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Master's Thesis in Service Management

and Supply Chain Management

"Annie, Are You OK? Strategic Alignment of Aftermarket Distribution Network"

A Case Study in the Medical Simulation Sector

SMMP40 | 30 Credits

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Abstract

Global industrial providers increasingly recognize the aftermarket as a significant source of untapped value, yet many remain challenged in the pursuit of capturing it. This research examines a global medical simulation provider where the absence of strategic segmentation between primary product flows and the distribution of spare parts has produced persistent operational misalignment. Left unaddressed, such misalignment can seriously undermine service performance and aftermarket value realization, ultimately constraining a firm's capacity to leverage the aftermarket as a source of competitive edge.

This study adopts a Design Science Research (DSR) approach, utilizing the CIMO logic to structure the development of a managerial artifact aimed at strategically aligning the aftermarket distribution network with its operational reality. To address the underlying causes of this misalignment, a Current Reality Tree (CRT) is employed to deconstruct the ill-structured nature of aftermarket friction, surfacing the causal links between fragmented governance, misaligned performance metrics and KPIs, undifferentiated network design, and a fundamental mismatch between supply and demand. The diagnostic phase provides a rigorous empirical foundation for the following design of an intervention, ensuring that the artifact is grounded in the organizational realities of the case company, rather than generalized assumptions. Guided by the CRT findings and structured through the CIMO logic, the resulting artifact introduces a structural separation between aftermarket and primary distribution flows.

Keywords

Design Science Research, Aftermarket Logistics, Spare Parts Distribution, CIMO, CRT Analysis, Segmentation, Supply Chain Design, Segmented Distribution, Spare Part Management

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"We can't affect all possible outcomes or make everything come together exactly the way we want. But we can choose to act from our brightest intentions. We can take responsibility for the moral quality of our actions and our words. That's no small thing. It matters a great deal, and we can all do it." (Bjorn Natthiko Lindeblad, 2020).

This sentiment has been our guiding principle throughout this study, a reminder that while we cannot solve every complexity, the effort to design better, more aligned solutions is a responsibility that matters a great deal.

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List of Abbreviations

The following abbreviations and definitions are used in this study.

DSR	Design Science Research
CIMO	Context, Intervention, Mechanism, Outcome
CRT	Current Reality Tree
KPIs	Key Performance Indicators
OEMs	Original Equipment Manufacturers
SKUs	Stock Keeping Units
OM	Operations Management
SCM	Supply Chain Management
DND	Distribution Network Design
SCDN	Supply Chain Network Design
DCs	Distribution Centers
TCs	Technical Centers
SD Logic	Service-Dominant Logic
UDEs	Undesirable Effects
RCs	Root Causes
FLs	Facts of Life
ERP	Enterprise Resource Planning
CRM	Customer Relationships Management

1. Introduction

In the first chapter a background is provided for the thesis. This background will include the research problem and context, purpose, aim, research questions and delimitations of the study.

1.1. Research Background

The global industrial sector has been subjected to a fundamental transition from pure manufacturing models to service-centered economies. In this change, competitive advantage is no longer derived solely from the initial sale of finished goods, but from the ability to guarantee operational continuity and uptime throughout a product's lifecycle. Consequently, firms and original equipment manufacturers (OEMs) operating in high-stakes environments, such as medical simulation technology or industrial machinery, are under growing pressure to continuously deliver value through aftermarket services (Zanjani & Nourelfath., 2014). As posited by McKinsey & Company, organizations investing in industrial equipment increasingly expect products to operate reliably, with minimal downtime, predictable maintenance, and reduced exposure to unexpected repair costs (Kervazo et al., 2025). These expectations highlight how aftermarket performance has become closely related to customer satisfaction and long-term competitiveness, particularly in uncertain environments where reliability and availability are critical factors.

The aftermarket is an intricate environment, which includes several different operations. However, there are some dominating operations taking place, including technical field service, maintenance, customer service, accessories sale and spare parts distribution (Wagner et al., 2012; Gupta et al., 2024; Kervazo et al., 2025). Furthermore, it expands by integrating secondary market transactions, such as product recovery processes and return flows, and various external actors, such as third-party logistics providers, distributors and end-users. Therefore, the aftermarket can be understood as a system where service generates value continuously, rather than through transactional exchange. Vesco (2024) supports this by highlighting that top performers in the aftermarket reap the benefits of double total shareholder returns, and that a successful aftermarket operation can increase revenue up to 40% in the span of a few years. It then becomes evident that the aftermarket is a primary stage where value is co-created and sustained, customers are retained and revenue is generated (Cohen et al., 2006).

The complexity of the aftermarket is not unique to a single industry or firm, but can be observed across a wide range of industrial contexts. Saccani et al. (2007) highlights issues in the automotive industry, and note that multiple companies deal with complexities related to large amounts of Stock Keeping Units (SKUs) and unstable demand. Furthermore, as noted by Sherbrooke (2004), spare parts management in the aerospace industry requires differentiated strategies to balance cost-service trade offs due to high variability and criticality of components. Similarly, equipment manufacturers face the challenges of handling long product lifecycles and global networks, leading to a large portfolio of products that requires availability of spare parts (Cavalieri et al., 2007; Vesco., 2024). A consistent pattern observed in these sectors is that the traditional supply chain models and distribution networks are insufficient in handling the variable demand of spare parts and the complexity of the aftermarket, while also generating value through service.

According to Wagner et al. (2012), strategic planning in spare parts logistics has become a necessity due to shifting market dynamics, such as global competitive pressure and technical equalization. In this environment, the supply chain becomes the real product; it is no longer about selling a piece of equipment, but rather selling the assurance that the equipment will always work. To capture the unutilized potential of this shift, which is characterized by high profit margins and long-term customer loyalty, service providers must balance and prioritize a series of elements (Cohen et al. 2006). Competitive advantage is then increasingly dependent upon the ability to configure satisfactory distribution networks in the aftermarket, but due to structural complexity and vast amounts of SKUs, the aftermarket often relies on existing structures rather than distinct strategic designs. Without a dedicated, segmented design for aftermarket logistics that accounts for the unique behavior of spare and service parts, the aftermarket will then remain an afterthought (Wagner et al., 2012; Kervezo et al., 2025).

1.2. Research Problem

The strategic importance of the aftermarket is becoming increasingly difficult to ignore. In capital-intensive industries such as aerospace, industrial equipment manufacturing and medical technology, aftermarket services hold a great majority of margin potential, outweighing the initial sale in terms of long-term financial value (Cohen et al, 2006; McKinsey & Company., 2017). Yet, despite this recognized value potential, a persistent gap exists between strategic intent and operational execution, one that manifests most explicitly in how firms design and manage their aftermarket distribution networks.

The source of this gap lies in a structural misalignment, where aftermarket distribution is designed using the same logic as primary production flows, in spite of the two operating under fundamentally different demand conditions. Hence, when these distinct operations are merged, as is common in firms where the aftermarket remains secondary to traditional manufacturing, the resulting friction undermines both service performance and operational responsiveness. The aftermarket is not simply the downstream execution of production; it constitutes a distinct supply chain domain that requires its own configuration logic.

The operational consequences of this misalignment are well-documented. Capital becomes trapped in overstocked or obsolete inventory at central distribution hubs, while regional operations lack the critical spare part availability needed to service customers in a timely manner (Cohen et al., 2006). Delayed deliveries, low inventory visibility, and inconsistent service availability are symptomatic consequences, but the underlying cause is not poor execution, it is the absence of distribution design logic native to aftermarket conditions. In the absence of such a logic, service teams and aftermarket stakeholders are reduced to a reactive capacity, which ultimately precludes strategic planning and erodes customer trust.

This deterioration carries consequences that extend beyond operational inefficiency. Prolonged equipment downtime and interrupted customer operations impose direct financial and reputational costs on the firms responsible for service delivery (Kervezo et al., 2025). More strategically significant, however, is the opportunity cost, firms that remain structurally incapable of translating aftermarket potential into reliable service performance forgoes a durable source of competitive differentiation. Rather than functioning as a value-generating capability, the aftermarket is relegated to a cost center, a position that reflects not a lack of strategic ambition, but a shortfall of organizational means to realize it.

This research is motivated by the observation that existing frameworks for supply chain network design and inventory management have been largely developed in the context of primary production flows, and do not adequately address the unique characteristics of the aftermarket (Cohen et al., 2006; Gupta et al., 2024). In the absence of a segmented, scientifically grounded logic for network configuration, the aftermarket remains characterized by internal fragmentation and operational misalignment. This research problem ultimately translates into a state of latent market potential, where firms find themselves technically capable of providing high-level service, yet strategically constrained by a distribution structure that has yet to bridge the gap between central efficiency and regional requirements. It is this gap, between the strategic recognition of aftermarket value and the structural capacity to capture it, that this thesis seeks to address.

1.3. Aim

The aim of this thesis is to design and evaluate a managerial artifact for strategically aligning the aftermarket distribution network configuration with the operational demands of a global medical simulation provider. The phenomenon of aftermarket distribution is studied through the empirical context of a global case company to provide a deeper understanding of operational challenges. By adopting a DSR approach, the study seeks to bridge the gap between theoretical operations management literature and practical operational design. The choice of a DSR approach is reasoned in its ability to act as an integration between theory and practical design, by aiming to develop a solution to a problem (Hevner et al., 2004).

To ensure a rigorous design process, this study utilizes the CIMO logic (Context, Intervention, Mechanism, Outcome). Within this logic, the Current Reality Tree (CRT) is used to define the existing context and environment, ensuring that the resulting intervention is precisely designed to trigger the mechanisms required for optimized network distribution configuration.

1.4. Research Questions

In light of the aforementioned context and problem, this study aims to seek answers to the following research question(s):

RQ1: What are the core problems of the current operational misalignment within the aftermarket distribution network?

RQ2: How can a segmented distribution framework be developed as a mechanism to optimize aftermarket component availability?

1.5. Delimitations

This study is delimited to aftermarket spare parts distribution and excludes activities upstream in the supply chain such as product design, manufacturing and planning, innovation and introduction of new products. These areas may have significant influence on spare parts from a long-term perspective, but they are outside the scope of this research as the focus lies in studying mechanisms related to distribution and replenishment. In addition, this thesis focuses on structural network design and governance, encompassing decisions regarding network configuration, inventory principles, and distribution strategy. Outside the scope lies short-term operational considerations such as for example daily scheduling, local inventory decisions, and individual ordering. Additionally, long-term monitoring and implementation follow-up of the proposed interventions is outside the scope of this thesis, but acknowledged as a suitable field for future research.

Furthermore, the thesis is also delimited to physical spare parts, excluding aspects of the aftermarket related to software, digital services, preventative maintenance, consumables, and provision of information. This is due to the fact that these aspects, although important for the aftermarket, differ significantly from physical spare parts in the form of demand and overall operational handling.

2. Literature Review

This chapter covers previous literature concerning aftermarket operations and logistics. It seeks to provide an overview of the key knowledge contributions in this area of research. It contains various sub-themes that all affect aftermarket operations.

2.1. Operations Management

Operations Management (OM) is identified as a field of various functions that all facilitate the achievement of organizational goals through the efficient utilization of resources (Chase et al., 2006; Krajewski et al., 2011). While the field was historically anchored in the principles of Scientific Management, with research focused on labour productivity, standardized task optimization, and mathematical production control models (Skinner, 1985; Hopp & Spearman, 1995), its scope has expanded considerably alongside the industrial shift toward service-oriented functions (Bayraktar et al., 2007; Cohen et al., 2006). This evolution reflects a broader recognition that operational processes could not be adequately understood through factory-floor logic alone, that the complexities of real-operations demanded both empirical grounding and a more holistic view of how organizations create and deliver value across global supply chains (Flippini, 1997; Bayraktar et al., 2007). Emphasizing this multi-functional scope, Chopra & Sodhi (2004) define the area of OM as the design and management of transformation processes that produce value for society.

Contemporary OM is therefore understood as operating on two distinct but interdependent levels. At the strategic level, it concerns the configuration of value chains, network design, and the alignment of operational capabilities with long-term organizational goals. At the operational level, it governs the day-to-day processes through which those capabilities are executed, monitored and adjusted in

response to demand characteristics (Chase et al., 2006; Krajewski et al., 2011). The tension between these dual levels, where strategic intent fails to translate into operational reality is a recurring theme in literature and constitutes one of the field's most significant challenges. It is precisely this dual-level character, and the misalignments it can produce, that makes OM the natural theoretical foundation for examining how aftermarket distribution networks are configured.
A further significant shift occurred with the integration of computing, which gave rise to Material Resource Planning (MRP) systems. These systems characterized a "push-type" environment, where production schedules were dictated by top-down, deterministic circulations (Orlicky, 1994). This centralized logic was eventually challenged by the rise of Japanese manufacturing philosophies, most notably just-in-time (JIT) and the Kanban method, which introduced "pull-type" production and shifted the academic focus from supply-driven output to demand-driven flow (Bayraktar et al., 2007). This transition was codified by the seminal work of Womack et al. (1990), whose analysis of lean production transformed OM into a critical and functional discipline by demonstrating that competitive advantage was no longer found solely in manufacturing speed, but in the strategic alignment of product development, operational processes and performance metrics.

This trajectory further accelerated in line with the increasing dependency on digital networks and real-time information flows between suppliers, manufacturers and customers. As Bayraktar et al. (2007) note, this connectivity brought growing recognition of SCM as a tool for inter-organizational integration, and as a key field in contemporary OM research. Hence, strategic alignment between overarching supply chain strategy and the logistical capacity of an organization has become a central preoccupation of the field, precisely because the gap between the two levels is where competitive advantage is often lost (Bayraktar et al., 2007).

2.2. Spare Parts Management

Unlike traditional manufacturing supply chains, spare parts distribution and management is characterized by a degree of uncertainty that necessitates different distribution mechanisms and network designs (Zanjani & Nourelfath., 2014). The movement of traditional products corresponds with what Cavalieri et al. (2008) refers to as a smooth demand pattern, where demand is relatively stable with modest variations of demand size. However, spare parts are more often characterized by intermittent demand, which appears randomly with some time periods having no demand at all, making traditional forecasting and supply chain planning less effective in the aftermarket (Cohen et al. 2006; Cavalieri et al., 2008; Wagner et al., 2012).

Therefore, spare parts distribution exemplifies a “wicked problem”, a challenge that is not only characterized by difficulty, but an inherent resistance to a single, definitive solution (Rittel & Webber, 1973; Gupta et al., 2024). According to Gupta et al. (2024), such problems are defined by a high degree of complexity, and a diverse array of stakeholders with differing perspectives. This is further compounded by an evolving nature where the problem itself shifts when the market context changes, making it a recurring theme in OM and SCM. Finally, wicked problems lack a clear solution, and they are pervasive across the value chain, emerging from the complex combination of market variations, supply and demand forces, and organizational structure (Holmström et al., 2009; Gupta et al., 2024).

The wicked problem is further perpetuated due to the tendency of firms to group the aftermarket chain and the traditional supply chain under the same operations, rather than systematically separate them into two separate chains (Cohen et al., 2006; Wagner et al., 2012; Zanjani & Nourelfath., 2014). Huiskonen (2001) notes that the different characteristics of spare parts in relation to regular goods creates pressure on the aftermarket logistic process and the efficiency of spare parts distribution. Examples of such characteristics are considerable financial effects of stockouts, higher expectations of service levels, sporadic demand, difficult forecasting, high variation of pricing and complexity of parts. The management of these trade-offs is further strained when organizational functions fail to align their strategic objectives with operational realities, rendering the aftermarket problem truly wicked.

2.3. Strategic Alignment

A fundamental theme within the aftermarket literature is strategic alignment. As noted by Persson and Saccani (2009), the academic and managerial discourse has shifted from viewing the aftermarket as a secondary burden to manufacturing activities, to recognizing it as a value-adding activity. Such a shift highlights the need for the logistics network and supply chain to be strategically aligned in order to deliver specific customer values, rather than uniform production outputs. Achieving the inherent potential of the aftermarket requires such alignment, which Wagner et al. (2012, p. 70) define as "the adjustment of an object in relation to other objects so that the arrangement can lead to the optimization of results". In the context of the aftermarket, strategic alignment recognizes the necessity of addressing both external market conditions and internal organizational arrangements. This ensures that products, processes, organizational structures and systems are harmonized to support overarching business goals.

To meet the strategic demands of the aftermarket, Huiskonen (2001) emphasizes that the design of a distribution network cannot be performed in isolation from other dimensions within a supply chain system. The aftermarket must be distinguished and strategically designed to accommodate the high degree of heterogeneity in demand, cost, and criticality across various SKUs. As supported by Cohen et al.

(2006), who identify poor integration and the misapplication of manufacturing logic to service networks as primary drivers of aftermarket failure. To counter such misapplication, Armistead & Clark (1991) posit that the starting point for effective aftermarket operations must be the firm's competitive strategy, which is subsequently translated into functional and operational strategies.

Performance is thus dependent upon its interaction between logistics and broader supply chain aspects, such as product design and demand considerations. Wagner et al. (2012) argue that because primary product parts serve as the templates for spare parts, high-performing firms must integrate aftermarket requirements into the early stages of product design. At its core, the main objective of any strategy and inventory management system is to fulfill the desired service level, while optimizing inventory, logistics investments and costs (Huiskonen, 2001). As further proposed by Huiskonen (2001), a primary mechanism for achieving this coordination and alignment is supply chain segmentation, a concept that allows for differentiated management of parts based on their specific characteristics and requirements, which will be further explored in the next section.

2.4. Supply Chain Segmentation

The concept of market segmentation, often referred to as segmentation theory, was pioneered by Smith (1956), and has been thoroughly established in both literature and practice. However, the application of this theory in supply chain management was only solidified in research during the past decade (Godsell et al., 2011). Smith's influential work challenges classic economic assumptions of market homogeneity and perfect competition, arguing that real-world markets are, on the contrary, characterized by imperfect competition and a fundamental diversity in both supply and demand.

According to Smith (1956), segmentation is a demand-side concept, in which it involves tailoring supply chain efforts to meet specific user requirements by dividing products or customers into different segments. Furthermore, the depth of a market position stems from a firm's ability to effectively define and penetrate such segments, allowing for a precise alignment of resources with different customer needs (Smith, 1956). However, applying this concept in the aftermarket is challenging, where product heterogeneity is more pronounced. Here, supply diversity is driven by fragmented production methods and unequal progress in product development among competitors, which fuels the 'SKU explosion', referring to the dramatic increase of unique parts required by a company to manage the aftermarket (Cohen et al., 2006; Persson & Saccani, 2009). In this situation, the precise alignment suggested by Smith (1956) then becomes a hurdle in terms of logistics operations, specifically spare parts distribution.

Due to this heterogeneous nature of spare parts demand, a one-size-fits-all philosophy and logistics design, applied to both original equipment and spare parts, cannot achieve both high service levels and cost efficiency (Huiskonen, 2001; Wagner et al., 2012). The demand for spare parts can be further distinguished in terms of various factors such as volume, criticality, variability, lifecycle stage, and technological compatibility, which results in a multi-dimensional complexity of the aftermarket. This is what Gupta et al. (2024) refers to as the 'wicked problem', where supply, demand and internal inventory variance interact across complex network structures. Hence, by differentiating strategies and network configuration across segments, firms can better align internal capabilities with external requirements.

2.4.1. Schools of Thought

A critical tension exists in the literature regarding how segments should be defined. While Smith (1956) framed segmentation as a demand-side strategy, identifying groups with similar needs and tailoring offerings to match, modern supply chain discourse suggests that a holistic strategy must also reflect product characteristics (Godsell et al., 2011). This has led to the emergence of two primary schools of thought.

1. The School of Lean-Agile

The first school of thought noted by Godsell et al. (2011), is largely influenced by the work of Fisher (1997) and later expanded by Christopher & Towill (2000). This school argues that supply chain strategy must be driven by product characteristics, specifically volume and demand variability. This paradigm utilizes the concept of Order Winners (OW) and Order Qualifiers (OQ) to determine the appropriate logistics pipeline, i.e. choosing the most appropriate pathway or method to transport a product from a warehouse to the end-customer, based on how that product behaves in the market.

A primary contribution of this school is the DWV3 framework, which categorizes products based on lifecycle duration, delivery windows, volume, variability and variety (Christopher & Towill, 2000). By profiling demand through these characteristics, it enabled firms to reconcile the Lean paradigm, focused on cost-efficiency and waste elimination for stable, high-volume parts. On the other side, the Agile paradigm prioritizes responsiveness and availability for volatile, low-volume components.

2. The Strategic Alignment School

Compared to the product-driven models, the Strategic Alignment school seeks to formalize the link between market requirements and organizational culture. Rooted in the "alignment theory” of Chorn (1991) and Gattorna (1998), this school suggests that a supply chain’s effectiveness depends on the synergy between four competitive forces; situation, strategy, organizational culture and leadership style (Godsell et al., 2011).

In the aftermarket, this implies that segmentation must go beyond SKU data to reflect the behavioral logic of the customer. Whether a segment requires an administrative logic focused on cost or an integrative logic focused on rapid system uptime, the firm’s internal processes must be harmonized with these external service expectations. This understanding further ties to Wagner et al’s. (2012) definition of alignment. As Godsell et al. (2011) conclude, a truly effective supply chain capability must combine both market segment considerations and product characteristics to avoid the pitfalls of over-serving or under-serving critical customer groups.

2.5. Network Design

In supply chain and logistics, the configuration of the network structure is seen as the physical manifestation of a company’s strategy (Tsiakis et al., 2001; Persson & Saccani, 2009). While Distribution Network Design (DND) is a well-documented concept in literature, the actual use in daily operational decisions is often overlooked. As noted by Asmussen et al. (2018), most research focuses on design rules, but neglect the internal process of how organizations actually make such decisions. Because of this gap, the performance of distribution networks, especially in complex global value chains, is often not fully understood (Reich et al., 2021).

2.5.1. Supply Chain to Distribution

At a strategic level, supply chain network design (SCND) represents an end-to-end optimization challenge. It encompasses the entire value chain, from upstream production points and supplier sourcing to downstream customer markets, by determining the physical placements of facilities, selecting transportation modes, and allocating capacity across a network of various suppliers, customers, products and components (Mangiaracina et al., 2019; Reich et al., 2021). Building upon this broad foundation, DND functions as a subset focused specifically on the downstream segment. This involves configuring the flow of finished goods through various facility types and hierarchical levels, commonly referred to as echelons. These echelons serve as the designated nodes where inventory is strategically positioned to meet market demand efficiently (Cohen et al., 1986; Tsiakis et al., 2001; Mangiaracina et al., 2019). A primary method for determining the structure of a distribution network involves evaluating the number of echelons, and as Rodrigue (2024) suggests, the complexity of a network is generally proportional to the number of echelons it incorporates. Managing these echelons effectively therefore requires a synthesis of strategic and operational decisions, ranging from the geographical location of facilities to more tactical inventory allocation choices (Tsiakis et al., 2001; Mangiaracina et al., 2019).

