



CHALMERS
UNIVERSITY OF TECHNOLOGY



Logistics Flow Improvement at Volvo Cars Body Shop

Master's thesis in Supply Chain Management

Viktoría Brá Gosadóttir
Widdad Lobad

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2026
www.chalmers.se

Logistics Flow Improvement at Volvo Cars Body Shop

Viktoría Brá Gosadóttir
Widdad Lobad

Department of Technology Management and Economics
Division of Supply and Operations Management
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2026

Logistics Flow Improvement at Volvo Cars Body Shop
VIKTORÍA BRÁ GOSADÓTTIR
WIDDAD LOBAD

© VIKTORÍA BRÁ GOSADÓTTIR, 2026.

© WIDDAD LOBAD, 2026.

Department of Technology Management and Economics
Chalmers University of Technology
SE-412 96 Gothenburg
Sweden
Telephone +46 31 772 1000

Gothenburg, Sweden 2026

VIKTORÍA BRÁ GOSADÓTTIR
WIDDAD LOBAD

Department of Technology Management and Economics
Chalmers University of Technology

Summary

In the automotive industry, material supply systems often involve interdependent production units with different priorities, creating challenges in balancing transport efficiency and material accessibility. This thesis studies the material supply interface between Volvo Cars Body Components (VCBC) and the Body Shop at Torslanda (TA), where packaging configurations and replenishment methods have created operational challenges related to handling effort and material accessibility.

The purpose of this study is to analyze the material supply interface between VCBC and the Body Shop TA and identify opportunities for improving material flow performance. A qualitative single case study was conducted based on interviews, observations and internal company data. The empirical findings were analyzed using theories related to supply chain coordination, internal logistics and the Actor-Resource-Activity (ARA) model.

The findings show that the material supply challenges reflect misalignment between operational priorities, resource configurations and logistics activities across the material supply interface. While VCBC prioritizes batch production, transport efficiency and standardized logistics processes, TA operates under limited line-side space and continuous material accessibility requirements.

The study further identifies coordination challenges related to fragmented decision-making across functions with different priorities and responsibilities. The findings suggest that stronger system-wide coordination and joint evaluation of logistics decisions may improve overall material flow performance.

The study concludes that future improvements should focus on selective adaptation of packaging and replenishment solutions rather than broad standardization. More structured coordination mechanisms, stronger cross-functional evaluation and selective testing of packaging configurations may improve material accessibility and logistics performance while balancing trade-offs between transport efficiency, handling effort and production stability across the material supply interface.

Keywords: Internal logistics, material flow, supply chain coordination, unit load size, material replenishment, packaging, ARA model, automotive production

Acknowledgements

Welcome to the final and slightly bittersweet chapter of our journey at Chalmers: the master thesis chapter.

Conducted in collaboration with Volvo Cars, this project marks not only the grand finale of our master's studies, but also the very last report we will ever submit as master students. Along the way, we experienced moments of excitement, confusion, breakthroughs, and the occasional existential crisis over wording and deadlines. Somewhere in the process, "just one final revision" turned into a phrase we learned not to trust.

Our biggest and warmest thank you goes to our supervisor and professor at Chalmers, Frida Lind, whose positivity, guidance, and encouragement made this journey far more enjoyable than we could have imagined. You always managed to make us smile and feel excited to keep going. Your insightful feedback, positivity, and ability to make everything feel possible meant a lot to us. Simply put, this thesis would not have been the same without you. Every project deserves a Frida, and we truly hit the jackpot!

We would also like to extend our gratitude to Volvo Cars, and to Poya Shameli and Daniel Lindholm, for the opportunity to conduct this project and for the insights shared along the way.

Finally, to our families and friends - thank you for your endless support, encouragement, and patience throughout these months and supporting us through every stressful deadline and moment of doubt. We could not have done this without you. Your patience deserves an honorary degree at this point.

And now, after countless hours, many revisions and more versions of this thesis than we dare count - here it is: the final piece of our master's journey. We hope you enjoy reading it, after all, it only took an unreasonable amount of caffeine and several years of studying to make it happen.

Viktoría Brá Gosadóttir, Gothenburg, June 2026
Widdad Lobad, Gothenburg, June 2026

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

AGV	Automated Guided Vehicle
AI	Artificial Intelligence
ARA	Actors, Resources and Activities
IT	Information Technology
JIS	Just-in-Sequence
JIT	Just-in-Time
KPI	Key Performance Indicator
SCM	Supply Chain Management
TA	Body Shop TA in Torslanda
TB	Paint Shop in Torslanda
TC	Final Assembly in Torslanda
VCBC	Volvo Cars Body Components

Contents

List of Figures	xii
List of Tables	xiii
1 Introduction	1
1.1 Background	1
1.2 Purpose	3
1.3 Research questions	4
1.4 Scope and Limitations	4
1.5 Structure of the report	5
2 Theoretical framework	6
2.1 Supply Chain Management	7
2.2 Supply Chain Coordination	7
2.2.1 Why Supply Chain Coordination is Necessary	8
2.2.2 Benefits of Supply Chain Coordination	9
2.2.3 Coordination Mechanisms in Supply Chains	9
2.3 Supplier Relationships	10
2.3.1 Types of Supplier Relationships	10
2.3.2 Interdependence and Coordination Between Units	11
2.4 Benefits of Collaborative Supplier Relationships	12
2.4.1 Value Creation Through Collaboration	12
2.4.2 Interaction and Involvement in Supplier Relationships	13
2.5 Internal Logistics and Material Flow Design	14
2.5.1 Control Principles of Material Flow	15
2.5.2 Material Replenishment Strategies	15
2.6 Line-side Presentation and Production Interface	17
2.6.1 Line Feeding Principles	17
2.7 Packaging and Unit load size in Production Logistics	18
2.7.1 Unit Load Size, Handling and Ergonomics	18
2.7.2 Unit Load Size and Space Utilization	19
2.7.3 Unit Load Size and Flow Efficiency	19
2.8 ARA Model	20
2.8.1 Dimensions of the ARA Model	20
2.8.2 Resource Interaction and Interdependencies	21
3 Methods	22

3.1	Research Strategy	22
3.2	Data Collection	23
3.3	Data Analysis and Research Quality	24
3.4	Ethical Considerations	25
3.5	AI Declaration	25
4	Empirical Findings	26
4.1	Description of the Production System	26
4.1.1	Production Conditions at VCBC	27
4.1.2	Observations From a Comparable Stamping Production Environment	28
4.1.3	Current Packaging and Delivery Flow	29
4.1.4	Coordination between VCBC and TA	29
5	Analysis	31
5.1	Coordination Mechanisms and Supplier Relationships	31
5.1.1	Coordination Barriers	32
5.1.2	Information Sharing	32
5.1.3	Joint Decision Making	33
5.1.4	Collaborative Planning	33
5.1.5	Coordination Contracts	34
5.1.6	Collaborative Value Creation	35
5.2	Material Flow Analysis	36
5.2.1	Actor Layer	37
5.2.2	Resource Layer	39
5.2.3	Activities Layer	41
5.3	ARA analysis	43
5.3.1	Operational Misalignment	44
5.3.2	Coordination Challenges	44
5.3.3	Material Flow Trade Offs	45
6	Discussion	47
6.1	Managing Operational Misalignment	47
6.2	Managing Coordination in an Interdependent System	48
6.3	Material Flow Trade Offs and Resource Adaptation	49
7	Conclusion and Implications	51
7.1	Managerial Implications	51
7.2	Future Research	53
	Bibliography	54

