that the current situation lacks.

6 Discussion and conclusion

The results of this study show that the lifecycle requirement and feedback flow between ES and EPPT lacks defined structure and relies on individual initiative, with three key challenges defining the current situation.

The findings were not completely surprising, as the study was initiated because the flow was recognised as insufficient. However, an interesting observation was that EPPT respondents rated the flow more negatively than ES, which suggest a disconnect between what is communicated and what is actually received and utilised.

The findings align with the theoretical framework of this study. The difficulties match the challenges of transferring tacit knowledge across organisational boundaries (Lartey et al., 2022; Nonaka, 1994) and the reliance on personal contacts reflects with silo dynamics described by Waal et al. (2019). The proposed feedback loop responds to these challenges and is supported by Akbar et al. (2018), who describe feedback loops as dynamic processes of organisational knowledge creation.

6.1 Theoretical and managerial implications

From a theoretical perspective, this study adds to the knowledge of how tacit knowledge transfer challenges play out in cross-functional organisational contexts. The findings show in practice how knowledge management, cross-functional communication and feedback loops are connected, not just theoretically but in real organisational life. The study also shows how single-loop learning can work as a practical framework for structuring knowledge transfer between functionally distinct units.

From a managerial perspective, the findings suggest that improving the feedback flow requires action on three fronts at once. Defining clear responsibilities and a structured way of working, embedding lifecycle feedback into existing development processes, and providing a dedicated tool are not independent solutions but three connected parts of a holistic solution. Addressing them in isolation is unlikely to bring lasting change.

6.2 Future research possibilities

Future research could build on this study's findings by examining the implementation of the proposed improvements in practice. This would involve evaluating which elements function as intended and identifying areas that require adjustment.

More broadly, this study addressed only one of the many knowledge flows that exist across the product lifecycle within Wärtsilä Energy. Future research could take a wider perspective and examine how lifecycle knowledge management could be developed more comprehensively across the entire product lifecycle, involving a broader set of organisational units and phases of the product. The limitations of this study are discussed in chapter 3.

6.3 Conclusion

This study examined the current state of lifecycle requirement and feedback flow between Energy Services and Engine Power Plants Technology within Wärtsilä, with the goal of identifying the key challenges and developing a concrete proposal for improvement.

The first research question asked how the current state of the lifecycle feedback and requirement flow between the two units is. The data shows that while some communication does take place, it is largely informal and driven by individual initiative rather than any agreed process or structure. Lifecycle knowledge is communicated sporadically through personal contacts, with no centralised mechanism for capturing or sharing it.

The second research question focused on what challenges hinder this communication. Three issues stood out. ES has no defined way of working or clear responsibilities for providing feedback to EPPT. Lifecycle input is not built into EPPT's product development processes. And there is no dedicated tool to support the collection and transfer of lifecycle knowledge.

The third research question asked how the situation could be improved. A proposal way forward was developed based on the findings and the workshop. A four-stage feedback loop was created to provide the missing structure and responsibilities. On top of that, the proposal includes integrating lifecycle feedback as a defined step in EPPT's product development processes, and detailed requirements for a dedicated tool were specified during the workshop.

Overall, the study shows that improving lifecycle feedback and requirement flow does not require fundamental organisational change, but rather clear structure, defined responsibilities and the right tools to make collaboration between the two units more systematic and effective.

References

Akbar, H., Baruch, Y., & Tzokas, N. (2018). Feedback loops as dynamic processes of organizational knowledge creation in the context of the innovations' front-end. *British Journal of Management*, *29*(3), 445–463. https://doi.org/10.1111/1467-8551.12251

Ameri, F., & Dutta, D. (2005). Product lifecycle management: Closing the knowledge loops. *Computer-Aided Design and Applications,* *2*(5), 577–590. https://doi.org/10.1080/16864360.2005.10738322

Argyris, C., & Schön, D. A. (1978). Organizational learning: A theory of action perspective. Addison-Wesley Publishing Company.