2.5.2. Distribution Strategies

As a result of intermittent demand and particular product characteristics, the network structure of the aftermarket chain becomes a strategic challenge, typically necessitating a multi-echelon network structure, where central hubs replenish locally dispersed warehouses (Jacobs et al., 2017). However, realizing successful operations in the aftermarket depends on how well the physical network is aligned with its products, but also with the overarching service strategy (Godsell et al., 2011). Expanding on network design, Huiskonen (2001) argues that for a segmented distribution network to function, the broader logistics system must be designed across four key elements: strategy/processes, network structure, relationships and coordination. In which, strategy and processes refer to the support required from other functions in achieving the defined goals of different segments, and the network structure determines the physical echelon configuration. Furthermore, the management of relationships considers the level of collaboration and risk-sharing with suppliers. Finally, coordination and control systems ensure that information flows and performance metrics are aligned with the overarching goals of the entity (Huiskonen, 2001).

Building upon Huiskonen's (2001) proposition, Jouni et al. (2011) suggests that the effectiveness of these four elements, depends on the magnitude of variability across three aspects: supply, demand and internal inventory. Supply variance can for example be measured through availability constraints, lead time variance, and variance of availability. Demand variance, on the other hand, can be evaluated based on frequency and variability of demand, as well as price sensitivity. Lastly, the variance of internal inventory can be measured through internal processes regarding replenishment, ordering batch sizes and planning frequency. Factors within network configuration, such as the number of echelons, can have direct influence on the degree of variability across the distribution chain (Jouni et al., 2011). By acknowledging these variances, the authors emphasize that spare parts management is inherently multi-dimensional, necessitating central management in driving performance of the distribution chain.

2.5.3. Decision Domains in DND

The academic discourse further deconstructs DND into several tightly connected decisions. Rosenbaum (1981) examined two-level systems consisting of factory-supplied DCs and regional fulfilment centers. Through the application of heuristics, Rosenbaum demonstrated that total stock levels could be minimized by calculating specific levels for each echelon that collectively meet the required customer service threshold. Complementing this view, Tsiakis et al. (2001) categorize the network design process into four critical decision domains: location decisions, production decisions, inventory management and transportation decisions. Furthermore, Persson & Saccani (2009) propose that the architecture of a distribution network is shaped by strategic decisions regarding vertical integration, transportation systems, warehouse localization, and stock allocation, alongside the total number of echelons employed.

Arnäs & Woxenius (2013) expands the network design discussion by including the perspective of how heterogeneous goods can be handled in distribution and transportation. Heterogenous goods are defined as products that fall outside the standard procedures of the distribution network due to either physical or operational abnormalities. It is however important to note that limits for what goods are considered heterogeneous varies between actors (Arnäs & Woxenius, 2013). In this case, spare parts are considered heterogenous due to characteristics such as irregular demand and special handling requirements (Huiskonen, 2001). An implication of this is that in large-scale distribution systems based on standardized handling, heterogeneity may increase costs as these products cannot be molded into a standardized system and be easily consolidated within intermodal freight systems. To handle heterogeneous products, the distribution system must bridge differences not only in capacity, frequency and timing, but also in the physical and regulatory requirements of the goods themselves.

2.5.4. Topology in Spare Parts Distribution

Wang & Lin (2021) further argues that spare parts require distribution networks that differ from traditional goods, and propose that the most suitable network configuration can be derived through a modified scale-free topology. A scale-free network is understood as a network where a few major distributors act as central hubs while smaller nodes only have a few connections which enables efficient connectivity between hubs (Wang & Lin, 2021). The authors extend the standard scale-free network design, which only sort nodes based on number of connections, to include inventory capacity and transit time in decisions regarding what nodes should be connected. The optimal handling of spare parts is hence achieved through a decentralized network where the parts can flow through short and adaptive paths (Wang & Lin, 2021). Furthermore, a key point made by the authors is that spare parts management requires collaborative replenishment, where distributors have the opportunity to source from other nodes rather than completely depend on central facilities. The configuration suggested by Wang & Lin (2021) is likely to improve network robustness while also decreasing lead times, hence improving the ability of the system to respond to the intermittent demand of spare parts.

Basten & van Houtum (2014) further discusses how distribution networks are commonly configured by OEMs responsible for maintaining their own after-sales services, including spare parts distribution. They observe that three-echelon structures are the most prevalent, followed by two-echelon structures. In these networks, the middle echelon often functions as the primary provider of emergency fulfillment to support rapid deliveries. The authors also highlight the frequent use of lateral transshipment between warehouses to improve responsiveness and enable inventory pooling, which aligns with the emphasis on collaboration identified by Wang & Lin (2021). Further the authors reach the conclusion that the heterogeneity and variability of spare parts management require decentralized connectivity and flexible replenishment in the DND (Basten & van Houtum, 2014; Wang & Lin, 2021).

2.6. Literature Gap

The literature reviewed in this chapter establishes robust theoretical foundations across OM, strategic alignment, supply chain segmentation, network design and spare parts management, yet a specific blind spot remains at their convergence. Existing segmentation frameworks were developed primarily for primary production contexts and do not account for the critical, unstable demand nature of aftermarket flows (Cohen et al., 2006; Wagner et al., 2012; Basten & van Houtum, 2014; Gupta et al., 2024). Meanwhile, aftermarket research has largely diagnosed the problem of undifferentiated distribution without providing actionable insights suited to global network realities. DSR offers the methodological means to bridge this gap, translating theoretical insights into a managerial artifact, but has seen limited application in the aftermarket domain specifically.

3. Theoretical Framework

This chapter establishes the main theoretical basis for this thesis, which aims to synthesize SD Logic and Strategic Alignment Theory, in order to provide a solid theoretical baseline for aligning global distribution models with the value-in-use and operational requirements of the aftermarket.

The following section introduces two theoretical frameworks that will be used to effectively investigate how a segmented distribution framework can be applied to strategically align aftermarket network configuration at the case company. Service-Dominant (SD) logic provides the overarching theoretical lens for this study, positioning the aftermarket as a primary arena for value co-creation, and spare parts distribution as the vehicle for service value realization (Vargo & Lusch, 2004). The Strategic Alignment Theory serves as a mid-range theory that translates the abstract concept of service value realization and competitive advantage into managerial actions through alignment of internal capabilities, and segmentation as a key value facilitator (Fisher, 1997).

3.1. Service-Dominant Logic

SD logic, as introduced by Vargo and Lusch (2004), changes the traditional view of purchasing a product as a means for money in exchange for value, to a new understanding that views product or goods as a distribution mechanism for value. According to SD logic, value is co-created in the use of the product, rather than generated at the point of sale. Seen through this perspective, SD logic represents the core thought of the aftermarket, where the goal is to generate value for the customer through the supply of spare parts to uphold the current installed base and product lifecycles. This is in line with the argument that manufacturing supply chains and aftermarket supply chains are fundamentally different and that the misapplication of manufacturing logic to service networks, such as the aftermarket, is a primary driver of the 'wicked problem' (Cohen et al., 2006; Gupta et al., 2024).

3.2. Theory of Strategic Alignment

Assuming that aftermarket supply chains are inherently different from manufacturing supply chains, and requires a different logic to generate value, the concept of strategic alignment becomes central. To handle these differences, the reviewed literature indicates that distribution channels in the aftermarket must be strategically designed to match the specific characteristics of aftermarket components. While SD logic is important for establishing the strategic importance of a firm's performance in the aftermarket, Strategic Alignment Theory is useful in translating SD logic into operational design of distribution channels in the aftermarket.

Fisher (1997) extended the concept of strategic alignment from the field of IT, where it was initially developed by Henderson & Venkatraman (1999), into OM by arguing that misalignment between product characteristics and supply chain design causes poor performance. In Fisher's (1997) extension, heterogenous products with uncertain demand were segmented as innovative products, while homogeneous products with certain demand were segmented as functional products. Although his work is based on traditional goods rather than spare parts, the essentials of the alignment itself, meaning that demand characteristics must steer the structural configuration of distribution, is still highly applicable. Fisher's (1997) framework was empirically tested by Wagner et al. (2012) who examined the alignment of supply chain strategy and spare parts distribution. His findings show that firms that experience misalignment between contextual factors and supply chain strategy experience lower financial outcomes and measurable performance deterioration (Wagner et al., 2012).

Furthermore, the findings of Armistead and Clark (1991) regarding a firm's competitive positioning can be connected to Strategic Alignment Theory. The authors suggest that alignment between operations and competitive strategy is critical for a firm's success, furthermore that manufacturing and after sales support cannot be designed in isolation. The competitive strategy thus serves as a base for the provision of support in the aftermarket, and the system delivering that support must be designed to match the support task in question (Armistead and Clark, 1991).

In this research, the Strategic Alignment Theory is used in order to construct a managerial artifact seeking to achieve a strategically aligned aftermarket and distribution network configuration. By using alignment as a theoretical mechanism to connect these two domains, segmentation is viewed as the operational mechanism necessary to ensure strategic alignment in the aftermarket, thus facilitating a segmented distribution network.

3.3. Critique of the Theoretical Frameworks

While SD logic has enjoyed over a decade of academic recognition, as a primary framework for understanding the transition toward service-minded economies, it has faced academic scrutiny. A central criticism of SD logic fronted in literature concerns its tendency to obscure the complexities of social relations (Hietanen et al., 2017). By prioritizing the concepts of value-in-use and co-creation of value, the logic has a tendency to conceal underlying labour and power dynamics that sustain service systems. This abstraction is argued to turn "service" into a seemingly magical process that appears to be producing value on its own (Arnould, 2007; Hietanen et al., 2017). Another major critique of SD logic concerns its reliance on a circular argument, regarding the definition of "service". Wright & Russell (2012) argue that by defining all economic exchange as service, including physical goods, the logic becomes nearly impossible to disprove, yet it fails to provide empirical evidence that this definition actually leads to positive business outcomes.

Expanding the critique to strategic alignment, one must consider three perspectives. The first critique is presented by Ciborra (1997) who argues that alignment often is far more complex and volatile than suggested in models, which aggravates the implementation of stable alignment. Excessively relying on top-down understanding of organizational relations and strategy in practice may exclude the perspective of the complex nature of organizational processes (Ciborra, 1997). Chan & Reich (2007) further note that the concept of alignment itself, although useful, is multi-dimensional and should not be viewed as a static, single-dimensional process or concept. The concept of alignment may then be difficult to apply practically due to difficulties based on conceptual ambiguity and measurement difficulties (Chan & Reich, 2007). Moreover, Tallon (2007) argues that strict coherence to a system based on strategic alignment may inhibit an organization's ability to respond to rapid changes, hence rendering the organization less agile.

The implications of these critiques suggest that while SD Logic and Strategic Alignment provide a sophisticated base for service transition, they risk overstating the harmony of co-creation and the stability of organizational processes. By acknowledging that these frameworks can be circular or overly top-down, this study remains vigilant against treating value creation as a frictionless process, instead using empirical data to uncover hidden strains and frictions that the theory might otherwise obscure. We proceed with these frameworks as essential *diagnostic lenses* as they are particularly fitting for the aftermarket, where value is not found in the initial sale, but in the availability of spare parts.

3.4. Design Science Research (DSR) in OM and LSCM

Historically, research in OM and SCM has been largely ruled by the paradigms of natural and social sciences, focusing on exploring, describing and explaining existing phenomena (Romme, 2003; Van Aken, 2004; Dresch et al., 2019, Wiegmann et al., 2023). This focus, while theoretically rigorous, frequently overlooks the prescriptive needs of managers seeking to improve operational performance. Moreover, there has been a growing concern amongst major scientific communities such as the Production and Operations Management Society (POMS) that there exists a prominent gap between academic theory and industrial practice, noting that fewer organizations actually utilize operations research (Singhal et al., 2014; Dresch et al., 2019; Roth & Singhal., 2022). This concern is further echoed by Näslund (2024), who states that OM research is becoming increasingly esoteric, i.e. intended for a small group of people with specialized knowledge or interest.

To address this tension, DSR has been recently (re)discovered as a practice-oriented research philosophy (Ivan Su et al., 2020; Näslund, 2024). Unlike traditional explanatory research, DSR seeks to explore new solution alternatives, explain the explorative process, and improve problem-solving itself (Simon, 1996). DSR addresses these complexities by focusing on the development of a “means to an end”, formally defined as an artifact. An artifact, which Hevner et al. (2004) define as a construct, model, method, or instantiation, represents the purposeful entity developed by the researcher to solve the identified problem. As Dresch et al. (2019) argue, there is a strong wish to bring practitioners and researchers closer together, where DSR can be seen as a methodology that facilitates this. Building upon these requirements for interdisciplinarity and theoretical scrutiny, the development of DSR has provided a structured framework that aligns with SD logic and ensures strong practical implications (Peffers et al., 2007; Holopainen et al., 2020).

4. Methodology

This chapter outlines the chosen research design and methodological framework employed to address the identified aftermarket challenges, moving from overarching philosophy to the specific methods used for data collection. It details the chosen research strategy, the case company selection, and reflexive and ethical considerations that guides the research.

4.1. Research Philosophy

According to Clark et al. (2021), the quality of research is related to the explanation of philosophical positions taken and how these assumptions are used to guide understandings of reality and generation of knowledge. Discussions of philosophical positions allows for coherence between the research problem and chosen strategy, and creates a base for the understanding of how knowledge is created, viewed, obtained and validated in this study. Ontology refers to the nature of reality and regards any debate about how it is to be, while epistemology concerns the nature of knowledge and the debate of what is worth knowing (Clark et al., 2021).

4.1.1. Researcher's Philosophical Positions

This study takes upon a constructionist ontological position which explains that reality is created through social interactions and understandings rather than existing independently of social actors (Clark et al., 2021). Phenomena such as organizational practices and strategies are not fixed entities, but are continuously shaped by the affected individuals. In the context of the aftermarket, practices are influenced by how people understand and interpret factors such as product characteristics, service requirements, and operational constraints. Therefore, practices within an organization are not understood as merely systems, but as organizational constructs. This ontological position acts as the basis for the method of semi-structured interviews, as the analysis seeks to understand how professionals within an organization view spare part management and how these understandings influence the design of distribution strategies.

Furthermore, this study adopts an interpretivist epistemological standpoint. This perspective assumes that knowledge is generated through the understanding of how humans interpret and give meaning to their experiences and reality (Clark et al., 2021). In the context of operations management and the aftermarket, this standpoint explains that the aim is to develop a deeper understanding of how professionals understand and interpret the challenges of the aftermarket, and to develop an understanding of how to conceptualize these challenges in the specific context of the case company.

4.1.2. Scientific Reasoning

In qualitative methods, the research starts from the perspective of the subjects studied, and the objective of the research involves the generation of knowledge through the engagement with appropriate actors (Clark et al., 2021). This study does not take a purely inductive or deductive approach, but rather an abductive approach where the focus lies in understanding and identifying underlying patterns of a social phenomena, which is also frequently used in DSR (Holmström et al., 2009). Abductive reasoning is conducted through an iterative process where development and understanding is generated through alternation between theory and empirical material (Clark et al., 2021). In this research, the empirical findings of the aftermarket at the case company are interpreted based on overarching patterns discovered in previous research within the field of spare parts logistics. Consequently, the findings of this study should not be interpreted as objective representations of reality, but rather as interpretations developed through the interaction between the researchers, the theoretical framework, and the empirical material.

4.2. Research Design

4.2.1. Embedded Single-Case Study

Yin (2018) notes that case study research is particularly suited for investigating *how* or *why* some social phenomena occur within their real-world context, especially when the boundaries between the phenomenon and context are not clearly evident. This study employs an embedded single-case study approach to examine the phenomenon of operational misalignment within aftermarket distribution and the development of a managerial artifact aimed at optimizing component availability. This approach is highly compatible with DSR, which requires deep contextual immersion to develop prescriptive solutions for complex, real-world problems (Peffers et al., 2007).

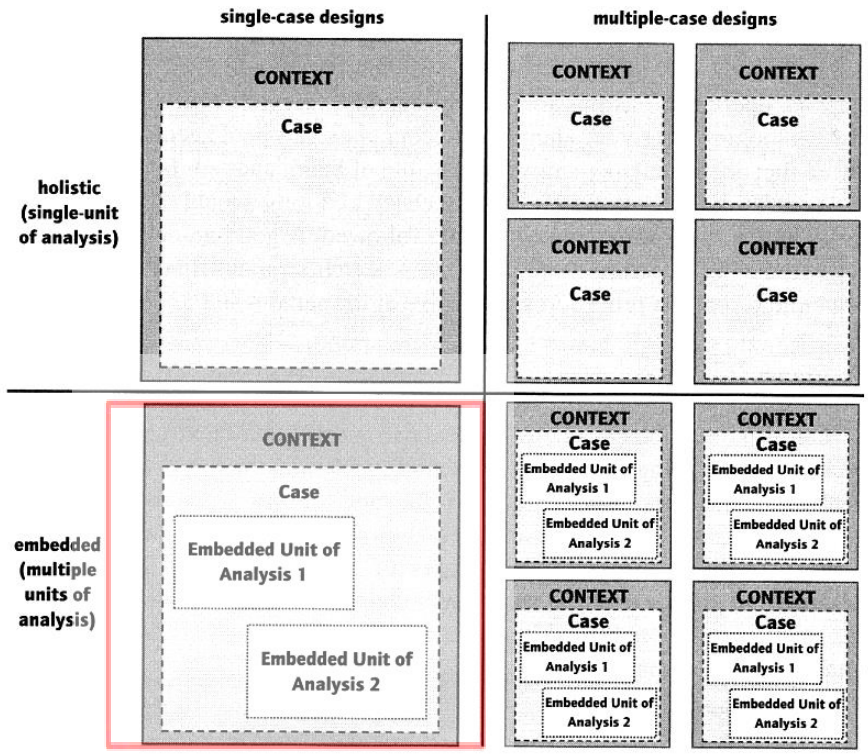
The primary rationale behind the choice of a single-case study is that it represents a *common case*. As Yin (2018) notes, the objective of a *common case* is to capture the circumstances and conditions of an everyday situation to obtain lessons about social or operational processes related to a specific theoretical interest. As Yin (2018, p. 45) states, "you would want to do a case study because you want to understand a real-world case and assume that such an understanding is likely to involve important contextual conditions pertinent to your case". While the findings are dependent upon the context of the case company, they hold value for analytical generalization, as the mechanisms observed are likely to exist in other organizations facing similar conditions (Yin, 2018). The challenges of aftermarket distribution at the case company are representative of those experienced across a wide array of firms (Sherbrooke, 2004; Saccani et al., 2007), providing a strategically relevant and informative case due to the case company's global presence and extensive portfolio.

Furthermore, this study follows an embedded single-case study design as proposed by Yin (2018) illustrated in Figure 1, where the phenomenon is examined through four primary subunits of analysis:

Subunit 1: Logistics
Subunit 2: Sales and Customer Experience
Subunit 3: Technical Service and Maintenance
Subunit 4: Services

These specific subunits were identified as they represent the critical interfaces within the service supply chain where divergent priorities typically manifest as operational friction. While logistics may prioritize cost-efficiency and delivery, technical services and sales prioritize immediate availability and service levels. As noted by Yin (2018), an embedded design serves as an important device for maintaining a case study's focus and preventing deviation from the original research intent. By analyzing the similarities and differences across these subunits, the research can account for the organization's internal complexity and identify recurring mechanisms behind operational misalignment. This ensures that the resulting distribution artifact is not a holistic generalization, but a targeted solution that addresses the specific needs of the organization.

Figure 1. Embedded Single-Case Study Design



Source: (Yin, 2018, p.96)

4.2.2. Case Selection

As suggested by Yin (2018), the empirical case was selected based on theoretical relevance, rather than trying to achieve maximum representativeness. No case firm will be able to act as a base for statistical generalization to an entire population of firms, but a carefully chosen case enables analytical generalization through mechanisms that can be identified across comparable industrial contexts. A case where the organization exhibits operational characteristics that can be widely observed is by Yin (2018) defined as a common case.

The case company, Laerdal Medical, was chosen as a common case since the company experiences a multitude of characteristics that are commonly observed within similar industries. Such examples are a wide array of SKUs, long product lifecycles resulting in large installed bases, reliance on authorized technicians, and high customer expectations on service delivery in the aftermarket (Sherbrooke, 2004). These common characteristics result in challenges regarding inventory positioning, service responsiveness and organizational alignment. These challenges have been addressed in industries such as for example automotive, aerospace, and, as with the case company, industrial equipment manufacturers (Saccani et al., 2007; Cavalieri et al., 2007).

The selection of a common case allows for the identification and analysis of causal mechanisms, identifiable across organizations, rather than case-specific practices. As noted by Yin (2018), the observations of mechanisms in one common case indicates that the mechanisms are likely to be relevant in other, structurally similar, organizations as well. This indicates that the case, which is further described in the following section, is suitable for Design Science research where the aim is to generate knowledge and an artifact that can solve real-world problems.