List of Figures

1.1	Simplified overview of the production flow and material supply interface studied in the thesis.	2
2.1	Conceptual model of supply chain coordination and material flow. Adapted from Mentzer et al. (2001).	6
2.2	The bullwhip effect. Source: Lee et al. (1997).	8
2.3	Illustration of the supplier relationship spectrum.	11
2.4	Conceptual overview of internal logistics and material flow.	14
2.5	An illustration of the ARA model.	20
3.1	Overview of the research process	22
4.1	Simplified illustration of TA layout and material flow (authors' illustration)	27
5.1	Actors in the material supply interface.	37
5.2	Resources in the material supply interface.	39
5.3	Illustration of serial, parallel and dyadic activities in the material flow	41

List of Tables

5.1	Actors, Resources and Activities in Material Supply Interface Between VCBC and TA	36
5.2	Key material flow challenges in the case	43

1

Introduction

Efficient material supply is essential in automotive production, where high material volumes, limited line-side space and frequent replenishment place strong demands on coordination. This thesis examines these challenges through the material supply interface between Volvo Cars Body Components (VCBC) in Olofström and the Body Shop TA in Torslanda (TA). The study is conducted in close collaboration with Volvo Cars as a part of a master's thesis at the Department of Technology Management and Economics, within the Division of Supply and Operations Management at Chalmers University of Technology.

The study addresses challenges related to logistics flow, packaging solutions and material replenishment in a production environment characterized by high demands on flow efficiency, material availability and space utilization. Since VCBC and TA operate under different conditions, objectives and performance measures, decisions that are efficient for one unit may create inefficiencies for the material flow as a whole.

Against this background, the thesis aims to analyze the current material supply setup from a system-wide perspective and to identify improvement opportunities that can support a more efficient and stable logistics flow between the two units. The introduction is followed by sections outlining the background, purpose, research questions and limitations of the study.

1.1 Background

Manufacturing systems are becoming increasingly complex, placing higher demands on efficiency, flexibility and stable material supply. In this context, the design of internal logistics and material supply has become an important factor for production performance (Uhernik, 2021). This is particularly relevant in automotive manufacturing, where part logistics must coordinate large numbers of parts, suppliers, containers and logistics activities to ensure that assembly lines do not run out of material. Lean-oriented systems such as Just-in-Time and Just-in-Sequence can reduce excess inventory and support continuous flow, but they also increase the need for precise coordination between logistics and production units (Boysen et al., 2015).

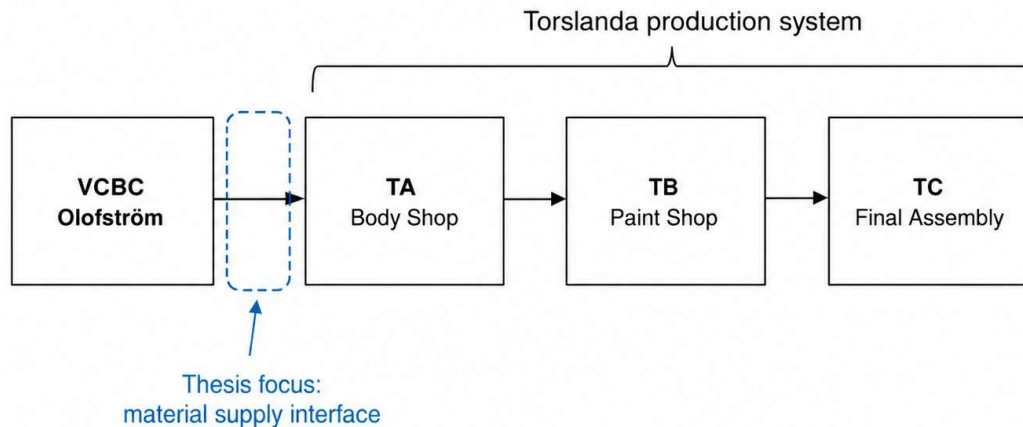


Figure 1.1: Simplified overview of the production flow and material supply interface studied in the thesis.

When material supply involves several production units with different operating conditions, objectives and performance measures, coordination becomes essential. Arshinder et al. (2008) argue that insufficient coordination can lead supply chain actors to optimize their own local activities rather than the performance of the system as a whole. In material supply systems, this can result in mismatches between packaging solutions, delivery systems, replenishment principles and the operational requirements of the receiving unit. Such mismatches can negatively affect flow efficiency, material availability and production stability.

This thesis is conducted in the context of Volvo Cars, a global automotive company with a strong industrial presence in Western Sweden. The company's production facility in Torslanda is one of its main manufacturing sites and produces a large number of passenger vehicles annually for the global market. The production system consists of three main operations: the Body Shop (TA), the Paint Shop (TB) and the Final Assembly plant (TC). TA represents the first stage of the vehicle production flow, where stamped and sub-assembled body components are assembled into complete car bodies before being transferred to subsequent production stages. Efficient material supply to TA is therefore important for maintaining production stability and supporting the overall performance of the wider manufacturing system.

A key supplying unit to TA is VCBC in Olofström, which manufactures and delivers stamped and assembled body components to Torslanda. As illustrated in Figure 1.1, the material flow between VCBC and TA is the focus of this thesis. It is characterized by high delivery frequency and large material volumes, with approximately 87 containers consisting of around 2,000 items delivered three times per day. This creates high demands on logistics flow efficiency, packaging alignment and coordination between the supplying and receiving units.

The current material supply interface involves several challenges. Delivery and packaging solutions are largely adapted to the operating conditions at VCBC, while TA faces different requirements related to space availability, internal material handling, replenishment and line-side space availability. As a result, solutions that support efficiency in the supplying unit may create handling, space and flow challenges in the receiving unit. These challenges are further influenced by replenishment logic, limited support for flow-oriented logistics and coordination across unit boundaries.

Taken together, the case illustrates a system-level logistics challenge. Packaging solutions, material flow design, replenishment principles and coordination practices cannot be evaluated separately, since decisions in one part of the flow affect performance elsewhere. This creates a need to analyze the material supply interface between VCBC and TA from a system-wide perspective, to identify improvement opportunities that support a more stable, efficient and coordinated logistics flow.

1.2 Purpose

The purpose of this thesis is to analyze the logistics flow between VCBC and TA in Torslanda from a system-wide perspective and to identify improvement opportunities for the material supply interface. The study focuses on how packaging solutions, delivery configurations, replenishment principles and coordination practices influence flow efficiency, material availability and production stability across the two units.