Babatunde, O. M., Munda, J. L., & Hamam, Y. (2020). Power system flexibility: A review. *Energy Reports, 6*, 101–106. https://doi.org/10.1016/j.egyr.2019.11.048

Bergh, D. D., D'Oria, L., Crook, T. R., & Roccapriore, A. (2025). Is knowledge really the most important strategic resource? A meta - analytic review. *Strategic Management Journal*, *46*(1), 3–18. https://doi.org/10.1002/smj.3645

Chung, J. Y. (2024). Stakeholder-engaged research: A multidisciplinary historical analysis. *Research for All, 8*(1), 6. https://doi.org/10.14324/RFA.08.1.06

Gaya, H. J., & Smith, E. E. (2016). Developing a qualitative single case study in the strategic management realm: An appropriate research design. *International Journal of Business Management and Economic Research, 7*(2), 529–538.

Goffin, K., & Koners, U. (2011). Tacit knowledge, lessons learnt, and new product development. *The Journal of Product Innovation Management, 28*(2), 300–318. https://doi.org/10.1111/j.1540-5885.2010.00798.x

Gupta, B., Iyer, L. S., & Aronson, J. E. (2000). Knowledge management: Practices and challenges. *Industrial management + data systems, 100*(1), 17–21. https://doi.org/10.1108/02635570010273018

Igba, J., Alemzadeh, K., Gibbons, P. M., & Henningsen, K. (2015). A framework for optimising product performance through feedback and reuse of in-service experience. *Robotics and computer-integrated manufacturing, 36*, 2–12. https://doi.org/10.1016/j.rcim.2014.12.004

Lartey, P. Y., Shi, J., Santosh, R. J., Afriyie, S. O., Gumah, I. A., Husein, M., & Bah, F. B. M. (2022). Importance of organizational tacit knowledge: Barriers to knowledge sharing. *Recent advances in knowledge management*. IntechOpen. https://doi.org/10.5772/intechopen.101997

Loock, M. (2012). Going beyond best technology and lowest price: On renewable energy investors' preference for service-driven business models. *Energy Policy, 40*, 21–27. https://doi.org/10.1016/j.enpol.2010.06.059

MacCarthy, B. L., & Pasley, R. C. (2021). Group decision support for product lifecycle management. *International journal of production research, 59*(16), 5050–5067. https://doi.org/10.1080/00207543.2020.1779372

Maier, C., Thatcher, J. B., Grover, V., & Dwivedi, Y. K. (2023). Cross-sectional research: A critical perspective, use cases, and recommendations for IS research. *International Journal of Information Management, 70*, 102625. https://doi.org/10.1016/j.ijinfomgt.2023.102625

Malinova, M., Gross, S., & Mendling, J. (2022). A study into the contingencies of process improvement methods. *Information Systems, 104*, 101880. https://doi.org/10.1016/j.is.2021.101880

Meyer, M., Fichtler, T., Koldewey, C., & Dumitrescu, R. (2022). Potentials and challenges of analyzing use phase data in product planning of manufacturing companies. *AI EDAM, 36*. https://doi.org/10.1017/S0890060421000408

Morse, J. M., Niehaus, L., Wolfe, R. R., & Wilkins, S. (2006). The role of the theoretical drive in maintaining validity in mixed-method research. *Qualitative Research in Psychology, 3*(4), 279–291. https://doi.org/10.1177/1478088706070837

Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science, 5*(1), 14–37. https://doi.org/10.1287/orsc.5.1.14

Nonaka, I., Toyama, R., & Konno, N. (2000). SECI, Ba and leadership, a unified model of dynamic knowledge creation. *Long range planning, 33*(1), 5–34. https://doi.org/10.1016/S0024-6301(99)00115-6

Nowell, L. S., Norris, J. M., White, D. E., & Moules, N. J. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods, 16*, 1–13. https://doi.org/10.1177/1609406917733847

Östlund, U., Kidd, L., Wengström, Y., & Rowa-Dewar, N. (2011). Combining qualitative and quantitative research within mixed method research designs: A methodological review. *International Journal of Nursing Studies, 48*(3), 369–383. https://doi.org/10.1016/j.ijnurstu.2010.10.005

Ørngreen, R., & Levinsen, K. (2017). Workshops as a Research Methodology. *Electronic Journal of E-learning, 15*(1), 70–81.