4.2.3 Case Company Profile: Laerdal Medical

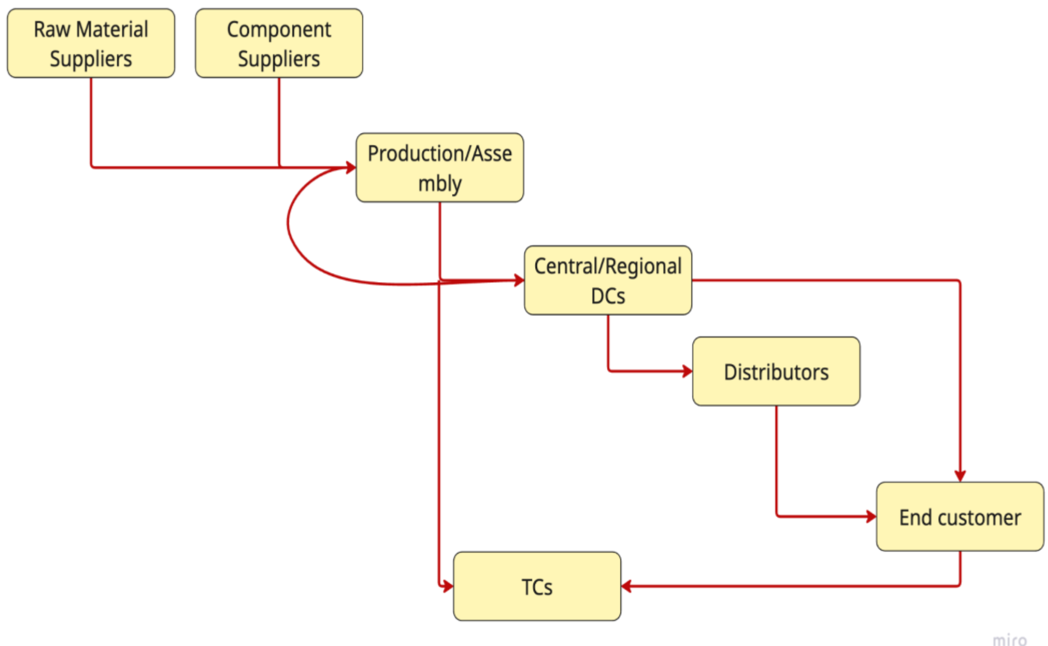
The case company, Laerdal Medical, is consistently identified as one of the global market leaders in the medical simulation market (Mordor Intelligence, 2026). Founded in 1940, the organization transitioned from a background in toys and plastics manufacturing to a mission-driven focus on life-saving medical education, a shift tightly linked to the global standardization of medical training (Grenvik et al., 2004; Phelps & Festa., 2014). The company's mission "*Helping Save Lives"* was further solidified in the 1960s with the development of the first standardized cardiopulmonary resuscitation (CPR) training manikin "*Resusci Anne*". This innovation became so embedded in the public consciousness that it even inspired the refrain “Annie, are you OK?” in Michael Jackson’s *Smooth Criminal.* Beyond its pop-culture footprint, this manikin marked the beginning of a new age in medical education, replacing traditional apprenticeship-based learning, with a standardized, risk-free environment where practitioners could “learn, do and improve” without compromising patient safety.

Today, the company operates at the intersection of healthcare, education, and high-tech manufacturing, maintaining a recognized position in the global medical simulation marketplace (Grand View Research, 2024). As a recognized company within this sector, the company utilizes a series of strategic partnerships with institutions such as the American Heart Association (AHA) and the British Heart Foundation. These partnerships move the company beyond a simple hardware manufacturer, positioning itself as a global leader in resuscitation programmes and digital learning platforms.

To support this mission, the company has scaled into a multinational corporation employing over 2500 employees across 27 different countries (Laerdal Medical, 2026). This global footprint is anchored by four primary manufacturing facilities located in Europe (EMEA), North America (NORAM) and Asia-Pacific (APAC), complemented by an extensive network of regional sales and development hubs.

The organization’s supply chain follows a traditional structure, transitioning from a linear upstream flow of raw materials and production into a complex, cyclical downstream flow. Central and regional DCs serve as the primary hubs, feeding a global landscape of distributors and end-customers as seen in Figure 2.

Figure 2. Supply Chain Flow



Source: Author's own work.

A defining feature of this model is the integrated service loop, where technical centers (TCs) act as pivotal nodes in the aftermarket. These centers are responsible for the repair and maintenance of products, creating a service-pull demand. This requires a constant exchange between decentralized local service points and the centralized distribution hubs to ensure the right parts are available for global maintenance needs.

4.2.4. Aftermarket Components at Laerdal Medical

Wagner et al. (2012, p.81) defines spare parts as "interchangeable items used to replace those removed during maintenance, and are only required after the primary product has been sold and utilized". However, in the context of the case company, the concept of the aftermarket contains a further distinction between spare parts and service parts.

Further specification entails that spare parts are replaceable components supplied with the purpose of restoring the functionality of a product following a failure. Service parts, on the other hand, encompass components that in the case of a failure need to be repaired by authorized technicians, either in-house or in the field. While both categories are critical in ensuring the fulfillment of service level agreements and achieving customer satisfaction, the process of supplying service parts is slightly more complex due to the involvement of a third factor, the authorized technician.

4.3. The 4-step DS Research Process and Theory Integration

The integration of DSR in OM is often operationalized through the four-phase framework proposed by Holmström et al. (2009). This process ensures the research remains grounded in both practical problem-solving and theoretical advancement. A description of each phase is presented below.

1. Solution Incubation: Framing the problem within a theoretical context.
2. Solution Refinement: An iterative process in which the rudimentary solution design is subjected to empirical testing.
3. Explanation (Substantive/Mid-Range theory): Examination, testing and evaluation of the artifact from a theoretical point of view. In this phase theoretical relevance is established for the solution.
4. Explanation (Formal theory): Generalizing findings to contribute to the broader field. Effectively, linking phase 3 and 4.

However, the success of DSR is dependent on its ability to integrate with mainstream, theory-oriented research. Holmström et al. (2009) submit that the most effective strategy for this integration is to strengthen the link between the refinement and explanation stages (phases 2 and 3). Further, the authors explain that a division of labour often persists in OM research, where industry focuses on practical problem-solving (phases 1 and 2), whereas researchers focus on testing explanatory theory (phases 3 and 4). This again draws a line in connection to the gap between theory and practice presented by Singhal et al. (2014) and Dresch et al. (2019).

To counter this, Holmström et al. (2009) argue that researchers should be actively involved in the second phase of solution refinement, rather than merely backtracking to interviewees about past events. By actively following or affecting development, he argues that researchers can produce substantive theory with higher empirical validity. Despite these benefits, explicitly linking phases 2 and 3 remains remarkably uncommon in OM research, representing an opportunity for more rigorous, practice-linked science.

4.3.1 Methodological Triangulation

This study adopts methodological triangulation, a strategy in which different methods are adopted to understand and explain a phenomenon (Flick, 2009). Triangulation is used to improve the quality of research by extending the approach to the issue being studied. First introduced by Denzin (1978), the objective is to produce a surplus of knowledge through different levels, ultimately promoting quality in qualitative research. As noted by Yin (2018), the credibility of a single-case design is strengthened by the use of multiple sources of evidence, which allows for the convergence of findings from various angles of inquiry. To strengthen the methodological rigor, empirical data was collected through three distinct methods.

1. Semi-structured interviews were used to capture the strategic perspectives of stakeholders across the global network, providing a foundational understanding of organizational needs and structure.

2. Site observations were conducted during a two-day visit and factory tour at the Norwegian HQ, these observations provided a physical and contextual anchor for the study, grounding the study in operational reality.

3. Longitudinal interviews were conducted bi-weekly with the same interviewee subject over the span of five months. In which the goal is to seek further knowledge into aftermarket operations and the development of the current organizational state, gather deeper data, and observe changes in perspectives (Hermanowicz, 2013).

By employing these methods for collecting empirical data, the research ensures that the findings are not limited to a single perspective. Instead, the use of different *lenses* allows for a more reliable and comprehensive understanding of the distribution network's complexities. A further justification for this specific selection of methods for data collection is grounded in the DSR process and theory integration.

4.3.2. Methodological Application: Design and Evaluation

Within the DSR paradigm, various levels of interventions exist. While 'full intervention' involves real-world testing and implementation, such deep immersion is often outside the scope of specialized academic research projects (Ivan Su et al., 2020). Consequently, this thesis adopts a *Design and Evaluation approach*.

Following the logic of Ivan Su et al. (2020), our design process involves following phases;

1. Designing an artifact: Grounded in theoretical justification and kernel theories, i.e. underlying theories drawn from natural or social sciences that provides a justification for an artifact to be developed.
2. Evaluating the artifact: Through “as-if” scenarios or scenario analysis to compare performance against the current state.
3. Compare performances: Entails a quantitative or qualitative assessment of the artifact's utility by measuring the predicted "to-be" outcomes against the existing baseline.

This approach provides higher validity than purely conceptual propositions while remaining feasible within the constraints of the study. By following this path, the research moves beyond observing regularities to developing a prescriptive artifact that addresses the specific logistics trade-offs faced by the case company.

4.4. Research Strategy

4.4.1. CIMO Logic

A primary advantage of DSR is its ability to tackle “ill-structured” or “wicked” problems in a systematic manner (Näslund, 2024). In SCM, it is often difficult to design effective interventions if the underlying mechanisms governing a problem are not understood (Gupta et al., 2024). An often used technique in DSR is the CIMO logic (Context, Intervention, Mechanism and Outcome), which helps researchers ensure that their interventions are grounded in specific organizational needs to improve decision-making and predictive capabilities (Kalaiarasan et al., 2023; Näslund, 2024).

Kalaiarasan et al. (2023) demonstrate this practical utility by applying CIMO logic to improve inbound supply chain visibility for a global manufacturer. Faced with a context of high shipment uncertainty, they designed the intervention (an SCV system) that triggered a specific mechanism (real-time event data) to achieve the outcome of improved deviation management. This application shows how the CIMO framework translates messy industrial logistical problems into structured, valuable solutions. Another example is provided by Reich et al. (2021), who demonstrate that the CIMO framework is specifically well-suited for network design research, as it moves from pure mathematical modelling to a practitioner's perspective. The authors further argue that by using the CIMO framework, researchers can generate the necessary knowledge required to solve complex in-field problems and support better managerial decision-making.

4.4.2. Current Reality Tree (CRT)

To analyze the qualitative data gathered from semi-structured interviews and observations, and to identify core conflicts within the aftermarket distribution, this study employs the Current Reality Tree (CRT). While CRT originates from the Theory of Constraints (TOC) (Goldratt, 1990), it is used here as a standalone logical diagnostic method to map the causal relationships between observed operational challenges, and to determine the current context of the aftermarket. The process begins by identifying Undesirable Effects (UDEs), i.e. symptoms that indicate systemic friction or performance gaps, and tracing them back to their root causes (RCs) (Peltokorpi et al., 2016; Gupta et al., 2024). Dettmer (2007, p. 100) defines UDEs as the most prominent indications that "something might be amiss in a system" representing negative states relative to the system's goals or critical success factors.

The data collected was analyzed in order to establish a set of UDEs which represents the most frequent or critical symptoms of the current aftermarket distribution network. Following the rigorous syntax provided by Cox & Schleier (2011, p. 697), each identified UDE adheres to specific logical guidelines; it must be a complaint about an ongoing reality that inhibits system performance, a description of a state rather than an action, and it must avoid being a "hidden solution" or a statement of wishful thinking. A further component of the CRT is the inclusion of Facts of Life (FLs), which are external or environmental factors that influence the current context. By adhering to these criteria, the CRT provides a validated, objective baseline of the current operational reality.

Through the application of sufficiency logic, these UDEs are linked to uncover the root cause (RCs), which represents the underlying systemic or strategic gaps where current distribution models fail to support the aftermarket requirements (Dettmer, 2007). This logic validates the effects of specific causes through "if-then" propositions, asserting that certain existing conditions are sufficient to produce a particular undesirable outcome (Dettmer, 2007). For instance, if a specific system is structured in a siloed manner, specific operational failures become logically inevitable.

The objectives of the proposed intervention, or artifact, are then inferred from the detailed problem definition through an iterative process (Peffers et al., 2007). By isolating the identified RCs, this research develops an intervention specifically designed to dismantle the causal chain of the CRT. This process includes determining the desired functionality of the artifact, which is drawn from established theory to ensure the solution is both practically relevant and theoretically grounded (Peffers et al., 2007).

4.5. Data Collection

4.5.1. Semi-Structured Interviews

This research uses semi-structured interviews as the primary qualitative data collection method. Qualitative research is particularly suited for this study as it provides the ability to gain deeper, contextual insight into complex global spare parts distribution operations that quantitative data cannot capture alone (Clark et al., 2021). This format allows for a multi-perspective exploration of the research problem, capturing the specialized knowledge of stakeholders who hold a direct interest in the aftermarket operations. As noted in IDEO's (2015, p. 39) field guide of design science: "There is no better way to understand the hopes, desires and aspirations of those you're designing for than by talking with them directly". Unlike structured formats, semi-structured interviews are directed by a pre-determined set of questions, and provides the flexibility to probe beyond the initial outline, allowing the researchers to uncover latent operational challenges and first-hand accounts of real experiences (Alam, 2002; Clark et al., 2021).

The choice of this method is further driven by the DSR approach of this study. As Dong (2009) states that in order to design effectively, researchers must be able to identify and deeply integrate the needs and wants of stakeholders, both users and others affected, into design decisions, which proves fitting in this context. Design interviews are often used in the front-end design process, to gather valuable stakeholder information, as they provide opportunities for in-depth conversations, which seeks to ground the artifact in empirical reality (Vredenburg et al., 2002; Rosenthal & Capper, 2006; Mohedas et al., 2022). The inclusion of stakeholder interviews is crucial in this specific context, as it is a critical component of design science, and will lead to more useful and applicable outcomes (Mohedas et al., 2022).

The interview guide was developed in alignment with DSR research principles and the CIMO logic, including CRT, to ensure the collected data directly supports the development of the artifact (see Appendix A). The guide was developed in advance of the interview process, in order to support the researchers in staying on topic and remaining focused, ensuring a standardized process across all interviews. The guide consists of 29 open-ended questions, categorized under the subthemes of professional context, aftermarket operations, strategic value, demand and service requirements, internal processes and cross-functional collaboration. The questions are aimed to facilitate a reflection on the participant's behalf regarding the aftermarket's value to their specific department. More targeted inquiries seek to uncover functional pain points and the underlying context of current operations to establish how these factors relate to other functions. Subsequently, other questions are more distinct regarding the characteristics of spare parts.

4.5.2. Sampling Techniques

A total of 7 high quality interviews were conducted through purposive sampling followed by snowball sampling. Purposive sampling, a form of non-probability sampling, builds upon strategic selection of embedded units that are likely to be able to provide rich and relevant information regarding the topic (Clark et al., 2021). Purposive sampling enables focusing in depth on relatively small samples, and is suitable for this study since it enables intentional selection of interviewees with specific knowledge of the case company's aftermarket. Since the study aims to examine spare parts logistics and network configuration at the case company, it is suitable to collect empirical data from interviewees directly involved in these processes. This approach is further aligned with the pillars of DSR, where relevant and operational data generates the development of a practical and context-bound artifact (Hevner et al., 2004; Clark et al., 2021).

After contacting the initial interviewees, these participants were asked if they could refer other possible participants who could provide valuable insights for our research. This approach is referred to as snowball sampling, and involves relying on the initial sample to recommend other participants (Clark et al., 2021). Given the complexity of aftermarket operations, the knowledge is not always formally visible and often distributed across the organization. Furthermore, snowball sampling is beneficial in situations where individuals may be hard to reach or where the topic is sensitive (Clark et al., 2021). Hence, snowball sampling may enable access to individuals within the organization with specialized knowledge that may not have been identified through the initial purposive sampling. The interviewees identified through these forms of sampling are listed below in Table 1.

Table 1. Interview Data

Semi-Structured Interviews				
Designation	***Role***	***Date***	***Duration***	***Format***
Interviewee 1	Programme and Services Manager	17-03-2026	1 hr and 5 minutes	Online (Microsoft Teams)
Interviewee 2	VP Operations and Services	30-03-2026	45 minutes	Online (Microsoft Teams)
Interviewee 3	Director Customer Experience and Services	31-03-2026	42 minutes	Online (Microsoft Teams)
Interviewee 4	Logistics Director	16-04-2026	50 minutes	Online (Microsoft

				Teams)
Interviewee 5	Technical Services Manager	09-04-2026	37 minutes	Online (Microsoft Teams)
Interviewee 6	Warehouse Manager	09-04-2026	40 minutes	Online (Microsoft Teams)
Interviewee 7	Technical Service Coordinator	24-04-2026	1 hr and 3 minutes	Online (Microsoft Teams)

Source: Author's own work.

New interviewees were sampled until saturation of the data was achieved. Clark et al. (2021) describes data saturation as the point where no new data regarding a category emerges from additional collection of empirical material, which for this research was deemed achieved after seven interviews with key stakeholders in different global locations. Saturation was not, however, a condition of immediate confirmation. For example, early interviews suggested that regional lead time failures were primarily attributed to insufficient stock levels, a framing that was continuously challenged as interviews were conducted. Interviewees 2, 3, 4 and 5 collectively redirected attention to the asynchrony between standard sea-freight replenishment cycles and urgent customer requirements. This shift in causal explanation evidence genuine data saturation, where categories must be fully developed and relationships between categories are established and validated (Strauss & Corbin, 1998; Clark et al., 2021). Since the aim of this thesis is to generate insights specific to the context described in the case rather than generate new theory grounded in the empirical material, data saturation is applied rather than theoretical saturation.

4.5.3. Observations

This study also utilizes qualitative observations, which were performed through shadowing and participating in meetings and daily operations during a two-day site visit. Observations are particularly useful since it allows for the examination of practices and events as they occur in real time, rather than simple reliance on retrospective accounts of events or practices (Clark et al., 2021). Furthermore, observations seek to reveal the nature of things through a mental process where the researcher adopts a particular way of seeing based on continuous questioning of what is being observed, which results in the researcher creating the reality that is observed (Barrios et al., 2022). Observations are suitable for this embedded single-case study due to the emphasis on understanding how the aftermarket network is enacted in everyday operations across different internal units. Furthermore, observations provide a great understanding of the organizational context of the case in which the phenomena is studied, which as argued by Yin (2018), acts as a base for understanding the phenomena itself.

In this study, observations are utilized to directly contribute to the solution incubation phase of the DSR process, where the problem was framed and defined within the case context. UDEs were identified and validated through observing real-time discussions and cross-functional interactions. The UDEs observed were then directly used in the development of the CRT together with the findings derived from interviews and longitudinal interviews. Throughout the shadowing and meeting participation, field notes were continuously recorded and later coded and compared with interview data. Additionally, the field notes included continuous reflective notes regarding the researchers own impressions to simplify the contextualization of the findings, and to maintain a reflexive stance in relation to potential biases (Barrios et al., 2022). As further suggested by Barrios et al. (2022), informed consent through thorough explanation of the project and research aim, was obtained from all people involved in the observed situations. A list of observations used in this research can be found in Table 2.

Table 2. List of Observations

Job Titles of Present Professionals	**Region**	**Date and Duration**	**Location**
Logistics Director; Logistics Manager EMEA; Supply Chain Lead EMEA; VP Operations and Services	Stavanger, Norway	29-01-2026, 8 hrs	Production facility (raw material production, assembly lines and warehouse tour, shipping lines etc.)
Logistics Director; Category Manager Indirect Spend	Stavanger, Norway	30-01-2026, 8 hrs	Production facility and HQ facility

Source: Author's own work.

4.5.4. Longitudinal Interviews

Further data collection was facilitated through longitudinal interviews with a key subject within the organization. These sessions functioned as a sustained method for the co-construction of knowledge, where repeated encounters allowed for continuous exploration of the operational environment (Charmaz, 2006; Wood et al., 2024). By utilizing a longitudinal format, the research was able to move beyond surface-level observations to capture the nuanced perspectives and technical motivations that characterize the current state of the aftermarket distribution within the case company.

The selection of Interviewee 4, as the primary longitudinal subject was deliberate. Their long organizational tenure provided institutional knowledge rarely accessible through a single interview session, an awareness of how current structural conditions evolved and why certain configurations and practices persisted. Their cross-functional visibility across logistics, supply chain and technical support meant accounts were not confined to an organizational silo, but placed them at the intersection of strategic intent and operational reality. Together, these characteristics made Interviewee 4 uniquely capable of serving as a consolidating mechanism for the broader interview data. Where other interviewees provided necessary perspectives, from within specific functional or geographic positions, Interviewee 4 supplied the integrative vantage point through which those accounts could be synthesized, tested for convergence, and reconciled where they diverged.

Importantly, this relationship extended beyond that of an ordinary respondent. As argued by Holmström et al. (2009), DSR researchers should actively involve practitioners in the refinement of the solution, rather than seeking them out retrospectively, thus producing substantive theory with higher empirical validity. Through the longitudinal interviews, the Interviewee therefore served as a co-constructor of knowledge, actively included in the progressive refinement of both the problem and the evaluation of proposed design interventions, rather than serving as a passive data source.

To ensure the research was grounded in organizational realities, these interviews were documented through structured meeting minutes (See Appendix A), which tracked the analytical progression of the study from initial problem identification to final mapping of the situation. For an embedded single-case study, this approach is particularly vital. As Yin (2018) notes, embedded design involves multiple units of analysis, and the longitudinal interviews served as a primary mechanism through which data from these subunits were consolidated.

4.6. Data Analysis and Coding

Coding and initial analysis of the collected data was performed continuously as data was collected to help develop a detailed understanding of the data as throughout the process of sampling and collecting empirical material (Clark et al., 2021). The process of coding the data and conducting initial analysis was performed following the guidelines described by Clark et al. (2021) to reduce the amount of material and give meaning to the collected data. The initial coding was done by familiarizing ourselves with the data through reading the transcripts and summarizing key points. The data was then read through again with the purpose of creating general codes regarding significant points to generate an index through which basic interpretation of the data could be done. The coding of data was done using NVivo which allows for sorting of data from the transcripts and qualitative analysis. After initial coding of all transcripts, the generated codes were reviewed and refined to better suit the phenomena they aimed to explain, through comparison with other codes and existing literature. Crucially, the coding process utilized causal coding (Saldaña, 2021) to identify logical chains rather than just thematic clusters. Furthermore, the coding and structuring of the CRT was conducted in accordance with the process outlined in Table 3 (Noreen et al., 1995). This enabled the transition from descriptive data to the "if-then" structures required for the CRT.

Table 3. CRT Construction

Step	Analysis Phase	Description
1	Data Preparation	Inserting and organizing raw data and transcripts into the analysis environment.

2	Categorization	Creating analysis categories based on constructs of organization, dynamics and problem/constraints identified in the literature.
3	Classification	Analyzing the interviews and classifying excerpts to align with the theoretical framework.
4	Variable Identification	Generating a report of unaltered excerpts to identify UDEs and structural variables.

Source: Noreen et al. (1995).

The coding process utilized a comprehensive set of thematic identifiers, ranging from 'ad-hoc workarounds' to 'urgency & escalation', to capture the systemic frictions within the aftermarket. These segments were extracted and linked to specific UDEs, ensuring that the subsequent causal analysis (the CRT) remained firmly grounded in the empirical reality of the participants. Table 4 provides a representative sample of how raw interview excerpts were translated into formalized UDEs; the complete list can be found in Appendix C.