To fulfill this purpose, the thesis examines the current material supply interface and identifies key constraints related to space availability, material handling and internal logistics in TA, while also considering the production and transport conditions at VCBC. Based on this analysis, the thesis identifies potential improvement opportunities related to packaging and material supply, considering the conditions of both the supplying and receiving units.

By relating the empirical findings to the theories within supply chain management, coordination and internal logistics, the thesis supports conclusions about how packaging, replenishment and coordination practices influence the performance of the material supply interface.

1.3 Research questions

In line with the purpose of this thesis, the research questions are formulated to describe the current material supply interface, identify key constraints and explore improvement opportunities between VCBC and TA. The questions address the current material and packaging setup, constraints affecting material flow, coordination practices between the supplying and receiving units and potential alternatives that could better support system-wide logistics performance.

The following research questions guide the study:

1. How is the current material, packaging and delivery flow between VCBC and the Body Shop TA designed and operated?
2. How do differences in operational conditions and objectives between VCBC and the Body Shop TA influence packaging, replenishment and material flow efficiency?
3. How do coordination mechanisms influence the alignment of packaging, delivery and replenishment decisions between VCBC and the Body Shop TA?
4. What improvement opportunities could support a more efficient and coordinated material supply interface between VCBC and Body Shop TA?

1.4 Scope and Limitations

The scope of this thesis is the material supply interface between VCBC and TA. The study focuses on the material supply, packaging solutions, delivery configurations, replenishment principles and coordination between the supplying and receiving units. Therefore, the study does not examine the entire Volvo Cars supply chain, external suppliers, or material flows outside this interface.

The main limitations of the study are:

- Single-company case study within Volvo Cars
- Time and resource constraints
- Dependence on available company data and access to personnel
- No full-scale implementation or long-term performance measurement

Since the study is conducted as a single-company case study within Volvo Cars, the findings are context specific and may not be directly transferable to other industrial settings.

The analysis is based on available company data, interviews, observations, and internal documentation collected during the study period. Consequently, the findings

are dependent on access to relevant personnel and production-related information.

The thesis does not include a full-scale implementation of proposed solutions, long-term performance measurement, or quantitative validation of effects after implementation. Instead, the study focuses on identifying and discussing improvement opportunities based on the current material supply setup and relevant theoretical frameworks.

1.5 Structure of the report

The thesis is structured into 7 chapters. Chapter 1 introduces the background, purpose, research questions, and the scope and limitations of the study. Chapter 2 presents the theoretical framework used to analyze the material supply interface. Chapter 3 describes the methodological approach, including data collection and analysis. Chapter 4 presents the empirical findings and describes the current material supply interface between VCBC and TA. Chapter 5 analyses the empirical findings using the theoretical framework, while Chapter 6 discusses the main findings of the study. Finally, Chapter 7 presents the conclusions of the thesis and answers to the research questions.

2

Theoretical framework

This chapter presents the theoretical framework used to analyze the material supply interface between production units. The chapter begins with broader perspectives on supply chain management, supply chain coordination and supplier relationships. These theories provide a foundation for understanding how material flows are influenced by interdependent decisions and interactions across organizational boundaries.

The chapter then narrows its focus to theories more directly related to the design and control of material supply systems, including internal logistics, replenishment strategies, packaging, unit load size, material handling and line-side presentation. Finally, an analytical framework is introduced to support the system-wide analysis of actors, resources and activities within the material supply interface.

Figure 2.1 provides an overview of how the theoretical areas in this chapter are connected. It shows that material flow is influenced not only by the physical movement of products, but also by coordination, information sharing and activities across organizational boundaries.

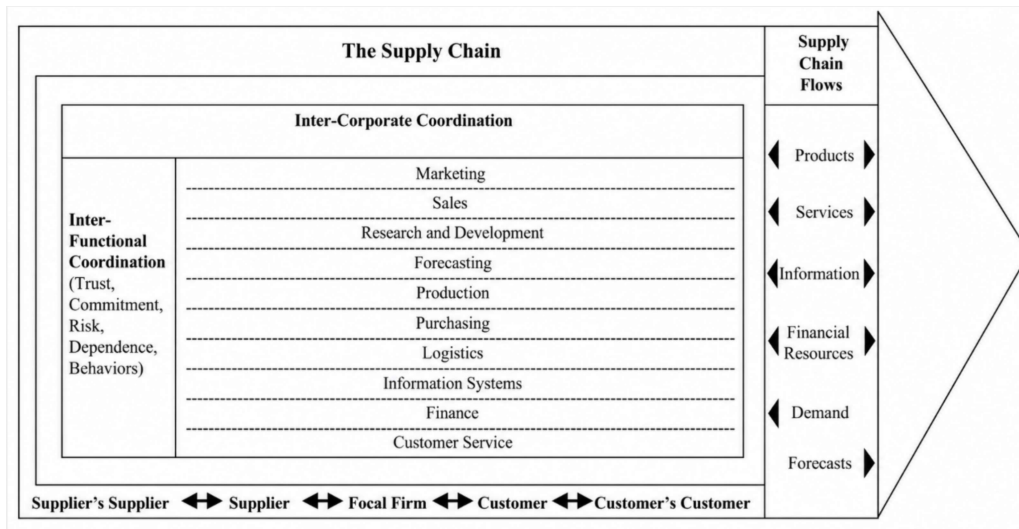


Figure 2.1: Conceptual model of supply chain coordination and material flow. Adapted from Mentzer et al. (2001).

2.1 Supply Chain Management

Supply chain management (SCM) refers to the management of flows, activities and relationships across organizational boundaries. Rather than focusing only on the movement of materials, SCM adopts a system-wide perspective in which suppliers, manufacturers and customers are viewed as part of an interconnected network. Mentzer et al. (2001) define SCM as the systemic and strategic coordination of business functions both within a firm and across organizations, to improve the long-term performance of individual firms and the supply chain as a whole.

Two characteristics of SCM are particularly important for this thesis. First, SCM is cross-functional, emphasizing the integration of activities such as procurement, production and logistics rather than managing these functions in isolation. Second, SCM is cross-organizational, meaning that key business processes must be coordinated across organizational boundaries between supply chain actors. Lambert and Cooper (2000) similarly argue that effective SCM requires the integration of key business processes across organizational boundaries to improve supply chain performance.

A central principle in SCM is the focus on overall system performance rather than isolated functional optimization. Mentzer et al. (2001) argue that SCM adopts a systems perspective in which the supply chain is viewed as a single entity rather than a set of fragmented parts, emphasizing coordination across functions and firms to improve overall performance. From this perspective, material and information flows should be coordinated to improve customer value, cost efficiency and responsiveness across the supply chain.