Saunders, M. N. K., Lewis, P., & Thornhill, A. (2023). *Research Methods for Business Students (9th ed.).* Pearson International Content. https://bookshelf.vitalsource.com/books/9781292402741 [restricted access]

Stark, J. (2011). *Product lifecycle management: 21st century paradigm for product realisation (2nd ed.).* Springer.

Sunnemark, F., Lundqvist Westin, W., Al Saad, T., & Assmo, P. (2024). Exploring barriers and facilitators to knowledge transfer and learning processes through a cross-departmental collaborative project in a municipal organization. *The learning organization, 31*(3), 358–374. https://doi.org/10.1108/TLO-01-2023-0003

Tucker, M. L., Meyer, G. D., & Westerman, J. W. (1996). Organizational communication: development of internal strategic competitive advantage. *The Journal of business communication, 33*(1), 51–69. https://doi.org/10.1177/002194369603300106

Waal, A. de, Weaver, M., Day, T., & Heijden, B. van der. (2019). Silo-Busting: Overcoming the greatest threat to organizational performance. *Sustainability, 11*(23), 6860. https://doi.org/10.3390/su11236860

Wärtsilä. (2025). Lifecycle requirements flow [Internal document]

Wärtsilä. (n.d.). About Wärtsilä. https://www.wartsila.com/about

Wynn, D. C., & Maier, A. M. (2022). Feedback systems in the design and development process. *Research in engineering design, 33*(3), 273–306. https://doi.org/10.1007/s00163-022-00386-z

Zohrabi, M. (2013). Mixed method research: Instruments, validity, reliability and reporting findings. *Theory and practice in language studies, 3*(2), 254–262. https://doi.org/10.4304/tpls.3.2.254-262

Appendices

Appendix 1. Survey Questions

Energy Services (ES) Survey

1. Your role in Energy?

2. Which lifecycle aspects are important in the power plant design and engineering considering your business line?

3. Do you think Engine Power Plants Technology is aware of these aspects?

4. Have these requirements been communicated with Engine Power Plants Technology?

* If answered 'No' → proceeded to Q5, then skipped to Q12.

* If answered 'Yes' → proceeded to Q6

5. Why haven't they been communicated?

6. Is there a process or standardized way to communicate these aspects and feedback?

7. Which systems or tools are used?

8. Here you can describe in more detail how the feedback flows in your situation.

9. Do you feel that actions have been taken based on your feedback?

10. How would you rate the feedback flow overall?

11. What doesn't work?

12. What is the single most important thing that could improve the feedback flow?

13. From your perspective, how should the feedback ideally flow?

Engine Power Plants (EPP) Survey

1. Your role in Energy

2. How much are you involved in EPP Technology development projects?

3. Have you received any requirements or feedback from Energy Services regarding lifecycle considerations?

* If answered 'No' → proceeded to Q4, then skipped to Q13.

* If answered 'Yes' → proceeded to Q5

4. Is there a clear reason why you haven't received any requirements or feedback?

5. From which business lines or functions have you received requirements or feedback related to lifecycle aspects?
6. Is there a standardized way or process for giving feedback?
7. Do you know where feedback is collected and do you have access to it?
8. Which systems or tools are used?
9. Is the feedback you receive systematically stored or documented?
10. Here you can describe in more detail how the feedback flows in your situation.
11. How would you rate the feedback flow overall?
12. What doesn't work?
13. What is the single most important thing that could improve the feedback flow?
14. From your perspective, how should the feedback ideally flow?