Table 4. UDE Coding Process

ID	**Statement**	**Interview Excerpt**	**Source**	**Code**
UDE 2	Ad-hoc local workarounds are the reactive response to inventory shortages.	*"I think this just causes us like because when we don't have the spare parts or the repair parts, this is where we have to kind of come up with a local solution where we either need to loan the customer part, we need to scavenge that same part*	Interviewee 1	Ad-hoc solutions

		from the existing model."		
UDE 13	Departmental KPIs for manufacturing, sales, service and logistics are conflicting.	*"You know, we have different departments with different KPIs. One department might be measured on how much they sell, the other might be measured on how quick they repair it or maintain it or install it and sometimes it becomes conflicting in the aftermarket."*	Interviewee 3	Customer impact
UDE 4	Historical consumption data for local stocking levels is unavailable to regional teams.	*"Since spare parts storage is managed by the logistics team, we do not have direct visibility into whether specific spare parts are physically available or in their designated locations."*	Interviewee 5	Data
UDE 8	Spare part ordering processes lack automation.	*"Explain to the customer why they have to wait. Then there is hidden cost to organize the spare part, especially when it has to come from the factory. Because this is really like a, like a Word document. There is no automation to order the part."*	Interviewee 2	Maintenance

Source: Author's own work.

4.7. Ethical Considerations

The ethical considerations employed in this thesis are guided by Clark et al's. (2021) synthesis of Diener et al's. (1978) four main principles; avoiding harm to participants; obtaining informed consent; avoiding invasion of privacy and deception. Each principle was addressed throughout the data collection and analysis.

The type of harm most plausible in this context was psychological or social rather than physical, for instance the risk of professional discomfort arising from disclosing organizational dysfunction or criticizing internal processes. This was mitigated by framing questions sensitively, maintaining a non-judgemental interview environment, and explicitly informing all participants that they could withdraw from the research at any point in time, or decline to answer any questions at any point in time without any consequences. Informed consent was obtained through multiple instances; where participants received a written information document prior to the interview detailing the research's focus, methods, data handling procedures, and verbal confirmation of consent to participate and be recorded was obtained both before and at the opening of each session. The same document also ensured transparency about how data would be used, as well as the participants were presented the opportunity to review and redact their transcription, thereby preventing any form of deception.

Re-identification risk was a particular concern in this study given the interview pool and the specificity of the roles represented. With seven interviewees drawn from a single organization, the combination of role title and interview content could, even without names, make individual participants identifiable to colleagues within the same case company. To manage this risk, the geographic locations were deliberately excluded from all reporting, and direct questions were carefully reviewed to ensure they could not be traced.

Member-checking was conducted selectively throughout the process. Key findings and author's interpretations were shared with the subject during the longitudinal interview sessions to verify the analytical representations of the organizational reality were accurate and fair. This served both an ethical function, ensuring participants were not misrepresented, and analytical one, consistent with the co-constructive nature of DSR (Holmström et al., 2009).

Data retention and destruction followed the principle of minimal retention communicated to all participants in the pre-interview information document. Raw data, including interview recordings and unedited transcripts, were stored securely on password-protected platforms accessible only to the authors. Upon the completion of this thesis, all data and empirical material will be deleted, in accordance with the commitments made to participants at the point of consent. Nonetheless, the authors took full responsibility for upholding the principles outlined above throughout the entire research process.

4.8. Reflexive Statement

Qualitative methods are dependent upon subjectivity, and the research is inherently shaped by the researchers interpretations of meanings and social realities (Olmos-Vega et al., 2022). Interpretations are thereby inevitably affected by the researcher's view and position, and rather than aiming for complete objectivity, this approach takes into account certain assumptions and experiences the researcher brings into the project (Alvesson & Skölberg, 2004). Olmos-Vega et al. (2022) emphasizes that reflexivity involves critical attention to factors that may influence the study being conducted, such as personal, interpersonal, methodological, and contextual issues in the research. This involved ensuring that the artifact was grounded in the participant's lived operational reality rather than our preconceived theoretical notions.

In this study, the authors' positioning has influenced both research design and interpretation of empirical material. Both authors have a background within supply chain management and service management, which emphasizes the role of service and value co-creation in logistics and supply chain management. This perspective may have affected the research in terms of attention directed toward how spare parts management and logistics network configuration may support service outcomes, in addition to performance trade-offs. Moreover, one of the authors has experience working with the case company as an intern, although in another department rather than the logistics department. Such familiarity may increase contextual understanding and improve understanding of organizational practices, but it may also increase potential bias regarding organizational practices and dynamics. In contrast, the second author has no connection to the company prior to the research which, although limiting initial understanding of organizational context, may provide a different perspective. Continuous awareness of the two positions, and intentional collaboration, questioning, and discussion, was utilized to create reflexivity in the research.

5. Analysis & Results

This chapter presents the analysis of the collected data and the resulting development of the research artifact. It transitions from the analysis and visualization of the current distribution network typology to the identification of UDEs, resulting in the synthesis of the CRT and CIMO framework, resulting in the final design propositions and expected outcomes.

5.1. Problem in Context

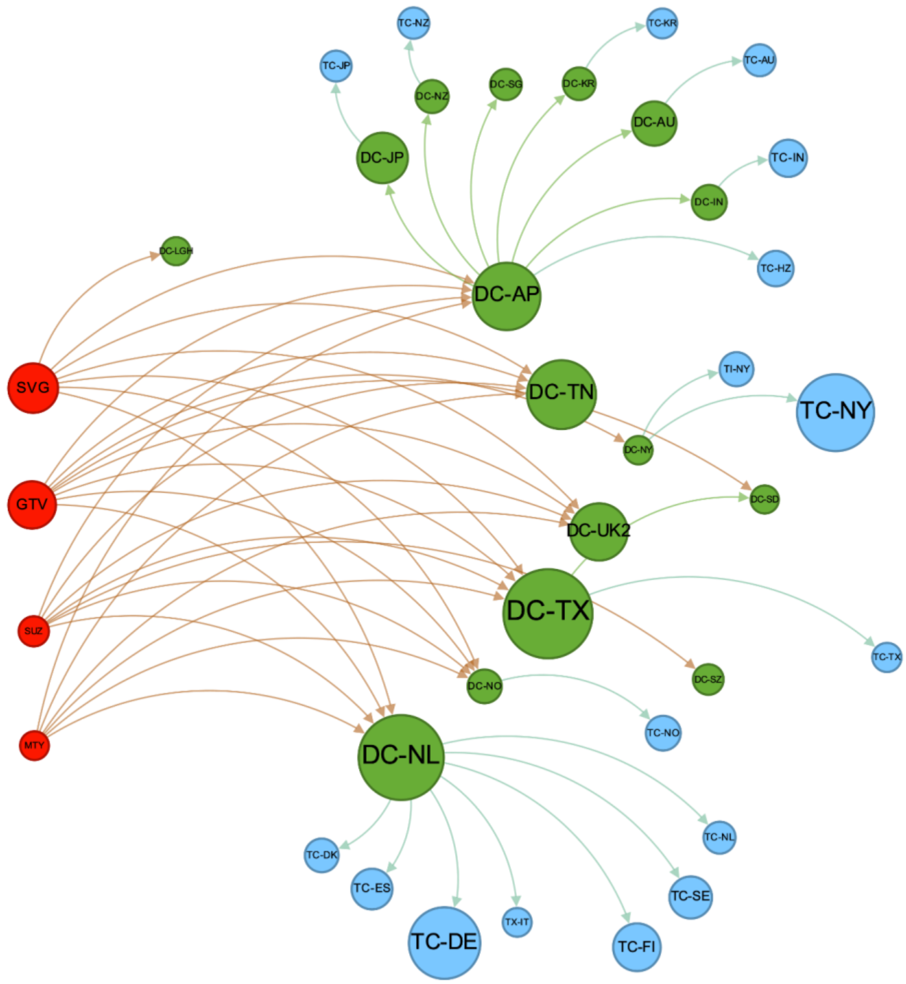
5.1.1 Current Network Topology

The supply chain network map utilized an AtlasForce 2 layout to visualize the relational and volumetric flow of the case company's global supply chain, as shown in Figure 3. This visualization provides a baseline representation of the current internal supply chain, identifying the primary nodes and high-density corridors that facilitate global distribution. While this map provides a general overview of the network's connectivity, it establishes the topological context for further analysis of spare parts distribution.

The nodes are categorized into three distinct tiers: primary manufacturing sites (red), DCs (green) and TCs (blue) as depicted in Figure 2. The primary manufacturing sites (SVG, MTY, GTV and SUZ) serve as the major production nodes in the network. Their central positioning reflects their role as the origin points for the global flow, securing downstream flow. Furthermore, the DCs constitute the regional fulfilment layers, and act as primary intermediaries between production and local markets. Finally, the TCs functions as specialized service hubs at the network's periphery. Unlike DCs, these centers are dedicated to product repair and maintenance, representing a core element of the aftermarket.

A critical analytical layer is provided by the node scale, which in this visualization is proportional to the current year-to-date holding capacity. This identifies DC-TX as the network's primary anchor for service and spare part SKUs. However, it is important to note that the visualization primarily represents "*in-phased*" SKUs, components fully integrated in the enterprise resource planning (ERP) system and governed by standardized distribution logic as of 2026. In contrast, the network is further burdened by a secondary flow of *"non-inphased"* parts. These components exist outside the ERP system, and must be manually managed, moving directly from factories to various DCs and TCs. While these manual flows are excluded from the visualization to prevent an illegible network map, they represent a significant driver of operational friction and systemic blindness.

Figure 3. Distribution Network Topology



Source: Author's own work using Gephi 0.10.1 and the ForceAtlas 2 spatialization layout.

5.1.1.1. Network Density and Connectivity

The network is composed of 37 nodes, representing the global footprint of manufacturing sites, distribution hubs, and technical centers. These nodes are interconnected by 52 directed edges, which represent the primary logistical corridors currently utilized for general flows. To quantify the structural density of this network, the average degree (*d*) is calculated by dividing the total number of edges ($|E|$) by the total number of nodes ($|V|$):

$$\bar{d} = \frac{|E|}{|V|}$$

$$d = \frac{52}{37} \approx 1.4$$

An average degree of 1.4 describes a network of structural heterogeneity, i.e. it describes a system where components are diverse and unequal in their influence. Rather than a uniform or random distribution where every site performs the same task, this network model reveals a clear "hub-and-spoke" system. In this configuration, a small number of "superhubs" (DC-TX, DC-NL, DC-AP etc.) consolidate the majority of the system's resources and inventory, while a larger number of "leaf nodes" (TC-NY, TC-DE, TC-NO etc.) manage the specialized periphery.

Essentially, this contrast maps the logistical intensity of the network, showing exactly where the system's capacity is concentrated. The resulting reliance on a few critical hubs explains the network's sensitivity to disruptions, because the network lacks redundant pathways, any friction in the "superhubs" or the manual "*non-inphased*" flow triggers issues and problems later on in the service chain.

5.1.2 Current Aftermarket Operating Mode

Within the established network topology, the aftermarket processes are formally governed by an ERP-centric architecture intended for standardized logistics handling. However, empirical evidence suggests a divergence between the formal structure and the operational reality. The current operation is characterized by a notion of reactivity, where the limitations of the formal system necessitate a reliance on ad-hoc, manual interventions to maintain service continuity.

> *"Yeah, in the long run, it's that firefighting is of course, but I think they* [aftermarket professionals]*, I totally understand why it's happening though, because it's like, again, we don't have systems that honors these small low value orders that may be a very important or any customer waiting for a broken down product. We* [the company] *tend to focus on selling new ones instead of repairing old."* (Interviewee 4).

5.1.2.1. Distributed Inventory and Buffering

A defining feature of the current operating model is restriction of inventory at local TCs and regional DCs. Under the existing logic, local stocking is confined to components and spare parts with high failure frequencies. Interviewees consistently argue that maintaining a comprehensive safety stock across the entire SKU portfolio is perceived as fiscally and operationally unfeasible due to the vast breadth of the catalogue. Consequently, the network is not configured for high-agility repairs across the full product range, but instead designed as a lean buffer for only the most predictable demand segments. This trend was exemplified during site observations at the TC-NO, where a technician demonstrated the "informal inventory" required for repairs, a physical bag containing a curated selection of high-frequency service parts. This highlights a critical reliance on informal compensatory mechanisms. These informal workarounds exist to bridge the gap between the centralized inventory logic and the decentralized, unpredictable needs of the service supply chain.

"I mean, also, these ad-hoc cushioning solutions that our service team, the sharp end, needs to do with cannibalizing parts from other products." (Interviewee 4).

However, this buffering approach faces some significant friction due to the unpredictable nature of product failures. The empirical material revealed that attempts at identifying popular spare parts have been complicated. As depicted in the below quotes, this long-tail distribution, which intensifies alongside product complexity, renders traditional ABC-style stocking strategies ineffective, as identifying a single set of 'essential' safety stock becomes problematic.

"By analyzing spare parts ordered over the past five years, we found that no specific parts could be meaningfully identified as high-frequency items. Failures occur across a very wide range of parts, making it difficult to define a limited and effective safety stock strategy." (Interviewee 5).

"It's a challenge to understand what we need to have in stock." (Interviewee 3).

To mitigate the resulting inventory gaps, the organization defaults to reactive "firefighting". This includes as one interviewee put it "cannibalizing demo products to ensure customer functionality" or escalating orders to emergency freight. Such reactive solutions can introduce a service vs. sustainability paradox, where the corporate mandate to reduce carbon emissions through sea freight directly clashes with urgent requirements for rapid spare part delivery. Although such strategies are often functional in ensuring customer satisfaction, they were described to increase internal cost and complexity through increased labour effort and stress induced by customer complaints.

> *"Have to put it* [spare or service part] *on a ship and it will take six months or we pay a lot of air freight and which is, you know, a big no no with all the sustainability goals and to get it here costs a lot of money and it blows out our kind of KPI for sustainability."* (Interviewee 1).

This highlights a strategic deadlock, where service responsiveness directly contradicts sustainability KPIs. Without proactive segmentation, the system is forced into a zero-sum choice between extreme lead times or expensive, high-emission air freight. While the organization maintains customer satisfaction through its reactive firefighting, it does so by absorbing significant internal strain and bypassing corporate mandates. Ultimately, this reliance on ad-hoc mitigation and expedited freight masks a structural inability to balance lean efficiency with agile service requirements.

5.1.2.2. Manual Processes

Beyond physical inventory constraints, the aftermarket operating model is defined by a dual-track sourcing logic based on the digital visibility of components. The empirical evidence reveals a critical distinction between "*inphased*" and "*non-inphased*" SKUs, which dictates whether an order request from the TCs follows an automated, standard process or a manual, contingent one.

For inphased components, those existing within the ERP and CRM systems, the process is generally functional. When demand aligns with local/regional availability, the flow is automated, lead time commitments are system-generated, and delivery follows standard channels. However, when a deviation occurs, such as a supply delay or a change in inbound status, the system (ERP) lacks the proactive feedback loop necessary to maintain synchronization. This is depicted in the below quote, stressing that there is no notification of changes in lead-time, which is observed as a frequently experienced pain point in aftermarket operations.

> *"I don't even receive an email or anything, an alert or something letting you know, you know what I mean?* [notification of delayed lead-times] *It's because, I know it takes, I know it's time-consuming, people have got other things to do, but an alert or something…" (Interviewee 7).*

The administrative burden of tracking urgent parts is then shifted onto human intervention, which is inherently unscalable and prone to errors. Without proactive system-generated notifications, the service supply chain remains fractured. This creates a governance vacuum where the digital system fails to provide the certainty required for efficient customer service.

> *"If you're doing* [ordering] *a non-inphased part, there's a whole different form you need to fill in, send it, and it's getting more manual."* (Interviewee 7).

These challenges intensify concerning non-inphased components. These SKUs exist outside the digital architecture, often due to breadth of the portfolio or the age of discontinued products. Because these parts cannot be ordered through the ERP, the process defaults to a contingent and manual flow. The TCs must directly contact local manufacturing sites, making the process heavily dependent on individual tacit knowledge to identify the correct unit and navigate production requirements. Interestingly, empirical evidence suggests that some regional teams might prefer this off-system approach.

> *"It* [non-inphased components] *has to be manually emailed to the factory and shipped directly to the country with not going through any warehouse or any distribution, basically logistics, my team and my function not involved. Yes, and actually some of the countries that I speak with is saying that that process is working the best. They like that way of doing it."* (Interviewee 4).

However, what makes this finding significant is not the malfunction itself, but the organizational response to it. As exemplified in the above quote, this preference is not unreasonable, it deserves to be taken seriously as a signal about the current system's productive logic. The manual route for how non-inphased parts work, in the narrow sense that it achieves urgency through interpersonal coordination, and bypasses the bureaucratic red-tape embedded in the formal channels. Where the ERP overlooks exceptions, a direct email to the factory produces a response. The informal process is faster just because it is informal, as it can be seen to function on the basis of social obligation and accountability, rather than process compliance.

However, this is where the paradox sharpens. The features that make the manual process locally effective undermines the general system. It results in a total loss of logistical visibility, fragmented information flow, and in extreme cases it disrupts the planned manufacturing schedules by inserting unscheduled one-off production requests. More fundamentally, it reveals that the formal system has failed to account for the urgency that the informal process delivers through personal relationships. The preference for workarounds is therefore not a resistance to change, but rather an adaptation to a governance structure that has not kept pace with the operational complexity of the aftermarket. As interviewee 4 notes, this is compounded by a misalignment of incentives at the factory level, as depicted below.

"Even though we had the example last year where we were four months behind on spare parts and we had to escalate super many times for the factory to release it. It was a challenge because there's no direct revenue in it. The factories have very little incentive to provide spare parts. They get minimal value, but the value of it to the organization can be extremely high. But at the end of the day KPIs matter… and we have no real KPI for spare parts delivery for the factories." (Interviewee 4).

Ultimately, this sourcing dichotomy reveals a digital misalignment, in which the system remains stable only when demand is standard, but defaults to informal workarounds when confronted with the long-tail complexity of non-inphased components. The productive explanation of this arrangement is one of local optimization at a systemic cost, where responsiveness is secured at the local level, but at the direct expense of logistical transparency, manufacturing efficiency and the scalability of aftermarket operations as a whole.

5.1.2.3. Internal Communication

The complexities of these manual processes can be further extended through fragmented information flows between technical service and logistics units. Because the formal system lacks a unified interface for aftermarket tracking (both inphased and non-inphased), coordination is heavily reliant upon interpersonal communication channels such as email and the CRM. This creates a state of information asymmetry, where technical service teams lack direct visibility into the real-time stock availability or order updates. Consequently, these teams are placed in a state of dependency, relying on the logistics function to manually relay critical data, which introduces significant opportunities for misalignment and uncertainty.

“Since spare parts storage is managed by the logistics team, we do not have any direct visibility into whether specific spare parts are physically available or in their designated locations.” (Interviewee 5).

"I hear escalations about main products if we're a week sometimes or if an important customer gets a week delay on a main product, a new product, sometimes it's escalated to me. But if a spare part, if I hear about it, it's probably like four months." (Interviewee 4).

This lack of transparency manifests physically as extended internal processing times. The empirical material indicates that when a spare part is not available locally, the administrative overhead required to process an order internally, before physical shipping even commences, can extend a full month. This suggests that the current network’s reliance on interpersonal coordination creates a “hidden” lead time component that rivals the duration of international shipping.

5.1.2.4. Strategic Misalignment and Mission Criticality

The analysis uncovers a tension between the case company’s identity and the lived experience of the aftermarket stakeholders. While the company remains a market leader with high-end service expectations, the current distribution model for aftermarket components struggles to uphold this expectation.

“We are a high service company. We do sell highly complex and expensive products. Like our product is a Mercedes, it's not a Skoda or a Fiat. If you buy a Mercedes, you expect Mercedes customer treatment." (Interviewee 4).

However, further investigation into the empirical material displays that the “*Mercedes*” treatment is exposed to lead-time volatility and a lack of spare and service part availability. This is not just a financial or logistical inconvenience, it directly impacts the customer's ability to perform mission-critical training. As noted by Interviewee 7, a missing part can halt life-saving education for an extended period of time.

> *"Well, it's critical because it's trained, you're training nurses or first aid people to do their job. So if you've not got the spare part, they can't do their job. And the thing is, the customer is relying on us. They've bought equipment to use. And if that equipment is not getting used for three months because you're waiting on a part, that's not really good."* (Interviewee 7).

This creates a sense of mission-friction, where the logistics system becomes a barrier to the company's purpose. This suggests that without a segmented and prioritized distribution capability, the gap between the brand value and the actual service delivery will continue to widen, eventually eroding customer loyalty and trust.

5.2. Identification of Undesirable Effects (UDEs)

The analysis of empirical interview data helps explain the context in which the phenomenon is studied, but does not clearly define the problem in a structured manner. Groop et al. (2017) notes that wicked problems also involve the challenge of framing the current problem within the context, and Dettmer (2007) argues that the starting point for constructing a CRT is the identification of UDEs. The UDEs represent the observable symptoms and negative outcomes caused by the current system as identified in the empirical material. The UDEs form the basis for the CRT analysis conducted in the following section, and are presented below in Table 5.

Table 5. UDEs

Denotation	**UDE**
UDE #1	The adoption of ad-hoc solutions increases long-term operational complexity
UDE #2	Ad-hoc local workarounds are the reactive response to inventory shortages
UDE #3	Organizational sustainability goals are adversely impacted by high carbon emissions from escalated freight
UDE #4	Historical consumption data for local stocking levels is unavailable to regional teams.
UDE #5	Expected delivery dates for spare parts fluctuate
UDE #6	Customer product downtime leads to a loss of organizational trust and product value
UDE #7	Regional lead time for spare parts frequently exceeds customer requirements
UDE #8	Spare part ordering processes lack automation
UDE #9	Urgent spare part production disrupts standard factory assembly line schedules
UDE #10	Safety stock levels are insufficient and challenging for high-variability spare parts
UDE #11	Urgent spare part requirements trigger a logistics escalation process
UDE #12	End-to-end responsibility for spare parts availability and service delivery is fragmented across functions

UDE #13	Departmental KPIs for manufacturing, sales, service and logistics are conflicting
UDE #14	Total Cost-to-Serve for aftermarket parts is disproportionately high relative to standard logistics benchmarks

Source: Author's own work.

5.3. Underlying Mechanisms

CRT serves as the foundational diagnostic tool for defining the Context (C) within the CIMO framework. Following the methodology of Scheinkopf (1999), the CRT maps the logical interconnections between observed UDEs and their underlying RCs. To ensure the validity of these causal relationships, the logic was examined using the categories of legitimate reservation (CLRs). These logical rules served as a coding framework for the qualitative interview data; by triangulating transcripts and observations, allowing for identification of similar patterns across different stakeholder perspectives, the CRT was refined to represent a verified consensus of the current organizational reality. In practice, the CLRs function as a stress test of the causal logic, allowing each causal link in the CRT to be challenged for clarity, existence, sufficiency, and consistency. Through stress testing, the CRT is ensured to not merely reflect individual perspectives and perceptions, but a rigorously validated causal structure derived from the empirical material.