2.2 Supply Chain Coordination

Supply chain coordination refers to the alignment of activities, decisions and objectives among different members of a supply chain in order to improve overall performance (Arshinder et al., 2008). Supply chains consist of several interdependent functions, such as logistics, procurement, production and inventory management, where decisions made in one part of the system can influence performance in other parts. Coordination is therefore necessary to manage these interdependencies and to ensure that individual activities contribute to the performance of the supply chain as a whole.

Without sufficient coordination, supply chain members may act according to their own local objectives, which can lead to inefficient resource use, increased uncertainty, excess inventory, poor material availability, and suboptimization. In production and logistics environments, coordination is especially important because material flow depends on the alignment of physical flows, information flows and decision making across different actors and functions.

Coordination can be supported through mechanisms such as information sharing, joint decision-making, collaborative planning and the use of information technology. These mechanisms, which will be discussed in more detail in Section 2.2.3, help reduce uncertainty, improve visibility, align objectives and support more efficient supply chain operations (Arshinder et al., 2008).

The following sections further explain why coordination is necessary, the benefits it can provide and the mechanisms used to support coordinated supply chain performance.

2.2.1 Why Supply Chain Coordination is Necessary

Lack of coordination among supply chain partners creates inefficiencies and instability across the supply chain (Costantino et al., 2014). One well-known example is the bullwhip effect, where demand variability is amplified as information moves upstream from customers toward manufacturers and suppliers, as illustrated in Figure 2.2. This often occurs when each stage of the supply chain makes decisions based on incomplete or distorted information, leading to larger order fluctuations, increased inventory, stock-outs and higher operational costs.

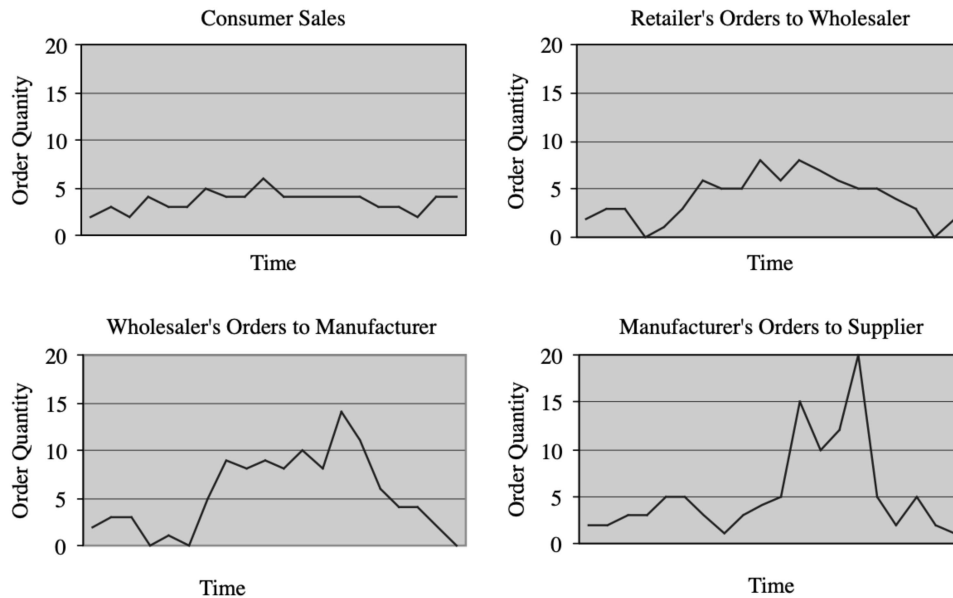


Figure 2.2: The bullwhip effect. Source: Lee et al. (1997).

Although the bullwhip effect is commonly discussed in relation to demand variability, it also illustrates a broader coordination problem. Decisions made by one actor can influence activities and performance in other parts of the supply chain

(Costantino et al., 2014).

Coordination is therefore necessary to align decisions, activities and information flows across the supply chain. Mechanisms such as information sharing and collaborative planning can reduce uncertainty, improve coordination among supply chain partners, reduce instability, improve service performance and support more efficient overall supply chain performance (Costantino et al., 2014).

2.2.2 Benefits of Supply Chain Coordination

Supply chain coordination and information sharing provide several important benefits for supply chain operations. By sharing information such as customer demand data, order histories and inventory records, supply chain actors can improve forecasting, reduce uncertainty and make more informed inventory and ordering decisions (Ouyang, 2007).

Improved information sharing also supports greater supply chain stability. When actors have access to relevant information from other stages of the supply chain, inventory and ordering decisions can be coordinated more effectively. This helps reduce order variability, improve inventory allocation and support a more stable flow of materials through the supply chain.

The bullwhip effect can generate substantial costs and instability across the supply chain through increased order variability and inefficient inventory allocation. By reducing uncertainty and improving access to shared information, supply chain actors can make more informed inventory and ordering decisions. This can reduce unnecessary inventory, improve supply chain stability and support more efficient overall supply chain performance (Ouyang, 2007).

2.2.3 Coordination Mechanisms in Supply Chains

Coordination mechanisms are important in decentralized supply chains because supply chain partners are often legally independent and have their own objectives, decision authority and planning responsibilities. In such environments, planning decisions are usually made separately by each party, which can lead to suboptimal outcomes for the supply chain as a whole. Coordination mechanisms are therefore required to align the decisions of individual supply chain actors and improve overall performance (Albrecht, 2010).

One important coordination mechanism is information sharing. Effective supply chain coordination requires the exchange of relevant information between actors, such as forecasts, costs and capacity utilization. However, companies may be reluctant to share sensitive information due to competitive concerns. This can create information mismatches that make coordination more challenging and increase the

need for mechanisms that support collaboration while considering the self-interested behavior of supply chain actors (Albrecht, 2010).

Coordination contracts are another mechanism used to improve coordination. These contractual agreements define rules for cooperation and provide incentives for supply chain members to follow coordinated plans. Coordination contracts can help distribute the benefits gained from coordination among actors and encourage decisions that improve the performance of the supply chain as a whole (Albrecht, 2010).

Collaborative planning is also an important coordination mechanism. In collaborative planning, supply chain partners jointly develop and align their plans. In contrast to centralized control, collaborative planning involves negotiation and the exchange of planning proposals between actors. Through this process, partners can evaluate alternative solutions and select plans that improve the overall efficiency of the supply chain while still considering the interests of each participating party (Albrecht, 2010).

Overall, coordination mechanisms play a crucial role in overcoming the challenges of decentralized decision-making. They enable supply chain partners to align their plans, reduce inefficiencies and improve the overall performance of the supply chain (Albrecht, 2010).

2.3 Supplier Relationships

Supplier relationships are important in material supply systems because the performance of one unit often depends on decisions and activities carried out by another. These relationships influence how material flows are coordinated, how resources are adapted and how operational requirements are communicated across organizational boundaries. This section discusses different types of supplier relationships and explains how interdependence between units creates a need for coordination.