Another component of the CRT is the inclusion of Facts of Life (FLs), which are external or strategic realities that, unlike RCs, are beyond the immediate control of the supply chain function. These elements, such as the inherent breadth of the product portfolio (FL #2) or the physical constraints of global shipping (FL #1), represent the fixed environment in which the system must operate. Within the CRT, these FLs act as stressors that exacerbate the negative impact of internal RCs. To illustrate the “Sufficiency Logic” used to construct the tree, following key transitions are exemplified:

→ **IF** Global ownership and accountability for aftermarket logistics and strategy are not clearly defined **THEN** end-to-end responsibility for spare parts availability and service delivery becomes fragmented across functions

→ **IF** the spare part supply chain is not segmented based on demand patterns, criticality and cost **AND** production portfolio continuously expands and increases in complexity **THEN** spare part ordering process lacks automation

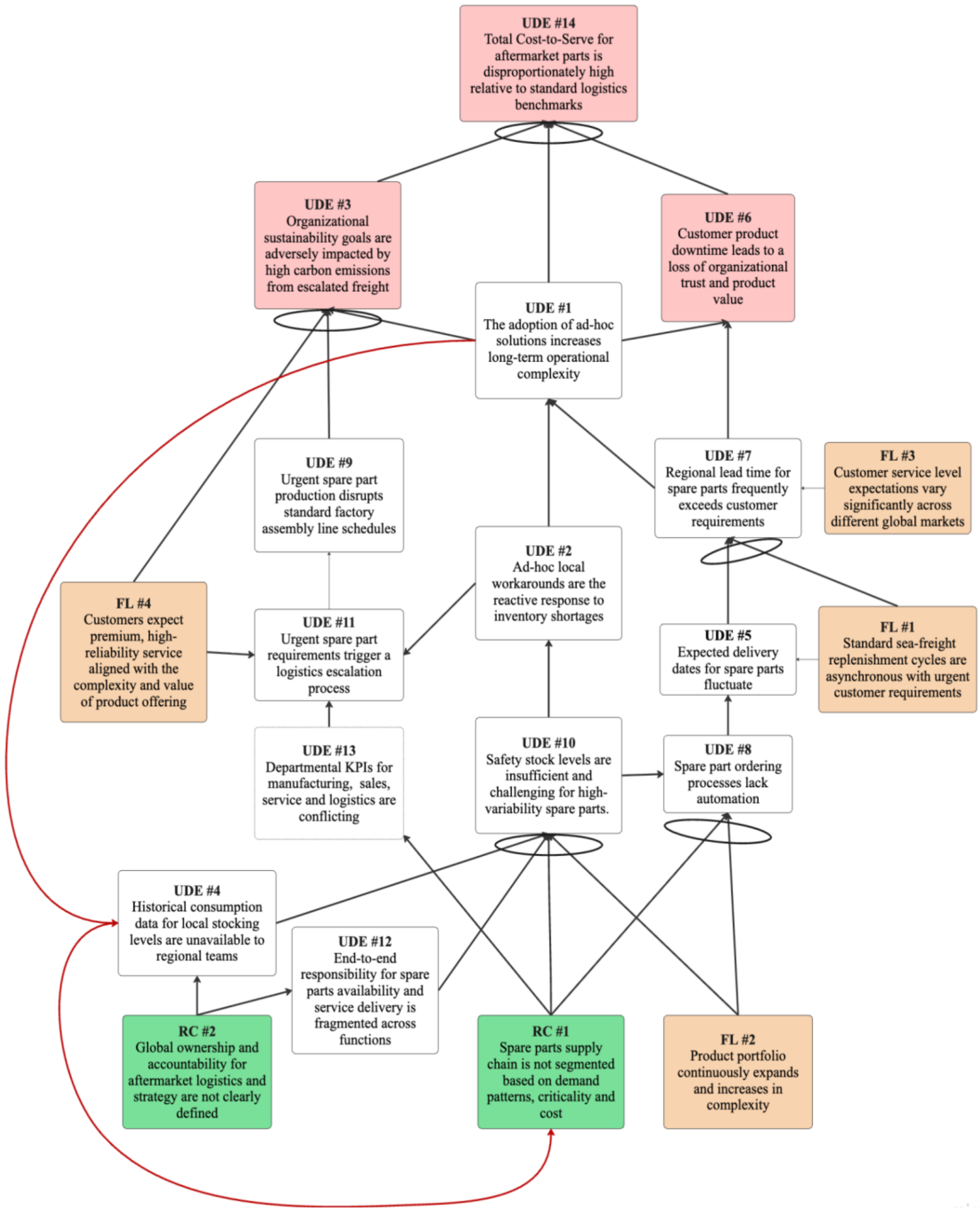
→ **IF** expected delivery dates for spare parts fluctuate **AND** standard sea-freight replenishment cycles are asynchronous with urgent customer requirements **THEN** regional lead times for spare parts frequently exceeds customer requirements

→ **IF** customers expect premium, high-reliability service aligned with the complexity and value of product offering **AND** urgent spare part production disrupts standard factory assembly lines schedule **AND** the adoption of ad-hoc solutions increases long-term operational complexity **THEN** organizational sustainability goals are adversely impacted by high carbon emissions from escalated freight

→ **IF** organizational sustainability goals are adversely impacted by high carbon emissions from escalated freight **AND** the adoption of ad-hoc solutions increases long-term operational complexity **AND** customer product downtime leads to a loss of organizational trust and product value **THEN** total Cost-to-Serve for aftermarket parts is disproportionately high relative to standard logistics benchmarks

The CRT figure reads bottom-up, as shown in Figure 4, following the sufficiency logic on which it is based. The bottom of the CRT is made up by the two root causes, RC #1 and RC #2, alongside FL #1, which represents an environmental factor that is constant, and amplifies the effect of the root causes. Upwards throughout the CRT are clusters of UDEs converging into the escalation chain, resulting in the critical end states at the top, UDE #3, UDE #6, and UDE#14. The self-reinforcing loop, representing the continuous connection between UDEs, root causes, and FLs are represented by the red arrow.

Figure 4. Current Reality Tree



Source: Author's own work.

The analysis of these logical chains reveals that the system's core problem is that the spare part supply chain is not segmented based on demand patterns, criticality and cost. This identifies a fundamental misalignment between the operational and the strategic environment.

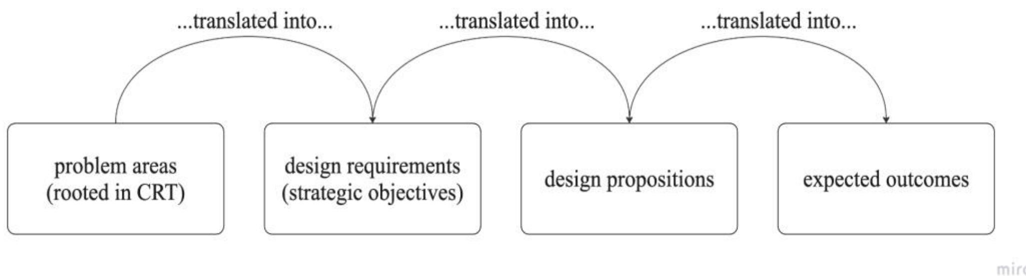
By failing to implement a segmented supply chain strategy, a persistent core conflict is created between the need to minimize inventory investment and the necessity of maximizing machine uptime. As shown in the top-level branches of the CRT, if this conflict remains unsolved, it forces the organization into a perpetual state of firefighting to compensate for the lack of tailored inventory strategies. Ultimately, the CRT suggests that without a strategic intervention to resolve this conflict and align inventory logic with the reality of SKU expansion, the system will continue to produce critical end-state UDEs. Furthermore, the CRT identifies a significant negative reinforcement loop where the reliance on ad-hoc workarounds (UDE #1) prevents the collection of clear historical data (UDE #4). This 'data-debt' further inhibits the organization's ability to implement the primary solution, supply chain segmentation. This suggests that the system will not naturally gravitate towards a solution. It requires a strategic intervention to break the cycle of reactive management.

5.4. Interventions

The core finding of the CRT is the discovery of a profound misalignment between operational execution and strategic intent. Hence, the development of the intervention follows a logic of successive translation, moving systematically from the empirical diagnosis to solution propositions, as shown in Figure 5. This process begins by converting the identified problem areas, the core misalignments in the CRT, into specific design requirements that serve as strategic objectives for the "to-be" state. These requirements act as the guiding criteria for the formulation of design propositions. Finally, the process identifies the expected outcomes of these propositions, ensuring that the proposed strategies for reconfiguring the service supply chain directly addresses the original constraints and achieves the desired strategic alignment.

Through the lens of SD logic, value is predicted to be realized through availability and responsiveness in the aftermarket rather than through the initial transaction of the sale. Strategic Alignment theory predicts that supply chain design must be differentiated in accordance with demand characteristics. Combined, these theories indicate that a firm such as the case company would have a segmented distribution structure and with clearly defined governance. However, the picture presented by the empirical material is inconsistent with this view. The empirical material consistently described fragmented ownership without defined accountability, a non-differentiated replenishment logic applied for all products, and a lack of KPIs that fosters systematic service performance. The CRT paints a picture of an organization stuck in firefighting mode based on reactive workarounds, rather than a strategically aligned framework that allows the generation of value. This discrepancy exemplifies the gap between theory and practice, and the proposed interventions are designed to target and close the gap.

Figure 5. Intervention Process



Source: Author's own work.

5.4.1. Problem Areas

The analysis of the CRT identifies four critical problem areas that drive the operational misalignment in the aftermarket. Each represents a cluster of UDEs that currently constrains the strategic potential of the aftermarket.

1. Fragmented Governance and Responsibility: A lack of global leadership and end-to-end control has resulted in a structural lack, where responsibility for spare parts flow is divided across echelons and departments.

2. Misaligned Performance and KPIs: The presence of conflicting KPIs and a lack of shared service goals forces local teams into perpetual firefighting to meet customer needs, often at the expense of global efficiency.

3. Non-segmented Supply Chain Design: The current approach fails to account for varying product characteristics or supply strategies, leading to a lack of differentiation in how spare parts are managed.

4. Mismatch between Supply and Demand: Without the decoupling of flows or distinct replenishment cycles, the system struggles to balance freight efficiency with the inherent urgency of spare parts, resulting in systemic instability.

5.4.2. Design Requirements

Consequently, the following design requirements derived in this section do not target individual symptoms/UDEs in isolation, they are formulated to address the underlying system constraint identified in the CRT, as shown in Figure 6. This is achieved through a formulation of a technological rule that captures the systemic nature of the problem and its solution space. As defined by Van Aken (2004), a technological rule represents a "chunk" of generalizable knowledge that links a specific intervention or artifact to a desired outcome or "to-be" state with a defined field of application. Framing the intervention as a technological rule enables the research to move beyond reactive "firefighting" of individual UDEs, such as volatile spare part availability or unreliable delivery times. Instead, it establishes a structured and transferable logic that connects systemic intervention to performance improvement.

1) Governance requirement

A unified point of strategic accountability must be established for aftermarket distribution design and performance management. This requirement follows from the identified root cause of fragmented responsibility (RC #2), which inhibits end-to-end control and perpetuates local and reactive workarounds. Centralized governance is therefore necessary to ensure coherent strategy deployment and system-wide coordination.

2) Performance alignment requirement

Performance metrics must be aligned across manufacturing, logistics, service and sales functions to ensure that incentives support system-wide service outcomes rather than localized efficiency targets. This requirement is grounded in the CRT's identification of conflicting KPIs as a driver of operational misalignment, reactive behavior, and sub-optimal decision-making (UDE #13).

3) Segmentation requirement

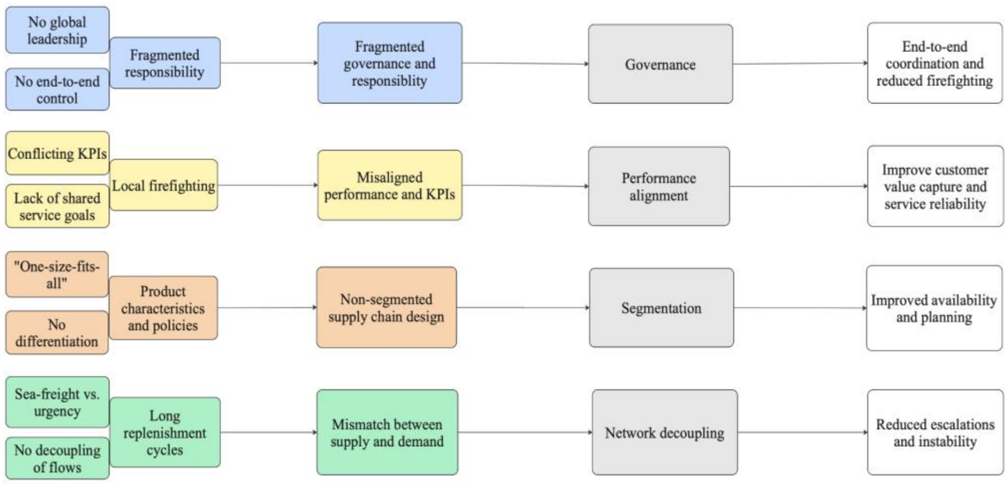
The aftermarket supply chain must be segmented to align stocking and replenishment policies with the heterogeneous characteristics of spare and service parts, including demand patterns, criticality and cost (RC #1). This requirement is derived from the CRT's identification of non-differentiated supply chain design as a core system constraint, leading to mismatches between supply mechanisms and demand behavior.

4) Network decoupling requirement

The distribution network must incorporate decoupling mechanisms that distinguish between efficiency-oriented replenishment flows and service-critical, time-sensitive demand fulfillment. This requirement emerges from the observed misalignment between standard replenishment cycles (e.g., sea freight) and urgent service requirements, which currently results in frequent escalations and reliance on costly emergency logistics (UDE #10).

Collectively, these design requirements establish a coherent set of system-level design principles that bridge empirical problem identification and solution development. By explicitly linking each requirement to underlying root causes, they ensure traceability and provide a robust foundation for the formulation of targeted interventions within the aftermarket distribution network.

Figure 6. Design Requirements



Source: Author's own work.

5.4.3. Design Propositions

The CIMO logic suggests that interventions need to be grounded in specific organizational needs, and based on the design requirements abovementioned, four interventions are proposed. Furthermore, as suggested by Dettmer (2007), the removal of one of the UDEs should collapse the chain upward from the UDE, indicating that complete treatment of the problem rather than symptoms requires interventions that target the root causes rather than the UDEs. In accordance with the CIMO logic and CRT conditions, each intervention was developed as a system-level design proposition which specifies the mechanism through which it is expected to generate outcomes. The research output from each proposed intervention is summarized in a design proposition which aims to explain how each intervention will cause an outcome, through the triggering of mechanisms, in this specific context.

Proposed Intervention 1: Centralized Governance and End-to-End Ownership

UDE # 12 identifies fragmented responsibility and lack of end-to-end accountability as a major mechanism in the enabling of escalation processes caused by insufficient stock. Without ownership, and hence accountability, there is no coherent point of authority across the organization, resulting in an aftermarket that is fragmented across logistics, service, production, and sales. As a consequence of this, decisions are made locally which decreases overall visibility, and reactive ad-hoc solutions are common which results in inconsistent performance. These points are supported by empirical data where findings exemplifies limited visibility, dependency on interpersonal communication, and delays in replenishment and inefficient distribution.

The proposed intervention suggests that the company should establish a role or function dedicated to the global aftermarket distribution governance. Responsibilities included in this role or function should be; end-to-end aftermarket strategy, decisions regarding inventory positioning across the distribution echelons, global replenishment and segmentation policies, responsibility of developing, and reporting on, relevant KPIs and coordination between involved functions. Such a function would trigger mechanisms to reduce ambiguity and enable consistency in aftermarket operations. Reducing the current fragmentation of decisions and responsibility would allow the system to work under a standardized replenishment logic, hence ensuring strategic alignment across the organization.

Design Proposition 1

In a context of global distribution of spare parts, characterized by intermittent demand and cross-functional interdependencies, reduction of fragmented decision making, through the implementation of centralized governance, will ensure strategic alignment across functions.

Proposed Intervention 2: Aftermarket Segmentation

As identified through the CRT, the core constraint in the current system is the lack of supply chain segmentation between spare parts and traditional parts, characterized by fundamentally different demand and service deliverables. As identified in the empirical material, this misalignment creates constant conflict between minimization of inventory and promised customer uptime. Furthermore, the increasing portfolio of parts, and its increasing complexity, as mentioned by multiple interviewees further undermines the distribution based on a unified replenishment logic. This results in manual processes as mentioned in UDE #8 and insufficient safety stock according to UDE #10.

The company should implement a formal segmentation model, distinguishing spare part distribution from distribution of normal goods. The segments should be linked to predefined policies, such as replenishment and inventory, related to each type of good. The basis of segmentation should explicitly recognize the differences in demand, service uptime requirements, and production and replenishment preconditions for spare parts in relation to normal goods. Each segment should be guided by a distinct distribution and replenishment logic strategically aligned with its primary objective. Through such segmentation, strategic differentiation allows for the two segments to be optimized individually, releasing more time and resources for core competencies.

Design Proposition 2

In an aftermarket context where there are differences between product groups, replenishment logic based on supply chain segmentation enables strategic differentiation of inventory and distribution which, through reduction of manual processes and ad-hoc solutions, improves availability of high variability spare parts.

Proposed Intervention 3: Multi-echelon Structure with Centralized Safety Stock

As identified in the CRT, UDE #9 and UDE #11 reflect issues connected to misalignment between standard replenishment logic and customer needs and service promises. The current network structure, which is both dependent upon a low level of inventory and reliance on sea-freight, is asynchronous with the high-criticality demand of the aftermarket. As a result of this, ad-hoc solutions and emergency airfreight prohibits environmental performance and increases total cost-to-serve as seen in UDE #3 and UDE #14.

To counteract this, the company should establish a multi-echelon network which is centralized through a global distribution center that holds safety stock through inventory of all low runner spare parts. This would allow for regional focus on keeping only efficiency stock for items where demand is more frequent or can be more easily predicted. Using the central DC for holding strategic safety stock allows for standardized distribution of intermittent parts, where service-critical parts can bypass normal production scheduling disruptions, hence shortening lead times. This structure generates a decoupling point in the aftermarket distribution network which increases availability of parts while also decreasing duplicity of low-running items across regional or local inventory.

Design Proposition 3

In global aftermarket networks characterized by critical goods with intermittent demand, positioning centralized insurance stock at a primary distribution echelon reduces regional stock-out risk through pooling effects and decreases escalation freight frequency by enabling faster access to critical inventory.

5.5. Expected Outcomes

Implementation of the suggested interventions is aimed to eliminate the core constraints as identified in the CRT through the targeting of root causes rather than the symptoms, i.e. the UDEs. Through the sufficiency logic of IF-THEN scenarios, revealing the causal interdependencies in the CRT, the interventions can be expected to remove a multitude of symptoms through the targeting of core problems. The suggested interventions result in four expected outcomes: 1. Reduction of ad-hoc workarounds, 2. Reduced lead times and improved delivery reliability, 3. Reduced disruption of factory operations, & 4. Improved transparency.

1. Reduction of Ad-hoc Workarounds

UDE #1 and UDE #2 describes a state of reactive improvisation in situations where the customer demand cannot be met. Supply chain segmentation and centralized governance in combination with clearly defined ownership is expected to reduce UDE #1 and UDE #2 through standardized practices. Furthermore, this is also expected to reduce UDE #3 and UDE #11, which regards emergency escalations of freight and administrative tasks, through a centralized stock and clearly defined replenishment rules.

2. Reduced Lead Times and Improved Delivery Reliability

UDE #5 and UDE #7, regarding fluctuating lead times and discrepancies between customer expectations and actual lead times, is expected to be reduced by the structural buffering induced by the multi-echelon network. Centralized safety stock allows for demand of critical parts to be met without increased local inventory. Additionally, a multi-echelon network with centralized safety stock also creates an environment where distribution can follow clear replenishment rules, resulting in stability of lead times and reduced emergency air freight.

3. Reduced Disruption of Factory Operations

In similarity with stabilization of lead times through replenishment rules, a decoupling of inventory through centralized safety stock also reduces the strain of production caused by emergency production of spare parts. Decoupled spare part inventory is expected to reduce UDE #9 through more stable production of spare parts as a result of clear replenishment rules.

4. Improved Process Transparency

In addition to improved lead times and stability of production, standardized replenishment policies are also expected to improve overall transparency and traceability, reducing UDE #14. Standardization of replenishment, favourably in combination with improved availability of data, will decrease the reliance on tacit knowledge and manual processes, generating consistent data that will strengthen future segmentation accuracy.

To achieve these expected outcomes, one must however consider possible trade offs and closely monitor for unintended effects in the intervention implementation. The decoupling of inventory in one centralized DC may for example increase vulnerability to disruptions, a consideration that is becoming increasingly central in supply chain management. Such a risk must be carefully considered and mitigation actions, such as contingency planning, should be implemented accordingly. Moreover, the vast product portfolio of spare parts indicates that not all items will be stocked regionally, and items ordered rarely may still be experiencing long lead times. Thus, one must keep in mind that transparency of service promises is still highly relevant to reduce UDE #7. Additionally, any organizational change may be expected to experience some resistance and short-term increase of costs, which needs to be managed in order for the organization to sustain the change. For example, centralized governance and KPI alignment may find resistance from local teams that are used to having their own autonomy of decisions. Hence, an intervention of governance must be clearly supported by top management and the organization in its entirety, which requires motivation and defined support of the change.

In conclusion, the CRT highlights key constraints to the current system, lack of segmentation and fragmented ownership. The four proposed interventions aim to address these root causes directly, hence also reducing the UDEs caused by the root causes. Despite some expected tradeoffs, the suggested interventions are expected to lower overall cost-to-serve, reducing UDE #14, and improve customer trust and loyalty, reducing UDE #6. Through these changes, the company is expected to transform from a reactive aftermarket distribution model to a strategically aligned multi-echelon distribution system.

6. Discussion

This chapter discusses the research findings in light of the two guiding research questions, evaluating the robustness and the utility of the developed segmented distribution artifact. Following the DSR approach, the discussion moves beyond the specific case company to extract generalized design knowledge. By synthesizing the core problems identified by RQ1 with the strategic interventions proposed in RQ2, this section demonstrates how a segmented distribution capability resolves systemic misalignments in the high-tech medical simulation aftermarket.

6.1. Key Findings: Core problems

The challenges observed within the case company are not reduced to operational shortcomings or managerial failure. They reflect something more structurally significant, a state where the problem itself resists a stable definition because its causes are interconnected and tangled (as exemplified in the CRT). Its boundaries are contested, and any intervention inevitably reshapes the problem it seeks to solve. This framing is important as it resists the temptation to treat the observed problems as repairable through incremental process improvement. Instead, what the empirical material reveals, is a system that is rational at the local level but corrosive at the systemic level.