2.3.1 Types of Supplier Relationships

Supplier relationships can be understood along a spectrum ranging from transactional, short-term interactions to long-term and collaborative relationships, as illustrated in Figure 2.3. According to Van Weele and Rozemeijer (2022). Traditionally, procurement relationships were more transactional and operational in nature, focusing primarily on purchasing activities and contract compliance. However, procurement has increasingly shifted toward active supplier relationship management aimed at improving supplier performance and long-term value creation (Van Weele & Rozemeijer, 2022).

Over time, increased market complexity and higher performance requirements have

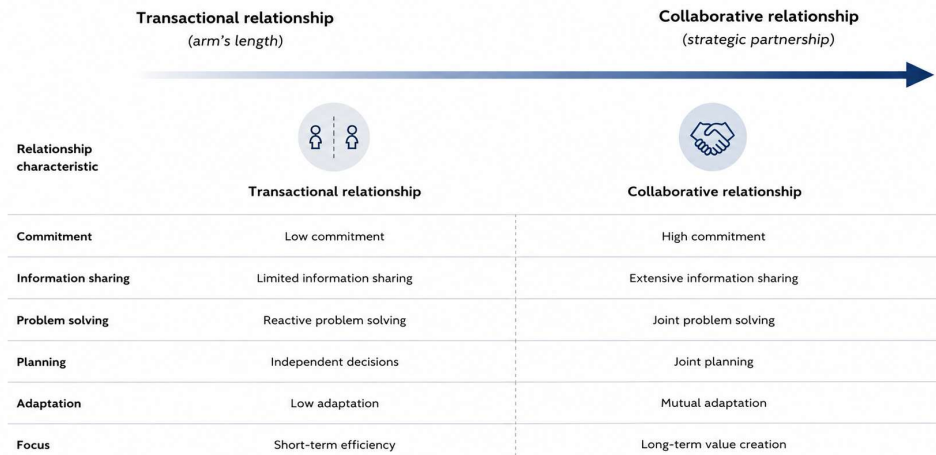


Figure 2.3: Illustration of the supplier relationship spectrum.

contributed to a shift toward more collaborative and integrated supplier relationships. Rather than relying solely on isolated exchanges, firms increasingly engage in continuous interaction, supplier development, and coordination activities to improve performance and secure long-term value. This development reflects a transition from operational procurement toward more strategic supplier relationship management, where suppliers are increasingly viewed as important contributors to competitiveness and innovation (Van Weele & Rozemeijer, 2022).

Transactional relationships are characterized by relatively low commitment, limited information sharing, and a stronger focus on short-term operational needs. Collaborative relationships, in contrast, involve higher levels of trust, commitment, information exchange, closer coordination and supplier development activities. These differences are important because the nature of the relationship affects how effectively firms can coordinate activities, improve supplier performance, and respond to operational requirements (Van Weele & Rozemeijer, 2022).

Supplier relationships are therefore not only economic exchanges but also involve continuous interaction and cooperation between firms. As a result, the type of relationship plays an important role in determining how effectively organizations can coordinate activities, improve supply performance, and create value within the supply chain (Van Weele & Rozemeijer, 2022).

2.3.2 Interdependence and Coordination Between Units

Relationships between units in a distribution network are often characterized by a high degree of interdependence (Gadde & Snehota, 2019). Supplier relationships have increasingly shifted from arm's length exchanges toward closer and more collaborative arrangements, where activities carried out by different actors become

increasingly interconnected (Gadde & Snehota, 2000). As a result, activities performed by one unit may affect the performance and organization of activities in another unit (Gadde & Snehota, 2000).

In supplier relationships, interdependence is particularly important because material supply depends on the alignment of decisions across organizational boundaries. The operational requirements of the receiving unit may influence how the supplying unit organizes production, packaging, and delivery activities.

This mutual dependency implies that supplying and receiving units cannot be analyzed as isolated functions. Instead, increasing interdependence requires coordination and integration of activities across units to improve overall performance (Gadde & Snehota, 2000). Without such coordination, individual units may prioritize local objectives, which can create inefficiencies at the system-wide level. For example, a supplying unit may prioritize transport efficiency, production stability, or economies of scale, while a receiving unit may prioritize handling efficiency, space utilization, and material availability. When these objectives are not aligned, issues such as packaging mismatch, inefficient replenishment flows, and increased handling effort may arise.

Therefore, the interdependence between supplying and receiving units makes coordination essential for achieving efficient end-to-end material flow and reducing system-wide inefficiencies.

2.4 Benefits of Collaborative Supplier Relationships

Collaborative supplier–receiving unit relationships are important because material supply is not determined only by transactions, but also by how actors work together over time to solve problems, adapt resources and improve operations. Earlier approaches to purchasing often focused on arm’s-length relationships, where suppliers were treated as interchangeable and dependence was avoided. However, this perspective has shifted toward a view in which supplier relationships can be important sources of operational efficiency, development and long term performance (Araujo et al., 2016; Gadde & Snehota, 2000).

2.4.1 Value Creation Through Collaboration

A key benefit of collaborative relationships is that they can create value beyond low purchasing prices. According to Gadde and Snehota (2000), the value of a supplier relationship depends not only on the exchanged product or service, but also on how the relationship fits with the buying firm’s operations and other relationships.

Collaboration can therefore generate both cost-related benefits through reduced inefficiencies, better use of resources and improved operational fit (Gadde & Snehota, 2000).

Collaboration can also generate development-related benefits. In collaborative relationships, suppliers may contribute knowledge, capabilities and improvement ideas that support the buying firm's operations. This means that suppliers are not only providers of materials or components, but also contribute to operational development and improvement. The potential value of collaboration, therefore, depends on how well the parties are able to use each other's resources and knowledge over time.

Collaboration is not automatically beneficial. Close supplier relationships require investments in coordination, communication and adaptation, all of which increase the costs of managing the relationship. High involvement with suppliers is therefore resource-intensive and should be justified by the expected benefits of the relationship (Gadde & Snehota, 2000).

This means that firms should not manage all supplier relationships in the same way, but instead adapt the level of involvement to the role and importance of each relationship (Gadde & Snehota, 2000). In some relationships, limited interaction may be sufficient, while more complex and strategically important relationships may require closer collaboration, joint problem solving and greater adaptation between the parties.

2.4.2 Interaction and Involvement in Supplier Relationships

The level of involvement in supplier relationships can be understood through three dimensions: activity links, resource ties and actor bonds. Activity links refer to how activities between parties are connected and coordinated. Resource ties describe how resources are connected, adapted or combined across organizational boundaries. Actor bonds refer to the relationships between individuals, functions, and organizational units involved in the relationship. These dimensions show that collaboration is not only based on formal agreements but also on how activities, resources, and actors become connected in practice (Håkansson et al., 2009).

Interaction is therefore central to realizing the potential benefits of collaborative relationships. Through communication, information exchange, and joint problem-solving, firms can identify improvement opportunities and develop solutions that could not be achieved by one party alone. At the same time, interaction requires continuous effort and may increase interdependence between the parties. Firms must therefore balance the benefits of collaboration with the cost of coordination, adaptation, and reduced flexibility (Gadde & Snehota, 2000).

Supplier relationships are dynamic rather than static. The level of involvement may

change over time as conditions, requirements and operational priorities evolve. This means that firms need to continuously evaluate how supplier relationships are managed and whether existing routines, resources and interaction patterns still support the needs of the relationship (Gadde & Snehota, 2019).

In summary, collaborative supplier–receiving unit relationships can provide significant benefits, but these benefits depend on how the relationships are managed. Achieving effective collaboration requires managing interaction, coordinating activities, and handling the costs and interdependencies associated with different levels of involvement (Gadde & Snehota, 2000; Gadde & Snehota, 2019).

2.5 Internal Logistics and Material Flow Design

Internal logistics concerns the movement, storage and replenishment of materials within a production system. It connects inbound material supply with the point of use in production and therefore plays an important role in ensuring material availability, stable production flow and efficient use of space and handling resources.

Material flow design refers to how these internal logistics activities are organized and controlled. This includes decisions about how materials are transported, when replenishment is triggered, how frequently deliveries are made, and how much material is stored close to production. As illustrated in Figure 2.4, internal logistics and material flow design can be understood as a connected system where control principles shape replenishment methods, packaging and material handling and line-side presentation. Poor material flow design can therefore lead to excess inventory, unnecessary handling, space constraints or material shortages.

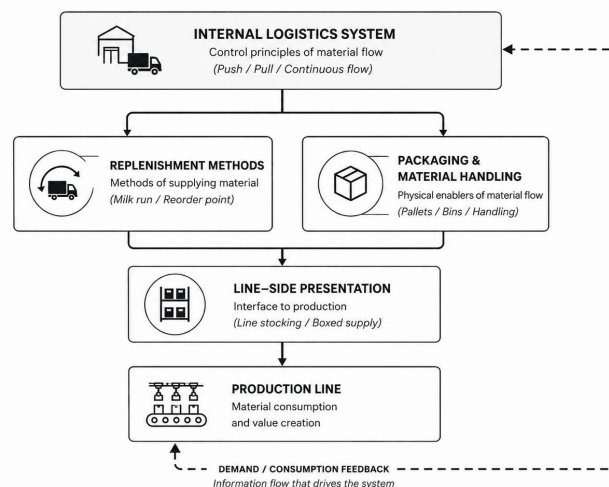


Figure 2.4: Conceptual overview of internal logistics and material flow.

2.5.1 Control Principles of Material Flow

Material flow can be controlled through different principles depending on how production and replenishment are triggered. Two common principles are push and pull systems.

In push systems, production and material flows are initiated based on forecasts, plans or predefined schedules. This approach can support planning and coordination when demand is relatively predictable, but it may also lead to excess inventory or poor responsiveness if actual demand differs from the plan (Jonsson & Mattsson, 2009).

Pull systems are characterized by demand-driven replenishment, where upstream activities are triggered by signals from downstream processes. Rather than producing based on forecasts, material supply is initiated when there is a need from the consuming process. This can help align material flow with actual demand and reduce overproduction. However, pull systems may still involve interruptions in flow, since production is only triggered when a signal is received. As a result, material movement can occur in discrete batches rather than as a continuous stream.

Continuous supply systems represent a more flow-oriented form of material supply, where processes are closely integrated and materials move steadily between operations (Jonsson & Mattsson, 2009). A key characteristic of continuous flow is the use of small batch sizes and frequent replenishment, which can contribute to shorter lead times, lower inventory levels and more efficient execution. Small batches and short setup times enable faster response and reduced throughput times.

The transition from pull-based replenishment to continuous flow involves a shift from signal-driven and intermittent replenishment toward a more stable and synchronized material flow. While both approaches are demand driven, continuous flow requires a higher degree of process integration and operational stability. Conditions such as short setup times, small batch sizes, flow oriented layouts, and stable processes are therefore important for continuous supply systems to function effectively.

2.5.2 Material Replenishment Strategies

A milk run system is a continuous supply logistics concept where a vehicle follows a fixed route and schedule to deliver materials to several production stations. Instead of sending a forklift whenever parts are needed, a transport vehicle performs regular delivery tours with multiple stops along a predefined route (Fussone et al.,2025). Milk run systems are often implemented using tow trains, which is a towing vehicle pulling several connected carts. This enables scheduled replenishment, where materials are delivered at regular time intervals rather than only when inventory reaches a certain level.

One important benefit of milk runs is improved transport efficiency. By consolidating deliveries into a single planned route, milk runs reduce the need for many separate transport trips to individual production stations. This can reduce unnecessary travel distances, improve vehicle utilization and make internal transportation more efficient. A planned milk run system can also reduce random vehicle movement inside the factory, which may improve both traffic control and workplace safety.

Milk runs can also help support a more predictable and stable replenishment system. Since deliveries occur according to a schedule, material supply becomes less reactive to shortages and easier to plan. Regular replenishment can reduce the need for large inventory buffers close to production stations, since smaller quantities can be delivered more frequently. This can free up valuable floor space and support a more flow-oriented material supply system.

Reorder point systems represent a type of pull system approach to material replenishment. In reorder point systems, replenishment is triggered when inventory reaches a predefined level. The concept has traditionally been used together with economic order quantity calculations to determine when and how much to replenish. According to Jonsson and Mattsson (2009), reorder point methods became widely used as companies moved from make-to-order to make-to-stock production, where shorter customer delivery times and longer manufacturing lead times required more systematic inventory planning.

However, reorder point systems have limitations in manufacturing environments, especially where demand is dependent on production processes. Their theoretical assumptions may not fully reflect the complexity of real production systems, where material needs are linked to production schedules, process dependencies and changing operational conditions. As a result, reorder point systems may lead to increased inventory levels, shortages and poor coordination of material flows.

Although reorder point systems can support decisions about when to release replenishment orders, they may also create challenges when used in complex production settings. If replenishment is triggered only after inventory reaches a certain level, material supply can become reactive rather than planned and flow-oriented. This can contribute to production disruptions, reduced productivity and weaker delivery performance. For this reason, reorder point systems are often complemented or replaced by more advanced planning and replenishment methods in manufacturing contexts.

2.6 Line-side Presentation and Production Interface

Line-side presentation refers to how materials are made available at the point of use in production (Schmid & Limère, 2019). This is an important part of the material supply system because it influences how easily operators can access components, how much space is required at the workstation, and how frequently materials need to be replenished. The design of the production interface, therefore affects both logistics efficiency and production performance.

In assembly environments, different line feeding principles can be used to supply materials to the line. These principles determine whether materials are delivered in large load carriers, smaller containers, sequenced deliveries or kits. The choice of line feeding principle is closely connected to packaging size, handling requirements, space utilization, and replenishment frequency. Therefore, line-side presentation should be understood as a link between internal logistics and the practical requirements on production.

2.6.1 Line Feeding Principles

Line stocking is a line feeding policy where a full load carrier, such as a pallet or box, is delivered directly from storage to the assembly line and remains there until it is empty (Schmid & Limère, 2019). This approach requires minimal logistical preparation and reduces handling effort. However, it increases line-side inventory and requires significant space at the workstation.