6.1.1. Fragmented Governance and the Paradox of Decentralization

A core finding is the state of fragmented governance, where responsibility is dispersed throughout the service chain in ways that produce local responsiveness at the cost of systemic coherence. This fragmentation is not accidental, but a predictable consequence of organizational growth that outpaced the governance structures initially designed to manage it. Hence, TCs and local teams become first-responders by necessity rather than design, ultimately absorbing the systemic failures at the point of occurrence, rather than resolving them at the point of origin.

This invites a direct line with Wagner et al. (2012), who identifies top-performers in the aftermarket to have dedicated after-sales departments. On the other hand, the authors present that bottom-performers lack this governance structure. However, where Wagner et al. (2012) treat governance fragmentation primarily as an organizational design failure, a problem of unclear mandates and misallocated responsibility, the empirical material from this case suggests something more nuanced. Where fragmentation is actively sustained by an incentive that makes ad-hoc workarounds more rewarding than systemic compliance. The global logistics function is not simply absent from local outcomes, it is structurally positioned to remain absent, as it does not capture the cost of the absence, as identified by Interviewee 4. The underlying incentive structure must therefore be realigned simultaneously, or there is a risk that the new governance incentives will simply be absorbed into the existing workaround structure.

A further interpretation in this research is that decentralization, in this context, functions as a paradox of organizational maturity. The global dispersion of decision-making authority was at an earlier stage of development, a source of agility. It is now a constraint. The TCs that once operated as periphery outposts have become global nodes in a service network with increased complexity.

6.1.2. KPI and Performance Gap

The lack of a central governance structure perpetuates a silo-mentality, where the aftermarket is then managed in functional isolation. Service teams measure repair volumes, local teams prioritize customer satisfaction, and the manufacturing function operates without meaningful KPIs for spare and service parts production. The result is a strategic dissonance, where the high-level goal of customer satisfaction remains constant, but the functional paths toward this goal are contradictory.

The empirical material points to a deeper issue than the absence of shared metrics and KPIs, the functions involved hold fundamentally different views of what the aftermarket is. Manufacturing treats spare part production as a low-priority, low-revenue activity, while service teams treat this as their core responsibility. This misalignment is not a coordination problem that KPIs can resolve on its own. Wagner et al. (2012) stress that aftermarket performance must be continuously monitored against both operational benchmarks and customer feedback, yet this assumes that the functions responsible for service delivery share a common understanding of what good performance looks like. In this case, this shared understanding does not explicitly exist. This stresses the need for the aftermarket to be recognized as a strategic priority.

6.1.3. The Non-Segmented Design as a Core Constraint

Closely intertwined with the governance challenge is the absence of a formally segmented supply chain design for spare and service parts. Aftermarket components are currently managed through a replenishment logic that fails to account for wide variability in demand, service criticality, and cost characteristics. By treating spare and service parts as a homogenous flow, the case company lacks the nuances to manage components based on their specific profiles, a condition that from a DSR perspective, represents a significant malalignment between the complexity of the aftermarket and the systemic response.

The theoretical foundation for segmentation as an intervention reaches back to Smith (1956), whose work challenged classical assumptions about market homogeneity, arguing that real-world markets are characterized by fundamental diversity in both supply and demand. For Smith (1956), a firm's market position is determined by its ability to define and penetrate segments, precisely aligning resources with differentiated customer needs. Applying this logic in the aftermarket, however, is inherently more challenging than in primary production contexts. Product heterogeneity is more pronounced as posited by Ärnas & Woxenius (2013), and the dramatic increase in SKUs makes precise alignment a significant logistical challenge. This research argues that it is precisely this complexity that makes segmentation not optional but necessary.

6.1.4. Mismatch Between Supply Capabilities and Demand Requirements

Cohen et al. (2006) argue that the effective spare parts management requires firms to navigate two interlocking hierarchies simultaneously; a product hierarchy, where the decision of whether to stock complete units or modules carries distinct cost and response time implications, and a geographical hierarchy, where the distance between stock and customer directly determines response speed and cost. The interplay between these two hierarchies, Cohen et al. (2006) contend, is what allows firms to intelligently deploy assets in a way that matches supply with demand. This research confirms the diagnostic power of that recognition, but finds that the case company has collapsed both hierarchies into one single flow, making it difficult to exploit the trade-offs described by Cohen et al. (2012).

This structural malalignment ultimately produces a mismatch between supply capabilities and demand requirements, that can be located within the Lean-Agile School of supply chain thought (Fisher, 1997; Christopher & Towill, 2000). The DWV3 framework, which profiles demand alongside dimensions of demand variability, volume and velocity, provides the analytical vocabulary for understanding why the system struggles. It attempts to apply Lean pipeline efficiency to a demand environment that is inherently volatile and low-volume.

Consequently, the observed firefighting can be seen as a symptom of a design that lacks the segmentation required to balance these competing paradigms.

6.2. Key findings: Segmented Distribution as a Mechanism for Aftermarket Optimization

The artifact developed in this research does not introduce entirely new concepts; segmentation, multi-echelon design and centralized governance, are each established in literature. What it contributes to is their synthesis into a coherent configuration logic purposely designed for the aftermarket, where these concepts have rarely been designed to work together. Underlying this synthesis is a theoretical reorientation, where the artifacts treat the aftermarket not as a downstream extension of manufacturing flow, but as a value co-creation arena, where service performance is jointly produced by the firm and its customers (Vargo & Lush, 2004). From this perspective, distribution network design is not only a logistical concern, but a strategic one as well, where the configuration of a network either enables or prevents the firm from fulfilling its role as a service provider. This reorientation has direct implications for how the three interventions are understood and evaluated.

6.2.1. Centralization of Aftermarket Governance

Centralized governance has been proposed in the literature as a remedy for coordination complexities (Wagner et al., 2012), but typically in isolation from the distribution logic it is meant to support. This research argues that governance centralization produces value when coupled with a segmented distribution logic, as without segmentation, a central authority enforces the same undifferentiated rules, which does not resolve the underlying structural mismatch. Viewed through the lens of Strategic Alignment Theory (Chorn, 1991; Gattorna, 1998), this intervention serves a deeper purpose. It creates the organizational conditions under which market requirements, strategy, and operational culture can be brought into synergy. Without a centralized authority defining and protecting aftermarket-specific service requirements, the alignment between what customers require and what the distribution network delivers remain unintended rather than designed.

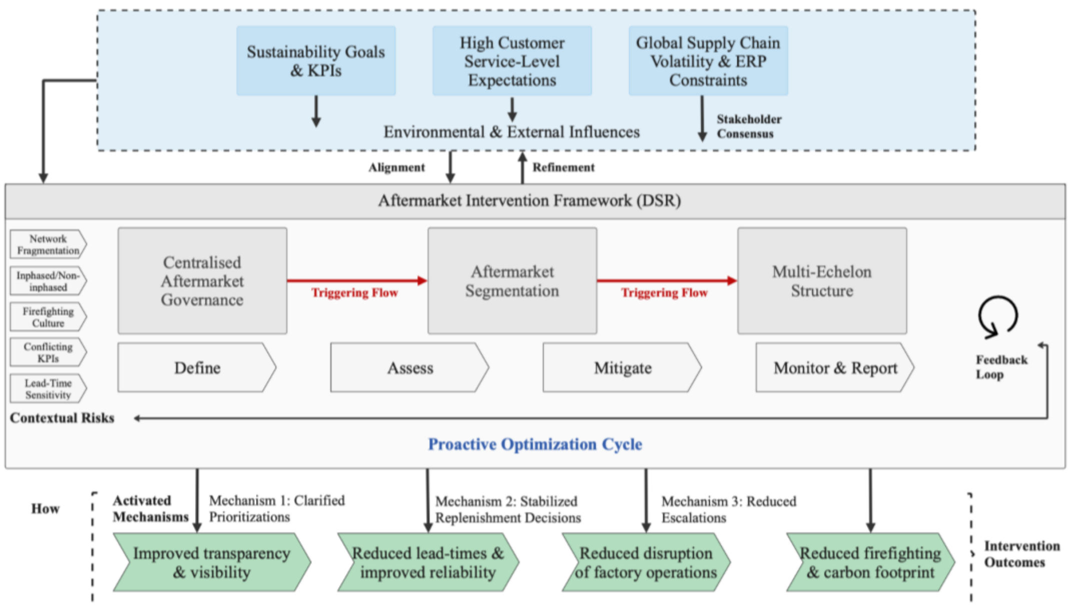
6.2.2. Segmentation as a Mechanism

While segmentation theory and lean-agile frameworks are well-established, their application in aftermarket contexts has remained underdeveloped (Godsell et al., 2011), a gap that becomes increasingly significant as portfolio complexity grows and the cost of undifferentiated treatment compounds (Cohen et al., 2006). The theoretical extension of this research argues that service criticality constitutes a necessary dimension, reflecting the nature of spare part value in aftermarket contexts. This extension is grounded in Vargo & Lusch's (2004) observation that value is determined by the customer in-use rather than embedded in the product. A component's criticality is not intrinsic, it is relational, defined by what its absence means for the customer's operational continuity. Segmentation logic that ignores this dimension will systematically prioritize volume over consequence, misallocating resources in precisely the situations where availability matters the most.

6.2.3. Multi-Echelon Design and the Aftermarket Decoupling Point

The multi-echelon structure and decoupling point are well-documented principles in supply chain literature (Basten & van Houtum, 2014; Wang & Lin, 2014). Their application in the aftermarket context, however, carries a specific interpretive claim, the decoupling point is not merely an inventory parameter but an organizational boundary, the points at which aftermarket logic separates from primary distribution. Wang & Lin (2014) suggest that lateral sourcing between regional nodes strengthens robustness and reduces lead time under intermittent demand, complementing the centralized safety stock logic and reducing dependence on emergency shipments. Taken together, the three interventions are not simply cumulative, but mutually constitutive. Governance makes segmentation enforceable, segmentation gives the decoupling point its operational meaning, and the decoupling point gives governance a structural mechanism through which service requirements can be physically realized across the network. In this sense, the artifact as a whole enacts the strategic alignment that Gattorna (1998) describes.

Figure 7. The Artifact: Aftermarket Intervention Framework for Strategic Optimization



Source: Author's own work.

6.2.4. Expected Outcomes of the Artifact

As illustrated in Figure 7, the three interventions; centralized governance, aftermarket segmentation and multi-echelon structure, do not operate as isolated improvements but as an integrated architecture whose value lies in their combination. From a DSR perspective, the artifact is evaluated not only by the rigor of its construction, but by the outcomes it is expected to produce in the organizational context it addresses (Hevner et al., 2004). The coherence of the artifact activates three logical mechanisms; clarified prioritization, stabilized replenishment decisions and reduced escalations. These mechanisms function as the bridge between structural intervention and strategic outcome, translating design intent into operational behaviors.

Collectively, they enable a transition from a reactive, manually driven model characterized by firefighting and ad-hoc coordination, toward a strategically governed distribution network in which material flows are structurally aligned with service commitments. In Vargo & Lusch's (2004) terms, this transition reorients the organization from a goods-dominant logic toward a service-dominant logic, where distribution is the mechanism through which customer value is reliably co-created. The expected outcomes of this transition are therefore not merely operational gains in availability and lead time, but a structural repositioning of the aftermarket as a strategically governed capability.

7. Conclusions

The final chapter aims to synthesize research findings, and evaluate the research's contribution to the field of spare parts management and relevant theories. It outlines the theoretical, managerial and societal implications of the research while addressing limitations and potential avenues for future research.

7.1. Research Implications

7.1.1. Theoretical Implications

The findings of this study contribute to the growing body of literature on aftermarket supply chains by demonstrating how operational misalignment emerges when standardized distribution structures are applied to heterogeneous and service-critical spare part environments. Through the combined application of SD logic and Strategic Alignment Theory, the study expands the current understanding of how aftermarket distribution networks function not merely as a logistical subunit, but as a central enabler of value realization in the aftermarket.

First, the findings extend SD logic by illustrating how spare part availability and distribution responsiveness become critical mechanisms for value creation in the aftermarket. While SD logic envisions goods as distribution mechanisms for service provision (Vargo & Lusch, 2004), the empirical findings of this study demonstrate that the distribution network itself becomes a key determinant of whether this value can actually be realized. In the study, delayed or unavailable spare parts does not only create inefficiencies, but it directly prevents customers from conducting mission-critical healthcare training activities. This suggests that aftermarket logistics and spare parts distribution is not to be viewed as secondary support functions, but as an integrated service capability that directly influences value-in-use. Consequently, the study contributes to SD logic through the use of DSR, by operationalizing how value creation in industrial industries is dependent on the alignment between distribution capabilities and aftermarket demand characteristics.

Furthermore, the research refines Strategic Alignment Theory within the context of aftermarket supply chains. While Fisher's (1997) framework primarily captures alignment as a fit between product characteristics and supply chain design, the findings suggest that alignment in this context requires broader considerations of service criticality, urgency and lifecycle complexity. The analysis depicts that the current operational instability identified does not initially stem from isolated inefficiencies, but rather from a structural mismatch between standardized replenishment logic and the heterogeneous characteristics of spare and service part demand. The findings specifically indicate that applying Lean and efficiency-oriented manufacturing logic to the aftermarket generates a systemic instability, manifested through reactive firefighting, fragmented governance, emergency freight escalation and informal mechanisms.

The findings further contribute to the field of supply chain management segmentation by conceptualizing segmentation as a systemic mechanism rather than solely an inventory optimization tool. Existing segmentation models often emphasize forecasting efficiency, SKU classification or differentiated stocking strategies. However, the findings of this study indicate that segmentation also performs an organizational and governance-oriented function by reducing operational vagueness and enabling differentiated service responses across varying demand conditions. In particular, the CRT analysis demonstrates that the absence of segmentation contributes to not only inventory shortages, but also fragmented accountability, KPI conflicts, information asymmetry, and excessive reliance on tacit knowledge and ad-hoc workarounds.

Therefore, the proposed segmented distribution framework extends the current understanding of segmentation by framing it as a mechanism for achieving structural alignment across logistics, manufacturing, service and governance functions. In this respect, segmentation then becomes a coordinating architecture capable of stabilizing operational flows in complex aftermarket distribution networks.

7.1.2. Managerial Implications

The findings of this study contain several important implications for managers responsible for aftermarket operations and spare parts distribution in global supply chains. Overall, the results suggest that improving aftermarket performance is less a question of efficiency improvements, but a question of fundamentally redesigning how aftermarket distribution networks are structured, governed and prioritized.

Firstly, the analysis highlights the importance of supply chain segmentation as a core design principle rather than an operational adjustment. The current distribution logic leads to systemic mismatches between demand characteristics and supply responses, particularly for low-volume, high-criticality spare parts. Managers should therefore move away from uniform replenishment strategies and implement differentiated policies based on factors such as demand volatility, product criticality, and service urgency. In practice, this may involve repeating fast-response flows from cost-efficient bulk replenishment flows.

Secondly, the study demonstrates the need for clearer governance structures and end-to-end accountability for spare parts distribution and service performance across manufacturing, logistics, service and sales functions. This also includes aligning KPIs across departments to reduce conflicting priorities between manufacturing efficiency, sustainability goals and customer service responsiveness.

The research also emphasizes the importance of improving digital visibility and reducing reliance on manual workaround processes. The current dependence on e-mail-based ordering, tacit knowledge and ad-hoc workarounds increases administrative complexity and pressure, and ultimately reduces the opportunity to reach competitive advantages in the aftermarket. Professionals in the aftermarket should therefore prioritize integrated systems that improve spare parts visibility, automate information flows and support proactive decision-making across the aftermarket network.

Finally, the findings suggest that global aftermarket managers and professionals should prioritize customer uptime and service continuity when designing aftermarket distribution networks. In practice, this means that critical spare and service parts upholding the entire functionality of a product may require differentiated replenishment structures compared to standard products. Due to the findings of this research, managers should therefore evaluate aftermarket performance not only through logistics cost and efficiency, but also through the operational consequences of customer downtime.

7.1.3. Societal Implications

The strategic realignment established through the artifact extends beyond operational and organizational performance, highlighting broader societal implications related to healthcare preparedness, sustainability and resource utilization. In the studied context, spare parts availability (or lack thereof) directly impacts the ability of healthcare professionals and training institutions to conduct medical simulations and emergency response training. Consequently, disruptions in the aftermarket service flows may indirectly affect the continuity and quality of healthcare education and preparedness activities.

The study also highlights the societal implications of inefficient aftermarket structures from a sustainable perspective. The current reliance on emergency freight and reactive logistics responses increases carbon emissions and resource consumption, particularly through escalated air transshipment. The findings therefore suggest that a more strategically aligned aftermarket network may contribute not only to improved service responsiveness, but also to reduced environmental impact through more predictable and proactive replenishment strategies.

Furthermore, the findings emphasize the importance of extending product lifecycles through effective aftermarket management. Improved spare part availability and repair capability may reduce unnecessary part replacement and contribute to more circular and resource-efficient consumption patterns. In this respect, a strategically aligned aftermarket network may support both organizational performance and broader societal goals related to sustainability and long-term resource stewardship.

7.2. Limitations

While the research provides deep insights into the medical simulation aftermarket, several methodological and contextual limitations must be acknowledged. First, as the findings are rooted in a single organizational context, and data is drawn from a limited selection of interviewees, the statistical generalizability of the artifact is constrained. However, the findings support analytical generalization through the identification and discussion of mechanisms common across multiple entities within a similar context. Furthermore, the identification of RCs and the selection of requirements are influenced by the researcher's interpretation of interview material and observations. This subjectivity may affect the construct validity of the study, as the transition from raw material data to the logical links in the CRT relies on the researcher's analytical lens. In addition, the snapshot nature of the CRT captures operational realities at a specific point in time, meaning it does not fully account for the long-term shifts or seasonal demand variations that could alter the causal logic of the analysis over an extended period of time.

The research was further constrained by the availability of key personnel across different global regions. While a representative sample was interviewed, the perspectives of certain regional hubs may be underrepresented, potentially overlooking specific local logistical hurdles that could affect the global rollout of an aftermarket strategy. This compounded by the sensitive nature of supply chain performance and competitive advantages, certain proprietary data and specific performance metrics were generalized. This presents an obstacle in presenting the full magnitude of the misalignment.

As common in DSR, this study focuses on the design and initial evaluation of the artifact rather than its long-term implementation. Consequently, the research concludes at the point of strategic suggestion, leaving any unintended long-term consequences of the new design remain outside the current scope. Finally, due to the time constraint of the thesis, the number of "build-evaluate" cycles were limited. While the artifact was validated through expert feedback and logical verification, a more extensive longitudinal study would be required to observe the full stabilization of the system in a live environment.

7.3. Future Research

While this thesis contributes with a managerial framework aimed at improving strategic alignment in aftermarket distribution, there are several remaining opportunities for future research. Firstly, the utilization of DSR in logistics and supply chain management could be expanded, as the body of existing research within the field is outweighed by explanatory research rather than prescriptive and solution-oriented contributions. By conducting additional studies exploring solutions to aftermarket problems in real organizational environments, the presented artifact could be strengthened. This would allow researchers to refine the rules for decision making and produce outputs with stronger direct relevance for industry decision-making.

Secondly, future research would benefit from a more extensive, longitudinal research approach which allows the proposed interventions to be followed and evaluated over time. Such an approach would allow for evaluation of whether the expected outcomes are actually realized over time in practice. A longitudinal perspective would also allow for the identification of unintended consequences of the interventions, such as for example new bottlenecks or organizational resistance emerging after implementation. This would allow for a cycle of evaluation and refinement, which would strengthen the proposed interventions, ultimately creating a stronger artifact in relation to real organizational problems.

Finally, future research would benefit from exploration of how AI and emerging advanced analytics may support aftermarket operations. A central finding in this study is the reliance on manual processes and problems related to limited visibility, and a key characteristic of spare parts is the difficulty related to forecasting using traditional methods. Using AI to develop forecasting, detection of chances in inventory or demand, and decision-making could potentially strengthen the accuracy of interventions through the reduction of variances or detection of patterns undetectable by humans. As a result, such implementation could enable more dynamic alignment between aftermarket components, demand, and distribution.

7.4. Concluding Remarks

This thesis aims to explore the emergence of operational misalignment in global aftermarket distribution networks. The research was conducted through an embedded single case study of Laerdal Medical, a global medical simulation provider. The findings indicate that identified inefficiencies were not isolated operational problems, but rather symptoms of deeper structural constraints. The analysis demonstrated that core problems of fragmented governance, conflicting KPIs, and the absence of segmentation between traditional goods and spare parts resulted in a system with limited visibility and inconsistent service performance.

Through the application of DSR, the study developed a managerial artifact, a framework addressing the identified root causes. The proposed framework introduces the interventions of centralized governance, principles of segmentation, and a multi-echelon distribution network with centralized safety stock to better align the aftermarket network with the unique characteristics of intermittent and service-critical demand. Hence, the artifact represents a fundamental reorientation, from viewing the aftermarket distribution network as an extension of the traditional supply chain, towards treating it as a strategically differentiated function of the organization.

In a final concluding remark, the study emphasizes the importance of deliberate structural reformation aimed at aligning service expectations and distribution design. While the artifact is grounded in the specific context of the case, the findings and the identified mechanisms reflect challenges commonly observed among a multitude of global manufacturers and service providers. Consequently, this thesis contributes both theoretical and practical insights that support a broader understanding of aftermarket logistics as a critical enabler of value creation and effective service delivery.

References

Aken, J.E. van (2004). Management Research Based on the Paradigm of the Design Sciences: The Quest for Field-Tested and Grounded Technological Rules. *Journal of Management Studies*, 41(2), pp. 219–246. doi: https://doi.org/10.1111/j.1467-6486.2004.00430.x.

Alam, I. (2002). An Exploratory Investigation of User Involvement in New Service Development. *Journal of the Academy of Marketing Science*, [online] 30(3), pp. 250–261. doi: https://doi.org/10.1177/0092070302303006.

Alvesson, M and Sköldberg, K. (2004). *Reflexive methodology: new vistas for qualitative research*. London: Sage.

Armistead, C. and Clark, G. (1991). A Framework for Formulating After-sales Support Strategy. *International Journal of Operations & Production Management*, 11(3), pp. 111–124. doi: https://doi.org/10.1108/eum0000000001269.

Arnäs, P.O. and Woxenius, J. (2013). Approach for handling heterogeneous goods in intermodal freight networks - revisited. In: *13th WCTR*. The 13th World Conference on Transport Research.

Arnould, E.J. (2007). Service-Dominant Logic and Consumer Culture Theory: Natural Allies in an Emerging Paradigm. *Emerald Group Publishing Limited eBooks*, 2111(06), pp. 57–76. doi: https://doi.org/10.1016/s0885-2111(06)11025-x.

Asmussen, J. N., Kristensen, J. and Wæhrens, B. V. (2018). Cost Estimation Accuracy in Supply Chain Design: The Role of Decision-Making Complexity and Management Attention. *International Journal of Physical Distribution and Logistics Management.* 48(10), pp. 995-1019. doi: https://doi.org/10.1108/IJPDLM-07-2018-0268

Barrios, H. E. M., Mosquera, J.D.S and Sanchez, A. R. (2022). OBSERVATION AS A RESEARCH TECHNIQUE. (REFLECTIONS, TYPES, RECOMMENDATIONS AND EXAMPLES). *Russian Law Journal*, 10(4). doi: https://doi.org/10.52783/rlj.v10i4.4348

Basten, R. J. I. and van Houtum, G. J. (2014). System-oriented inventory models for spare parts. *Surveys in Operations Research and Management Science.* 19(1), pp. 34-55. doi: https://doi.org/10.1016/j.sorms.2014.05.002

Bayraktar, E., Jothishankar, M.C., Tatoglu, E. and Wu, T. (2007). Evolution of operations management: past, present and future. *Management Research News*, [online] 30(11), pp. 843–871. doi: https://doi.org/10.1108/01409170710832278.

Cavalieri, S., Gaiardelli, P. and Ierace, S. (2007). Aligning strategic profiles with operational metrics in after-sales service. *International Journal of Productivity and Performance Management*, 56(5/6), pp. 436–455. doi: https://doi.org/10.1108/17410400710757132.

Cavalieri, S., Garetti, M., Macchi, M. and Pinto, R. (2008). A decision-making framework for managing maintenance spare parts. *Production Planning & Control*, 19(4), pp. 379–396. doi: https://doi.org/10.1080/09537280802034471.

Chan, Y.E. and Reich, B.H. (2007). IT Alignment: What Have We Learned? *Journal of Information Technology*, 22(4), pp .297–315. doi: https://doi.org/10.1057/palgrave.jit.2000109.

Charmaz, K. (2006). *Constructing grounded theory: a practical guide through qualitative analysis.* SAGE Publications: London.

Chase, R. B., Jacobs, R. and Aquilano, N. J. (2006). *Operations Management for Competitive Advantage.* McGraw-Hill: Irwin.

Chopra, S. and Sodhi, Manmohan.S. (2004). Managing Risk to Avoid Supply-Chain Breakdown. *MIT Sloan Management Review*, [online] 46(1). Available at: https://www.researchgate.net/publication/237646139_Managing_Risk_to_Avoid_Supply-Chain_Breakdown [Accessed 18 March 2026].

Chorn, N.H. (1991). The 'Alignment' Theory: Creating Strategic Fit. *Management Decision*, 29(1). doi: https://doi.org/10.1108/eum0000000000066.

Christopher, M and Towill, D.R. (2000). Supply Chain Migration from Lean and Functional to Agile and Customised. *Supply Chain Management: An International Journal*, 5(4), pp. 206–213. doi: https://doi.org/10.1108/13598540010347334.

Ciborra, C. (1997). De profundis? Deconstructing the concept of strategic alignment. *Scandinavian Journal of Information Systems*, 9(1), pp. 67–82. doi: https://doi.org/10.17705/3sjis.00902.

Clark, T., Foster, L., Sloan, L. and Bryman, A. (2021). *Bryman's Social Research Methods*. 6th ed. Oxford: Oxford University Press.

Cohen, M. A., Argawal, N., and Agrawal, V. (2006). *Winning in the Aftermarket.* Harvard Business Review. https://fishmandavidson.wharton.upenn.edu/wp-content/uploads/2016/06/Winning-in-the-Aftermarket_HBR_May_06.pdf

Cohen, M.A., Kleindorfer, P.R. and Lee, H.L. (1986). Optimal stocking policies for low usage items in multi-echelon inventory systems. *Naval Research Logistics Quarterly*, 33(1), pp. 17–38. doi: https://doi.org/10.1002/nav.3800330103.

Cox, J.F. and Schleier, J.G. (2011). *Theory of constraints handbook*. New York Mcgraw Hill Professional.

Denzin, N. K. (1978). Triangulation: A Case for Methodological Evaluation and Combination. *Sociological Methods*, pp. 339-357.

Dettmer, W. (2007). *The Logical Thinking Process*. Quality Press.

Diener, E., Diener, E. and Crandall, R. (1978). *Ethics in Social and Behavioral Research*. Chicago: University of Chicago Press.

Dong, A. (2009). *The Language of Design: Theory and Computation.* Springer: London.

Dresch, A., Daniel Pacheco Lacerda and Valle, A. (2015). *Design science research: a method for science and technology advancement*. Cham: Springer.

Dresch, A., Lacerda, D. P and Valle, A. (2019). Design science in operations management: conceptual foundations and literature analysis. *Brazilian Journal of Operations & Production Management.* 16 (2), pp. 333-346. doi: 10.14488/BJOPM.2019.v16.n2.a13

Filippini, R. (1997). Operations management research: some reflections on evolution, models and empirical studies in OM. *International Journal of Operations & Production Management*, 17 (7), pp. 655–670. doi: https://doi.org/10.1108/01443579710175583.

Fisher, M. (1997). What Is the Right Supply Chain for Your Product? *Harvard Business Review*, [online] (March-April Issue), Jan. Available at: https://hbr.org/1997/03/what-is-the-right-supply-chain-for-your-product [Accessed 18 March 2026].

Flick, U. (2009). *An introduction to qualitative research.* 4th ed. London: Sage.

Gattorna, J. (1998). *Strategic Supply Chain Alignment Best Practice in Supply Chain Management*. 1st ed. London: Routledge.

Godsell, J., Diefenbach, T., Clemmow, C., Towill, D. and Christopher, M. (2011). Enabling supply chain segmentation through demand profiling. *International*

Journal of Physical Distribution & Logistics Management, 41(3), pp. 296–314. doi: https://doi.org/10.1108/09600031111123804.

Goldratt, E.M. (1990). *The Haystack Syndrome, Limited*. Gower Publishing Company.

Grand View Research (2024). *Medical Simulation Market (2026-2033): Size, Share & Trends Analysis Report By Product & Services (Healthcare Simulation Software, Simulation Training Services), By Technology (Virtual Patient Simulation, 3D Printing), By End Use, By Region, And Segment Forecasts*. [Online] Available at: https://www.grandviewresearch.com/industry-analysis/medical-healthcare-simulation-market [Accessed: 13 May 2026].

Grenvik, A. and Schaefer, J. (2004). From Resusci-Anne to Sim-Man: The evolution of simulators in medicine. *Critical Care Medicine*, 32(Supplement), pp. 56–S57. doi: https://doi.org/10.1097/00003246-200402001-00010.

Groop, J., Ketokivi, M., Gupta, M. and Holmstrom, J. (2017), "Improving home care: knowledge creation through engagement and design", Journal of Operations Management, Vol. 53 No. 1, pp. 9-22, doi: 10.1016/j.jom.2017.11.001.

Gupta, M., Lowalekar, H., Chaudhari, C.V. and Groop, J. (2024). A design science approach to manage spare parts distribution: combining design logic and Goldratt's thinking processes. *International Journal of Physical Distribution & Logistics Management*, 54(7-8), pp. 775–801. doi: https://doi.org/10.1108/ijpdlm-08-2023-0288.

Henderson, J.C. and Venkatraman, H. (1999). Strategic alignment: Leveraging information technology for transforming organizations. *IBM Systems Journal*, 38(2.3), pp. 472–484. doi: https://doi.org/10.1147/sj.1999.5387096.

Hermanowicz, J. C. (2013). The Longitudinal Qualitative Interview. *Qualitative Sociology.* 36(2), pp. 189-208. doi: 10.1007/s11133-013-9247-7

Hevner, A., March, S., Park, J. and Ram, S. (2004). Design Science in Information Systems Research. *MIS Quarterly*, [online] 28(1), pp. 75–105. doi: https://doi.org/10.2307/25148625.

Hietanen, J., Andéhn, M. and Bradshaw, A. (2017). Against the implicit politics of service-dominant logic. *Marketing Theory*, 18(1), pp. 101–119. doi: https://doi.org/10.1177/1470593117692023.

Holmström, J., Ketokivi, M. and Hameri, A.P. (2009). Bridging Practice and Theory: A Design Science Approach. *Decision Sciences*, 40(1), pp. 65–87. doi: https://doi.org/10.1111/j.1540-5915.2008.00221.x.

Holopainen, J., Mattila, O., Pöyry, E. and Parvinen, P. (2020). Applying design science research methodology in the development of virtual reality forest management services. *Forest Policy and Economics,* 116. doi: https://doi.org/10.1016/j.forpol.2020.102190

Hopp, W.J. and Spearman, M.L. (1995). *Factory Physics : Foundations of Manufacturing Management*. Irwin/McGraw-Hill.

Huiskonen, J. (2001). Maintenance spare parts logistics: Special characteristics and strategic choices. *International Journal of Production Economics*, 71(1-3), pp. 125–133. doi: https://doi.org/10.1016/s0925-5273(00)00112-2.

IDEO. (2015). *The Field Guide to Human-Centered Design.* 1st Ed. [Online] Available at: https://design-kit-production.s3.us-west-1.amazonaws.com/ [Accessed: 20 March 2026].

Ivan Su, S., Fan, X. and Shou, Y. (2020). A design science-based case study of retail chain delivery operations and its implications. *International Journal of Physical Distribution and Logistics Management.* 51(3), pp. 212-235. doi: https://doi.org/10.1108/IJPDLM-11-2019-0352

Jacobs, A., Nieman, W., and Kotzé, T. G. (2017). Spare Parts Logistics for Aftersales Support: A Case Study in the South African Automotive Industry. In: *Conference: 1st African Operations Management Conference, 2-4 Oct 2017, Misty Hills, Johannesburg*, p. 1-14. https://www.researchgate.net/publication/326041161_SPARE_PARTS_LOGISTICS_FOR_AFTERSALES_SUPPORT_A_CASE_STUDY_IN_THE_SOUTH_AFRICAN_AUTOMOTIVE_INDUSTRY

Jouni, P., Huiskonen, J. and Pirttilä, T. (2011). Improving global spare parts distribution chain performance through part categorization: A case study. *International Journal of Production Economics*, 133(1), pp. 164–171. doi: https://doi.org/10.1016/j.ijpe.2010.12.025.

Kalaiarasan, R., Agrawal, T.K., Olhager, J., Wiktorsson, M. and Hauge, J.B. (2023). Supply chain visibility for improving inbound logistics: a design science approach. *International Journal of Production Research*, 61(15), pp. 5228–5243. doi: https://doi.org/10.1080/00207543.2022.2099321.

Kervazo, F., Yeon, H., Trottier, S., Fonseca, A. and Rivera, S. (2025). *How aftermarket service providers can meet new customer expectations.* [online]. Available at: https://www.mckinsey.com/capabilities/operations/our-insights/how-aftermarket-service-providers-can-meet-new-customer-expectations [Accessed 15 May 2026].

Krajewski, L. J., Ritzman, L. P. and Malhotra, M. J. (2011). *Operations Management: Processes and Supply Chains.* Pearson Education, 9th ed.

Kutanoglu, E. and Lohiya, D. (2008). Integrated inventory and transportation mode selection: A service parts logistics system. *Transportation Research Part E: Logistics and Transportation Review*, 44(5), pp. 665–683. doi: https://doi.org/10.1016/j.tre.2007.02.001.

Laerdal Medical (2026) *About us*. [Online] Available at: https://laerdal.com/au/about-us/ [Accessed: 13 May 2026].

Lincoln, Y. S., and Guba, E. G. (1985). *Naturalistic inquiry.* Beverly Hills, CA; Sage.

Mangiaracina, R., Perego, A., Seghezzi, A. and Tumino, A. (2019). Innovative solutions to increase last-mile delivery efficiency in B2C e-commerce: a literature review. *International Journal of Physical Distribution & Logistics Management*, [online] 49(9), pp. 901–920. doi: https://doi.org/10.1108/ijpdlm-02-2019-0048.

McKinsey & Company (2017). *Industrial Aftermarket Services.* [online]. Available at: https://www.mckinsey.com/~/media/McKinsey/Industries/Advanced%20Electronics/Our%20Insights/Industrial%20aftermarket%20services%20Growing%20the%20core/Industrial-aftermarket-services-Growing-the-core.ashx [Accessed: 18 May 2026]

Mohedas, I., Daly, S. R., Loweth, R. P., Huynh, L., Cravens, G. L. and Sienko, K. H. (2022). The use of recommended interviewing practices by novice engineering designers to elicit information during requirements development. *Design Science*, 8. doi: https://doi.org/10.1017/dsj.2022.4.

Mordor Intelligence (2026) Medical simulation market size and share analysis – growth trends and forecasts (2026–2031). Hyderabad: Mordor Intelligence.

[online]:https://www.mordorintelligence.com/industry-reports/medical-simulation-market [Accessed: 29 April 2026].

Näslund, D. (2024). Action research in LSCM since 2010 – the emergence of design science. *The International Journal of Logistics Management*, 36(1), pp. 118–142. doi: https://doi.org/10.1108/ijlm-02-2024-0105.

Noreen, E., Smith, D. and Mackey, J. (1995). *Theory of Constraints and Its Implications for Management Accounting: A Report on the Actual Implementation of the Theory of Constraints*. North River Press: Boca Raton, Florida.

Olmos-Vega, F., Stalmeijer, R., Varpio, L. and Kahlke, R. (2022). A Practical Guide to Reflexivity in Qualitative research: AMEE Guide no. 149. *Medical Teacher*, [online] 45(149), pp. 1–11. doi: https://doi.org/10.1080/0142159X.2022.2057287.

Orlicky, J. and Plossl, G. (1994). *Orlicky's Material Requirements Planning*. New York: McGraw-Hill.

Peffers, K., Tuunanen, T., Rothenberger, M.A. and Chatterjee, S. (2007). A Design Science Research Methodology for Information Systems Research. *Journal of Management Information Systems*, 24(3), pp. 45–77. doi: https://doi.org/10.2753/mis0742-1222240302.

Peltokorpi, A., Nisén, H., Groop, J., Reinikainen, T., Bengs, A. and Pirttimaa, M. (2016). Applying the Theory of Constraints to Improve Throughput in a Forensic DNA Laboratory. *Forensic Science Policy & Management: An International Journal*, 7(1-2), pp. 37–49. doi: https://doi.org/10.1080/19409044.2015.1110734.

Persson, F. and Saccani, N. (2009). Managing the after-sales logistic network – a simulation study. *Production Planning & Control*, 20(2), pp. 125–134. doi: https://doi.org/10.1080/09537280802707530.

Phelps, M. and Festa, M. (2014). The most kissed lips in the world? *Journal of Paediatrics and Child Health*, 50(9), pp. 748–748. doi: https://doi.org/10.1111/jpc.12702.

Reich, J., Kinra, A., Kotzab, H. and Brusset, X. (2021). Strategic Global Supply Chain Network Design - how decision analysis combining MILP and AHP on a Pareto front can improve decision-making. *International Journal of Production Research,* 59(5), pp. 1557-1572. doi: https://doi.org/10.1080/00207543.2020.1847341

Ritter, H. J. W. and Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences,* 4(2), pp. 155-169. doi: http://www.jstor.org/stable/4531523

Rodrigue, J.P. (2024). *The Geography of Transport Systems*. 6th ed. Routledge. doi: https://doi.org/10.4324/9781003343196.

Romme, G. (2003). Making a Difference: Organization as Design. *Organization Science.* 14(5), pp. 558-573. doi: 10.1287/orsc.14.5.558.16769

Rosenbaum, B.A. (1981). Service Level Relationships in a Multi-Echelon Inventory System. *Management Science*, 27(8), pp. 926–945. doi: https://doi.org/10.1287/mnsc.27.8.926.

Rosenthal, S.R. and Capper, M. (2006). Ethnographies in the Front End: Designing for Enhanced Customer Experiences. *Journal of Product Innovation Management*, 23(3), pp. 215–237. doi: https://doi.org/10.1111/j.1540-5885.2006.00195.x.

Roth, A.M. and Singhal, V.R. (2022). Pioneering role of the *Production and Operations Management* in promoting empirical research in operations management. *Production and Operations Management*. doi: https://doi.org/10.1111/poms.13847.

Saccani, N., Johansson, P. and Perona, M. (2007). Configuring the after-sales service supply chain: A multiple case study. *International Journal of Production Economics*, 110(1-2), pp. 52–69. doi: https://doi.org/10.1016/j.ijpe.2007.02.009.

Saldana, J. (2021). *The Coding Manual for Qualitative Researchers.* SAGE Publications.

Scheinkopf, L.J., 1999. Thinking for a Change: Putting the TOC Thinking Processes to Use. Boca Raton: St. Lucie Press.

Sherbrooke, C. C. (2004). *Optimal inventory modeling of systems : multi-echelon techniques*. Boston: Kluwer Academic.

Simon, H.A. (1996). *The sciences of the artificial*. Cambridge, Massachusetts: The MIT Press.

Singhal, K., Sodhi, M. S. and Tang, C. S. (2014). POMS Initiatives for Promoting Practice-Driven Research and Research-Influenced Practice. *Production and Operations Management.* 23(5), pp. 725-727. doi: https://doi.org/10.14488/BJOPM.2019.v16.n2.a13

Skinner, B.F. (1985). Cognitive science and behaviourism. *British Journal of Psychology*, [online] 76(3), pp. 291–301. doi: https://doi.org/10.1111/j.2044-8295.1985.tb01953.x.

Smith, W.R. (1956). Product Differentiation and Market Segmentation as Alternative Marketing Strategies. *Journal of Marketing*, [online] 21(1), pp. 3–8. doi: https://doi.org/10.2307/1247695.

Strauss, A. and Corbin, J. (1998). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. 2nd ed. Thousand Oaks: Sage

Tallon, P.P. (2007). Inside the adaptive enterprise: an information technology capabilities perspective on business process agility. *Information Technology and Management*, 9(1), pp. 21–36. doi: https://doi.org/10.1007/s10799-007-0024-8.

Tsiakis, P., Shah, N. and Pantelides, C. C. (2001). Design of Multi-echelon Supply Chain Networks under Demand Uncertainty. *Industrial & Engineering Chemistry Research*, 40(16), pp. 3585–3604. doi: https://doi.org/10.1021/ie0100030.

Vargo, S. L. and Lusch, R.F. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, 68(1), pp. 1–17. doi: https://doi.org/10.1509/jmkg.68.1.1.24036.

Vesco, S. (2024). *Why aftermarket and service are vital to OEMs - and how to excel.* [online] *https://www.mckinsey.com/~/media/mckinsey/industries/advanced%20elecrtonics/our%20insights/why%20aftermarket%20and%20service%20are%20vital%20to%20oems%20and%20how%20to%20excel/why-aftermarket-and-service-are-vital-to-oems-and-how-to-excel-vf.pdf*
[Accessed: 11 March 2026].

Vredenburg, K., Mao, J.-Y., Smith, P.W. and Carey, T. (2002). A survey of user-centered design practice. *Proceedings of the SIGCHI conference on Human factors in computing systems Changing our world, changing ourselves - CHI '02*. doi: https://doi.org/10.1145/503376.503460.

Wagner, S.M., Jönke, R. and Eisingerich, A.B. (2012). A Strategic Framework for Spare Parts Logistics. *California Management Review*, 54(4), pp. 69–92. doi: https://doi.org/10.1525/cmr.2012.54.4.69.

Wang, F. and Lin, L. (2021). Spare parts supply chain network modeling based on a novel scale-free network and replenishment path optimization with Q learning.

Computers & Industrial Engineering, 157(107312). doi: https://doi.org/10.1016/j.cie.2021.107312.

Wiegmann, P. M., Talmar, M. and de Njis, S. B. (2023). Forging a sharper blade: A design science research approach for transition studies. *Environmental innovation and societal transitions*, 48, pp. 100760–100760. doi: https://doi.org/10.1016/j.eist.2023.100760.

Womack, J.P., Jones, D.T. and Roos, D. (1990). *The machine that changed the world*. London Etc.: Simon & Schuster.

Wood, C. V., Salusky, I., Jones, R. F., Remich, R., Caliendo, A. E. and McGee R. (2024). Using longitudinal qualitative research to understand the minoritized people. *Methods in Psychology.* Vol. 10. doi: https://doi.org/10.1016/j.metip.2023.100130

Wright, M. and Russell, D. (2012). Some philosophical problems for service-dominant logic in marketing. *Australasian Marketing Journal (AMJ)*, [online] 20(3), pp. 218–223. doi: https://doi.org/10.1016/j.ausmj.2012.02.002.

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods.* 6th ed. London: Sage.

Zanjani, M. and Nourelfath, M. (2014). Integrated spare parts logistics and operations planning for maintenance service providers. *International Journal of Production Economics,* 158, pp. 44-54. doi: https://doi.org/10.1016/j.ijpe.2014.07.012

Appendices

a) Longitudinal Interviews

Date	Research Phase	Activity	Analytical Contribution
07/01/2026	Preliminary Scoping	Initial definition of research scope, problem area and case company delimitation.	Established a baseline understanding of the organizational context, and anchored the research within the aftermarket distribution domain.
29-30/01/2026	Contextual Mapping	Two-day site visit including factory and distribution hub tour, with informal observation and discussion.	Empirically grounded the research by aligning theoretical scope with the physical operational reality of the case company.
13/02/2026	Problem Definition	Identification and formalization of ill-structured problems in the aftermarket, discussing the transitioning from observed symptoms to underlying RCs.	Enabled the thematic formalization of the problem structure and provided justification for the DSR methodology and CRT analysis.
03/03/2026	Logic Synthesis	Presentation of RQs and examination of the problem through the lens of SD logic and CIMO.	Conceptually validated the research direction by anchoring emerging findings within the CIMO framework and functional-level service goals.

24/03/2026	Causal Analysis	Joint review of UDEs based on observed organizational frictions, informed by broader interview data.	Empirically validated the CRT analysis, by reconciling accounts from multiple interviewees through the integrative point of the subject.
16/04/2026	Artifact Refinement	Discussion of value-delivery mechanisms, CRT bottlenecks, and the proposed artifact.	Design refinement through final co-constructive validation of the proposed interventions and artifact, as encouraged by Holmström et al. (2009)

b) Interview Guide

Interview Guide

Script & Protocol

Welcome and Context

- ***Greeting:*** Thank you for taking the time to speak with us today. Our names are Alma and Karoline, and we are currently conducting research for our Master's thesis focused on optimizing aftermarket logistics for our degree in Service Management and Supply Chain at Lund University in Sweden.