Boxed supply is a line feeding policy where parts are repacked from large containers into smaller bins before they are delivered to the assembly line (Schmid & Limère, 2019). This reduces the quantity of material stored at the workstation and can improve space utilization, but it also increases logistics handling because additional preparation is required. Wänström and Medbo (2009) explain that smaller packaging can create benefits at the production line by reducing operators' walking distance, improving accessibility and allowing components to be presented at more ergonomic heights. As a result, non-value-adding work at the workstation can be reduced. However, boxed supply also creates higher requirements for the replenishment system. Since smaller containers hold fewer parts, they need to be replenished more frequently. This means that boxed supply is most effective when supported by a stable and frequent material flow. Smaller unit loads can also improve flexibility, since less inventory must be consumed before changes can be made. More frequent replenishment cycles, therefore provide more opportunities to adjust supply and can give better control over the material flow.

2.7 Packaging and Unit load size in Production Logistics

Packaging plays an important role in logistics because it affects both the movement of materials and how materials are handled, stored, and presented in production. Hanson and Finnsgård (2014) describe unit loads, such as containers, bins, and pallets, as an important interface between in-plant material supply and assembly. The unit load influences the configuration of the material supply system, including handling equipment, delivery routing, resource consumption, and parts presentation at the assembly station.

Unit load size is also closely connected to material handling and facility layout. Castillo and Peters (2002) define a unit load as a collection of parts that are moved together and argue that unit load and material handling considerations should be integrated into manufacturing system design. This supports the view that unit load size is not only a packaging decision, but a system level decision that affects transport frequency, handling resources and material flow performance.

Unit load size also creates a trade-off between material supply efficiency and assembly efficiency. Larger unit loads, such as EUR-pallets, can reduce the number of movements required for a given volume of material. Smaller unit loads, on the other hand, can support assembly efficiency by reducing the time assemblers spend fetching parts and by improving flexibility and ergonomics at the workstation. Packaging should therefore be viewed as a logistics design factor, not only as a protective container.

This system-wide view is also supported by Pålsson et al. (2013), who argue that industrial packaging interacts with logistics, manufacturing, and information systems. From a logistics perspective, packaging both influences and is influenced by activities such as warehousing, transport, and manufacturing processes. Packaging decisions can therefore have significant effects on logistics costs and supply chain performance.

2.7.1 Unit Load Size, Handling and Ergonomics

From a handling perspective, unit load size influences the number of material movements, the type of handling equipment required and the physical effort needed to access parts at the point of use. Larger unit loads, such as pallets, can reduce the number of movements required for a given volume of material, since more parts are transported in each load. However, larger unit loads may also require specific handling equipment, such as forklifts, and can also create longer distances or additional handling at the assembly station. Hanson and Finnsgård (2014) explain that unit load size is closely connected to the configuration of the material handling system, including facility layout, manpower requirements and handling equipment.

Smaller unit loads, such as boxes or containers, can support more compact parts presentation and reduce the time operators spend fetching parts. They may also improve ergonomics by allowing materials to be positioned closer to the operator, reducing unnecessary reaching, walking and awkward postures. However, these benefits depend on how the overall material supply system is configured. If the system is not adapted to smaller packaging, the number of replenishment and handling cycles may increase.

2.7.2 Unit Load Size and Space Utilization

Unit load size influences space utilization because it determines the amount of material stored and presented at the point of use. Larger unit loads, such as pallets, can contain a larger quantity of parts and may therefore be efficient from a transport and storage perspective. However, they also require more space at the assembly stations and may create a need for additional buffer locations close to the line. This can be problematic in production environments where line-side space is limited.

Smaller unit loads, such as boxes, bins or containers, can support more compact line-side presentation. Hanson and Finnsgård (2014) explain that smaller unit loads can be placed in flow racks, allowing several part numbers to be presented in a structured way within a limited area. However, improved space utilization at the line-side may create additional requirements elsewhere in the material supply system, such as repacking, more frequent replenishment and changes to the internal delivery system.

2.7.3 Unit Load Size and Flow Efficiency

Unit load size can influence flow efficiency by affecting delivery frequency, material handling, replenishment logic and the smoothness of internal material flows. As mentioned in previous sections, smaller unit loads may require more frequent replenishment because fewer parts are supplied in each load. However, this does not necessarily reduce flow efficiency. Hanson and Finnsgård (2014) show that smaller unit loads can be delivered using milk run systems, where several unit loads are transported together on the same route. In their case study, the higher replenishment frequency did not necessarily lead to increased man-hour consumption for in-plant deliveries, since the delivery system was redesigned and several unit loads could be delivered in each round.

The relationship between unit load size and flow efficiency should therefore be understood as a system-level trade-off. Larger unit loads may support upstream transport and storage efficiency, while smaller unit loads may support more frequent replenishment, compact line-side presentation and smoother material availability. The most suitable unit load size, therefore depends on the overall material supply configuration rather than on isolated transport, handling or space efficiency.



Figure 2.5: An illustration of the ARA model.

2.8 ARA Model

Material flow systems are not shaped by isolated decisions, but by the interaction between multiple organizational units, physical and intangible resources, and operational activities. To analyze these interdependencies from a system-wide perspective, the ARA model can be applied (Håkansson & Snehota, 1995).

The ARA model, developed within industrial network theory, conceptualizes business relationships as networks consisting of three interconnected dimensions: actors, resources, and activities, as shown in Figure 2.5. The model provides a structured way to analyze how different elements of a system are linked and how changes in one part of the system influence others (Håkansson & Snehota, 1995).

2.8.1 Dimensions of the ARA Model

Actors refer to the organizations, units, or individuals involved in the network. Actors control resources and perform activities, and their goals, capabilities, and decision making processes influence how the system operates. In a supply chain context, actors may include supplying units, receiving units, logistics functions, and planning departments. The relationships between actors are important because coordination challenges may arise when actors operate under different objectives, constraints, or performance measures (Håkansson & Snehota, 1995).

Resources include both physical and intangible elements used within the system. Physical resources may consist of packaging solutions, load carriers, transport equipment, storage areas and production facilities, while intangible resources include information, forecasts, standards and planning systems. Resources are closely connected to activities because their design and availability influence how material flow processes can be performed (Håkansson & Snehota, 1995).

Activities represent the operations and processes carried out within the system, such as production, packaging, transportation, storage, and replenishment. Activities are interconnected because the output of one activity becomes the input for another. Changes in one activity can therefore affect both upstream and downstream operations (Håkansson & Snehota, 1995).