- The purpose of this study is to explore the complexities of Laerdal Medical's spare parts distribution and logistics aftermarket. We are specifically looking at how a distribution model can help align internal operations with diverse market needs to manage the unique challenges of the aftermarket.

- ***The Value Proposition***: As someone directly involved in these operations, your perspective is vital to understanding these topics.
- *the real-world trade-offs between inventory availability, demand uncertainty, and service standards.*
- Semi-structured interview: Will follow a guide but if the questions lead us somewhere specific, we can investigate that topic further.

Ethics, Consent, and Confidentiality

- ***Confidentiality:*** Before we begin, we want to assure you that this interview is strictly confidential. Your name and specific identifying details will be anonymized in the final report. The data will be used exclusively for our academic research.

- ***Data Handling:*** With your permission, we would like to record this session to ensure we capture your insights accurately for transcription and analysis. The recording will be stored securely and deleted immediately upon the completion of our project.
- ***Right to Withdraw:*** Your participation is entirely voluntary. If at any point you feel uncomfortable or wish to skip a question - or end the interview entirely - please just let us know.

Final Check

- Consent: Do you have any questions regarding the research or how the data will be used? Do we have your informed consent to begin the recording?

Start of Interview Questions

Background and Professional Context

1. To get us started, we'd love to hear a bit about your background and what your life looks like outside of Laerdal?
2. What was your professional path prior to joining Laerdal (education, previous jobs etc.)?
3. How would you describe your current role and department?
4. Where are you physically based, and how long has your journey with the Laerdal been so far?
5. What is your favourite thing about being a part of Laerdal Medical?

6. Can you walk me through a typical day in your shoes, what are your main tasks or missions you typically focus on?

Aftermarket Understanding and Strategic Value

7. When you think about the ‘aftermarket’ at Laerdal, how would you describe its role?
    - *For example, do you see it more as a support function or a core driver of value for the customers?*
8. If you were to describe Laerdal’s spare parts to someone new, how would you describe them?
    - *Are there any specific complexities or ‘quirks’ about these parts that make them unique?*
9. In your own words, what does ‘winning’ look like for the aftermarket?
    - *How does a successful spare parts strategy help Laerdal in achieving its broader mission of helping save lives?*
10. From your point of view, where do you see the biggest ‘disconnects’ between what the aftermarket needs and what the operations side is currently able to provide?
11. What would you say are the primary frictions or misalignments that keep the aftermarket from reaching its full potential?
12. When there are issues with spare parts availability, how does that ripple down into your daily work?
    - *What are the specific pain points that make your job harder in those moments?*
13. What would you say is the most important element/aspect from the customer side, especially when it comes to supporting them and retaining them as a customer?

Demand and Service Requirements

14. When you look at the demand for spare parts, what kind of patterns do you notice?
    - *Do these patterns shift significantly depending on which product family they belong to?*
15. From your department's perspective, what actually makes a spare part 'critical'?
    - *Is it about the cost, the life-saving nature of the specific equipment/simulator, or perhaps the intensity of the customer's reaction when it's not working?*
16. Besides how often a part is needed, what other factors change how you decide to stock or ship it?
    - *For example: how bulky it is, its price point, or even how old the parent product is?*
17. If you were to group the spare parts into a few 'categories' based on how they behave or the headaches they cause, how would you label those groups?
18. What would you say is the biggest 'hidden cost' of a breakdown in the aftermarket?
    - *Is it a hit to the company's reputation, the loss of future sales, or perhaps the administrative weight of fixing the mistake?*

Process and Cross-functional Teams

19. When a spare part isn't where it needs to be, how would you describe the 'chain of command' for getting it back on track?
    - *Who are the key people or roles you look to for a solution in your region?*
20. How would you describe the current process for ordering a spare part?

- *Does it feel like a clear process, or something you have to navigate on your own?*

21. How would you describe the way information flows between your team and the department providing the spare parts?
    - *Does it feel like a natural, ongoing process, or does it mostly happen when an issue needs to be fixed?*
22. Could you describe one experience or incident, where something didn't go as planned because different teams might've had different goals?
    - *If so, what was the impact of that misalignment - did it affect the customer's trust, the budget, or the team's workload?*
23. How often do you navigate the tension between the goal of keeping inventory costs low, and the goal of keeping customers satisfied with availability?
24. When it comes to the 'after-sales' phase of a product's life, how supported do you feel by the rest of the organization?
    - *Where do you feel you have the most back-up, and where do you wish there was more?*

Synthesis & Reflection

25. Is there anything about the complexity of the aftermarket - perhaps something hidden that we haven't touched upon - that you feel is important for this research?
26. If you look 3-5 years into the future, do you think the way we manage spare parts today will still hold up?
    - *Or are there any shifts in the market or the way customers behave that might require Laerdal to change its approach?*
27. How do you think the current process would handle a major shock to the system?

    - Like another massive supply chain disruption, or increased demand for products?

28. Before we finish, is there anything else (at all) that you feel would be valuable to include, that we have not addressed yet?
29. *If you were to operate on an ideal basis, what do you require?*

Administrative Close: Thank you again for your time; your insights are incredibly valuable for our research and thesis.

- We will send over a transcript for your review if you'd like to clarify anything.
- As a reminder, all personal data will be anonymized in our final report.
- In case you have questions or remarks after the interview, you can contact us via email.

c) CRT Coding Overview

ID (only numbered are included in the final CRT)	Statement	Interview Excerpt	Source	Code
UDE 1	"The adoption of ad-hoc solutions increases long-term operational complexity"	"To mitigate this perception, there were cases where the Tech Team sourced temporary used parts, implemented an initial workaround to restore functionality, and then reworked the equipment again once the new spare parts arrived. While this approach helped address immediate customer needs, it also led to increased costs for the Tech Team, reduced operational efficiency, and additional stress due to ongoing customer complaints."	Interviewee 5	Ad-hoc Solutions
UDE 2	"Ad-hoc local workarounds are the reactive response to inventory shortages"	"Yeah, in the long run, it's that firefighting is of course, but I think they, I totally understand why it's happening though, because it's like, again, we may have, we don't have systems that honors these small low value orders that may be a very important or any customer waiting for a broken down product. We tend to focus on selling new ones instead of repairing old."	Interviewee 4	

		"So what would generally happen now is if the customer has an issue with the, you know, a part, you know, and they need to get a spare part available to them or get one out to them, we'll kind of message everyone who lives in that state and kind of say, hey, we're waiting on this part, you know, do you have a demo model? That we can take?"	Interviewee 1	
		"I mean, also, these ad-hoc cushioning solutions that our service team, the sharp end, needs to do with cannibalizing parts from other products."	Interviewee 4	
		"I think this is just causes us like because when we don't have the spare parts or the repair parts, this is where we have to kind of come up with a local solution where we either need to loan the customer part, we need to scavenge that same part from the existing model."	Interviewee 1	
UDE #3	"Organizational sustainability goals are adversely impacted by high carbon emissions from escalated freight"	"Every 12 months and that is a disturbance. In addition that it is expensive for the people to move it. And secondly, of course also when we need to fly it out, it costs money and it impacts the CO2 emission"	Interviewee 1	Air Freight

		"One of the goals that we have is air freight. We want to reduce air freight, which is a conflicting goal with the spare parts. So we for the region Asia Pacific had set very many spare parts to be put on the ocean, even though they were non-stopped because we didn't want to fly it. So we were giving two to three months lead time for spare parts, which is almost always unacceptable."	Interviewee 5	
		"You know, we we also struggle with spare parts and not having them in stock from time to time. You know we we've done, we're we're doing better now in terms of if it is something that requires is a real necessity, we will air freight it."	Interviewee 1	
FL 1	"Standard sea-freight replenishment cycles are a asynchronous with urgent customer requirements"	"Have to put it on a ship and it will take six months or we pay a lot of air freight and which is, you know, a big no no with all the sustainability goals and to get it here costs a lot of money and it it blows out our kind of KPI for sustainability, so"	Interviewee 1	
UDE 11	"Urgent spare part requirements trigger an logisitcs escalation process."	"Well, we have an escalation process to logistics, so usually it would go from the operations managers, or, or you know, they would reach out to the logistics team typically, and we try to figure out, okay, how can we how can we get the spare parts, and if it's urgent, you know, how do we get it to the customer, to the market, you know, sometimes we need to use air freight."	Interviewee 3	

UDE 4	"Historical consumption data for local stocking levels in unavaible to regional teams."	"Since spare parts storage is managed by the logistics team, we do not have direct visibility into whether specific spare parts are physically available or in their designated locations."	Interviewee 5	Data
		"We have specific patterns connected to quality problems. We have patterns connected to the usage. I mean, usage-based, or of course, the more it's used, the more it will tear, wear down. And there are also, of course, a great extent of erratic patterns - which is what spare parts are".	Interviewee 4	
		"What does that mean for me in terms of how many spare parts and service parts I should hold for my team locally? Cause I don't have the data behind it."	Interviewee 1	
	"Local technical support is unavailable in specific geographic regions".	"It's ages away and when that happens, when we've got no one available in that state to support the customer base, we struggle."	Interviewee 1	Distance

FL 3	"Customer service level expectations vary significantly across different global markets".	"With different expectations from customers in different markets, I think you know it's it's as something we deal with. I mean, customers have a lot of different expectations. In the Middle East, you know, it could be a very long time before they decide, but once they decide, they want everything immediately. In other markets, it is more about the planning and getting timelines and, you know, having more, more time for things, so it's something that we deal with, try to deal with every day to, but that that's of course complex to deal with different expectations everywhere, yeah."	Interviewee 3	
FL 2	"Product portfolio continuously expands and increases in complexity."	"Then I'm very certain that we have much more insights via the data that we can also predict, but right now we are due to the vast amount of portfolio, it is almost impossible to to forecast repairs."	Interviewee 2	Forecasting
		"We have maybe 50% repair parts. There we have a a kind of forecast and that's where the the the local team members with the logistics manager go over the list and they call it then do we have a safety stock and then those safety stock."	Interviewee 2	
	"The global aftermarket consists of high geographic and market diversity".	"However, it is very challenging to forecast when I said 26 countries and over 100 distributor markets that we are active in."	Interview 2	

UDE 5	"Expected delivery dates for spare parts fluctuate".	"I hear escalations about main products if we're a week sometimes or if an important customer gets a week delay on a main product, a new product, sometimes it's escalated to me. But if a spare part, if I hear about it, it's probably like four months."	Interviewee 4	Information Sharing
		"In addition, accurate estimated arrival dates for spare parts are critical. In reality, the expected delivery dates often change. Because these dates fluctuate frequently, we are unable to provide customers with a firm repair completion timeline and can only offer a rough estimate. This lack of reliability negatively affects customer satisfaction."	Interviewee 5	
		"And if they can't use it for six months, then they're now they're not getting the value of the warranty, let alone the investments so."	Interviewee 1	Customer Impact
UDE 6	"Customer product downtime leads to a loss of organizational trust and product value".	"Compared to parts or repair costs, the greater impact comes from downtime— specifically, the loss of customer trust, the drain on internal resources due to urgent response efforts, additional workload and schedule delays caused by escalations and temporary fixes, and, over the long term, reduced opportunities for renewals and additional sales."	Interviewee 5	

		"Yeah, customer loyalty and reputation is the biggest hidden cost, I would say. I mean, also, this ad hoc cushioning solutions that our service team, the sharp end, needs to do with cannibalizing parts from other products, with emails, administration saying sorry to the customer for 12 times, those are also, but the biggest hit and the highest risk one is for sure unhappy customers.	Interviewee 4	
UDE 13	"Departmental KPIs for manufacturing, sales, service and logistics are conflicting".	"You know, we have different departments with different KPIs. One department might be measured on how much they sell, the other might be measured on how quick they repair it or maintain it or install it and sometimes it becomes conflicting in the aftermarket."	Interviewee 3	
UDE 7	"Regional lead time for spare parts frequently exceed customer requirements".	"Sourced from a supplier could be that the factory don't have time to produce it, so that can take up maybe between one week to even maybe 3-4 months."	Interviewee 2	Lead Time
		"It's also important in terms of customer satisfaction that we have short lead times for spare part. If six months to get a spare part, it's potentially, you know, six months where they can't use the product or they need some kind of loaner product in between."	Interviewee 3	

		"In addition, accurate estimated arrival dates for spare parts are critical. In reality, the expected delivery dates often change. Because these dates fluctuate frequently, we are unable to provide customers with a firm repair completion timeline and can only offer a rough estimate. This lack of reliability negatively affects customer satisfaction."	Interviewee 5	
UDE 14	"Total Cost-to-Serve for aftermarket parts is disproportionately high relative to standard logistics benchmarks"	"I mean, had we had it on a shelf, of course we would have shipped it sooner than four months. But sometimes by mistake, it's put on a boat instead of on an airplane. But sometimes it has to be manufactured. So the factory needs to pick out a tool from a shelf that they haven't used for seven months and they need to schedule it and plan it and it's not on the top of the priorities and those are the those are the worst cases when that when those happens, like where we don't have it, we need to manage it."	Interviewee 4	
		"We have some, I mean, we have, of course, with working, we can get, we will get support if we're asking for it. We have some situations or some examples where we have reduced the lead time for spare parts explicitly for Stavanger by one week. We used to have two weeks default lead time regardless, but Stavanger reduced it to one week for like 400 or 500 components last year."	Interviewee 4	

	"Discrepency of priorities between manufacturing and service/sales." OR Departmental KPIs for manufacturing, sales, service and logistics are conflicting"	"That's one. Another one we see we see it very commonly for the factories where we where we lag behind on spare parts and there's no attention or very limited sense of urgency at the factory to even though we have we had the example last year where we were four months behind on spare parts and we had to escalate super many times for the factory to release it. It was a change because there's no dollars in it. The factories have very little incentive of the providing spare parts. They get $10. The value of it for the company can be $10,000. But on there, at the end of the day, KPIs matters. And we ask the divisions or units to stay with KPIs. And we have no real, actually, that's the point that I'm not saying before and think about. We have no real KPI for spare parts, service parts, delivery for the factories."	Interviewee 4	Urgency & Escalation
		"You know, they're not waiting on information. They they kind of, you know, see, feel supported, um, and you know, we're able to deal with the issue, you know, efficiently and promptly. And there's gonna be times when there's gonna be delays. You know, we we had an issue last year where it actually took six months to fix them."	Interviewee 1	Maintenance

	"The aftermarket mission prioritizes the reduction of equipment downtime".	Our primary focus is to ensure that the equipment operates smoothly by providing timely and effective technical support. The mission we value most is reducing equipment downtime through fast response and prompt action, ultimately improving customer satisfaction.	Interviewee 5	
UDE 8	"Spare part ordering processes lack automation"	" If you're doing a non-inphased part, there's a whole different form you need to fill in, send it, and it's getting more manual."	Interviewee 7	Manual Ordering Process for Non-Inphased Components
		"It has to be manually emailed to the factory and shipped directly to the country with not going through any warehouse or any distribution, basically logistics, my team and my function not involved. Yes, and actually some of the countries that I speak with is saying that that process is working the best. They like that way of doing it."	Interviewee 4	

		I don't even receive an email or anything, an alert or something letting you know, you know what I mean? It's because, I know it takes, I know it's time-consuming, people have got other things to do, but an alert or something…	Interviewee 7	
		There is no automation to order the part. We then sent an e-mail and fill out the form, which in 2026 ideally we would not do anymore.	Interviewee 2	
	"Field service and techncial service teams operate in a reactive capacity".	"This situation places the aftermarket and field service teams in a highly reactive position from the start and makes it difficult to meet customer expectation"	Interviewee 5	
UDE 9	"Urgent spare part production disrupts standard factory assembly line schedules".	"Then there is hidden cost to organize the spare part, especially when it has to come from the factory. Because this is really like a like a Word document. There is no automation to order the part. We then sent an e-mail and fill out the form, which in 2026 ideally we would not do anymore. And then of course the the third is that the factory has maybe to interrupt some of the assembly lines to make that part and then ship it back to the country."	Interviewee 2	Spare Parts & Distribution

		"Distributors and end customers in Latin America, which is again also a very huge area. How can we make it happen that we don't go overboard and have thousands of spare parts laying in Brazil, but at the same time manage to have very short lead times?"	Interviewee 2	
	"Localized inventory for holding spare parts results in high rates of stock obsolescence".	"Yeah, the the trade of of having really all necessary repair parts very close to the customer due to the portfolio is impossible, especially also not just only for the inventory cost, but we will face or we would face that we have done obsolescence in the spare parts."	Interviewee 2	
		"So I hear a lot about spare parts in general, that it is a challenge. It's a challenge to get them. It's a challenge to understand what we need to have in stock."	Interviewee 3	
		"On the other hand, delays in spare parts or inefficient processes immediately translate into customer dissatisfaction and disruptions to training."	Interviewee 5	
	"Spare part technical specifications are fragmented across product generations".	"One of the main challenges and complexities is that simulators and manikins require different parts depending on the product type and their release generation. This variation means that service and spare parts planning must be carefully aligned with the specific model and lifecycle stage of each device."	Interviewee 5	
		"The the spare parts, then they are very volatile."	Interviewee 2	

	"Volatility in spare part availability compromises customer use and product value".	"These quality and readiness gaps not only increase the burden on the aftermarket organization, but also directly impact customer trust, equipment uptime, and overall training continuity."	Interviewee 5	
UDE 10	"Safety stock levels are insufficient and challenging for high-variability spare parts".	"By analyzing spare parts ordered over the past five years, we found that no specific parts could be meaningfully identified as high-frequency items. Failures occur across a very wide range of parts, making it difficult to define a limited and effective safety stock strategy."	Interviewee 5	Stock
	"Product obsolenscence occurs prematurely due to localized spare part stockouts".	"So, having efficient spare part capacity is, of course, important. Without spare parts, you know, we might not be able to repair or maintain the products, and the only option might be to replace the entire product."	Interviewee 3	
		"It's a challenge to understand what we need to have in stock."	Interviewee 3	
	"Product portfolio continously expands through new developments".	"We've already increased our kind of service stock and spare parts stock quite a lot. The problem is that the company has got so many different spare parts now, so many different products, partner products."	Interviewee 1	

	"High solution complexity necessitates intensive project management for equipment installation."	"Of course, it's an important aspect to get all the parts and all the pieces and get it to the customers and get it installed. It's project management, our solutions are getting more and more complex. So, we deal with project management to get them installed. And as I mentioned, you know, we have the technical services to maintain it. We have educational services to teach our customers how to use them."	Interviewee 3	Aftermarket
		"I see the aftermarket not as simple post-sales support, but as a core function that directly impacts equipment uptime and customer trust. The availability of spare parts, the efficiency of service processes, and the speed of response all play a critical role in minimizing equipment downtime in the field and ensuring continuity of training."	Interviewee 5	
	"Aftermarket success is defined by the speed of technical response and part replacement".	"The key elements required to keep equipment performing at its optimal level and to maximize uptime—by minimizing downtime—include timely technical support, efficient service processes, and proper spare parts management."	Interviewee 5	
		"Success, in my view, is achieved when equipment is kept in optimal condition through preventive maintenance and timely part replacements, and when, in the event of a failure, the correct spare parts are quickly identified, supplied, and repaired."	Interviewee 5	

	"The aftermarket mission prioritizes a 99% equipment uptime goal".	"What our North Star, our goal is that we would like to have let's say 99% the customer work with the product. So that means that the uptime of the product is very steady and the product is available from Monday to Monday 24 hours."	Interviewee 2	
		"I mean, we're moving more and more towards providing solutions where the aftermarket is basically a long-term customer journey, where you know it's all about."	Interviewee 3	
	"Sustaining a high customer satisfaction requires continuous management of the end-to-end customer journey".	"So, and obviously, you know, within customer journey management, the customer experience is extremely important for both the strategy. I mean, we need to maintain a high customer satisfaction throughout the journey."	Interviewee 3	
		"We invest a lot in people that work in the aftermarket, not only sales, but in new type of competence that we need to maintain and support these customers in the future. So I think it's a lot of support and high priority for the company to improve the aftermarket across all levels."	Interviewee 3	
		"Yeah, so, so the aftermarket, I mean, it's it's a big topic."	Interviewee 3	
FL 4	"Customers expect premium, high-reliability service aligned with the	"We are a high service company. We do sell highly complex and expensive products. Like our product is a Mercedes, it's not a Skoda or a Fiat. If you buy a Mercedes, you expect Mercedes customer treatment."	Interviewee 4	Strategy

	complexity and value of product offering".		
RC 1	"Spare parts supply chain is not segmented based on demand patterns, criticality and cost".	"And that's the thing, we don't have one strategy for globally, but it should be a combination criticality, demand and cost."	Interviewee 4
RC 2	"Global ownership and accountability for aftermarket logistics and strategy are not clearly defined".	"Supply chain strategy-wise, but also somewhat organizationally. I want to have one global responsible for aftermarket in logistics that runs, I have the accountability of it that basically take the work that you deliver and start deploying it, build a structure, a strategy around it. May not be after we have operationalized it, but we can spend at least a year or two operationalizing, find a strategy, just I think with small methods, not small, but with dedicated efforts like that, in three to five years, we have a better, more tailor-made supply chain and organization for aftermarket."	Interviewee 4
		"I would describe it as a very important role because at the end of the day, even though we do sell products, but we sell training and education. So the outcome of our products is a person that has learned something.And the aftermarket is there to support and	Interviewee 4

		maintain and withhold the value of the solution or upholding the function of the solution."		
	"The spare parts portfolio is characterized by high-variety, low demand frequency, and long product lifecycles".	"The whole thing inherited with spare parts and service part is that there is a wide range of them. We have so many. And we have long product life cycles. So we have a product that has lasted for 20 plus years. And we can keep on adding products to our portfolio."	Interviewee 4	SKU Portfolio
		"Even, I mean, even on spare parts for every company would say it's a low frequency, high mix scenario, but even our main products. is low volume, high complexity, or high variation. So then if you go from the main product, low volume, high variation, then the spare and service part will be exploding low volume, high variation."	Interviewee 4	

UDE 12	"End-to-end responsiblity for spare parts availability and service delivery is fragmented across functions".	"It's stopping in the country or probably a lot of our service organization in the sharp end, they are absorbing it, they are cushioning it with ad hoc solutions and going the extra mile or do whatever, probably go to another store and just fix things themselves. And so that's, I would say, is the biggest disconnect."	Interviewee 4	Organizational Pain and Responsibility