2.8.2 Resource Interaction and Interdependencies

Business networks are shaped by interdependencies, resource interaction and relationships between actors and resources, which together influence how value is created and developed over time. Resources do not create value in isolation, they gain value through interaction with other resources in specific contexts. Resource interfaces represent the contact points where resources interact and influence one another, while relationships between resources reflect broader patterns of interconnectedness and interdependence that shape how resources are combined, adapted and developed (Prenkert et al., 2022). At the same time, business activities are characterized by different forms of interdependence, including serial interdependence, where one activity depends on another, dyadic interdependence, involving mutual adjustments between actors, and joint interdependence, where multiple actors rely on shared activities. These interdependencies require ongoing coordination and adaptation, while actors continuously influence and are influenced by one another through interaction, learning, and co-evolution. Consequently, business development emerges collectively through network relationships rather than through isolated decisions made by individual firms (Håkansson et al., 2009).

A key strength of the ARA model is that it focuses on the links between actors, resources and activities rather than analyzing them separately. Actor bonds describe relationships between actors, such as collaboration, communication and coordination. Resource ties refer to how resources are connected and adapted or combined across organizational boundaries. Activity links describe how activities are coordinated and synchronized within the system.

The ARA model therefore supports a system-wide analysis of material supply systems by showing how local decisions can have wider consequences. It is particularly useful for analyzing how decisions related to packaging, planning, replenishment or logistics resources influence several connected parts of a material flow.

landa. A qualitative case study approach is a research method that focuses on the complexity of work practices and interactions as they occur in a specific operational context (Dubois & Araujo, 2007).

The study followed an abductive logic inspired by systematic combining. Dubois and Gadde (2002) describe systematic combining as a case study approach where the theoretical framework, empirical fieldwork and case analysis develop in parallel rather than as separate sequential steps. This was suitable for the present study, since the material supply interface between VCBC and TA involved several interconnected dimensions including packaging, replenishment, internal logistics and coordination. Rather than following a strict linear research process, the study moved back and forth between empirical findings and theoretical concepts as the understanding of the case developed.

This approach was chosen because the studied interface involves complex logistics flows, organizational interaction and operational constraints that needed to be examined in context.

3.2 Data Collection

Data collection was primarily qualitative and consisted of semi-structured interviews, on-site observations and internal company documentation. Interviews were conducted with relevant stakeholders from both the supplying and receiving units, including logistics personnel and production representatives. Semi-structured interviews are suitable for exploring complex work practices because they provide guidance through predefined themes while still allowing flexibility for follow up questions and further explanation (Knott et al., 2022).

In addition to the semi-structured interviews, joint meetings and ongoing dialogue with key personnel from both the supplying and receiving units were maintained throughout the project. These meetings were held regularly to discuss the progress of the study, clarify process-related questions, and gain feedback on preliminary findings. Informal conversations with personnel in TA during February and May complemented the formal data collection and contributed to a practical understanding of daily material handling, line-side constraints, and operational challenges. The continuous interaction with key personnel also helped ensure that the analysis reflected the conditions of the production environment.

Due to the geographical distance to VCBC in Olofström and scheduling challenges, a visit to the facility could not be arranged. Instead, a site visit was conducted at a stamping factory with similar production characteristics. The purpose of that visit was not to collect direct case-specific data from the VCBC-TA interface, but to develop a deeper understanding of stamping production conditions and batch-based production logic.

This method was appropriate for this thesis because it enabled an in-depth exploration of material supply practices, coordination challenges and the practical constraints influencing packaging, replenishment and internal logistics. The interviews were complemented by on-site observations of material flows, packaging usage and internal logistics processes in the body shop. Internal company documentation related to logistics principles, packaging standards and material handling was also used to support and contextualize the empirical findings.

One of the authors had prior work experience at Volvo Cars, which provided familiarity with the production environment, internal terminology and general logistics context. This prior knowledge supported the interpretation of observations and interview findings. However, to reduce the risk of bias, the findings were based on interviews, observations and internal documentation collected during the study.

3.3 Data Analysis and Research Quality

The data analysis was conducted iteratively by matching the empirical findings with theoretical concepts. In line with Dubois and Gadde's (2002) concept of systematic combining, the analysis involved moving back and forth between data sources, the analytical framework and theory. Interview findings, observations and internal documents were compared with theories on supply chain coordination, internal logistics, unit load size and the ARA model in order to identify key interdependencies, constraints and improvement opportunities.

The analysis was structured using the ARA model, focusing on activities, resources, and actors within the material supply interface. This made it possible to examine how production, packaging, transport, replenishment, physical resources and organizational responsibilities are connected. The empirical findings were then related to theories on supply chain coordination, internal logistics, replenishment strategies, line feeding and unit load size.

Based on this analysis, alternative packaging and logistics flow solutions were evaluated with regard to their feasibility for both units and their expected impact on flow efficiency, coordination and production stability. Particular emphasis was placed on flow orientation, unit load size reduction and system-level coordination.

The quality of the study was strengthened by combining multiple sources of empirical material and by clearly linking the theoretical framework to the research purpose. Interviews, observations and internal documentation were used together to support the empirical findings and reduce reliance on a single source of information.

The theoretical framework was developed using academic literature considered rel-

evant and reliable for the research purpose. Priority was given to peer-reviewed journal articles, academic books and established literature within supply chain management, coordination, internal logistics and production logistics.

3.4 Ethical Considerations

Ethical considerations were taken into account throughout the study. Since the thesis was conducted in collaboration with Volvo Cars, the study followed the company's confidentiality requirements. Internal documents, production-related information and other sensitive company data were handled carefully and were not disclosed in a way that could harm the organization or reveal confidential information.

Interview participation was voluntary, and participants were informed about the purpose of the study. Interview material and observations were used only for the purpose of this thesis and were presented in a way that avoids exposing sensitive operational or personal information.

3.5 AI Declaration

AI tools were used to support this research by generating figures, illustrations and tables based on the authors' descriptions, as well as for language improvement and formulation alternatives. AI was also used to assist in identifying relevant literature and generating search suggestions. However, the selection and evaluation of all academic sources were carried out by the authors. All AI-generated content was reviewed and validated by the authors, who remain responsible for the accuracy and integrity of the research.

4

Empirical Findings

This chapter describes the current material supply interface between VCBC in Olofström and TA in Torslanda. The purpose is to describe the current material flow, the operational conditions in the supplying and receiving units, and the factors that influence how materials are produced, packed, delivered, received and handled.

The chapter is based on internal company documentation, layout material, observations from the production environment and a semi-structured interview with a logistics engineer at VCBC, as well as multiple informal interviews with personnel from TA.

4.1 Description of the Production System

The production system in Torslanda consists of several connected production stages, where TA represents the first stage in the vehicle production flow. In this stage, stamped and sub-assembled body components are assembled into complete car bodies before being transferred to the following production stages: the Paint shop (TB) and Final Assembly (TC). The paint shop is the smallest factory of the three and is responsible for painting the car bodies, after which they are transferred to Final Assembly, where the vehicle is completed through the installation of components such as the engine, electrical systems, cameras, doors and windows.

Since TA represents the first stage of the production flow, material availability in this stage is important for maintaining production stability and flow efficiency throughout this system. Several operations in TA are supported by automated robots, primarily responsible for welding and transporting sub-assembled parts. The production environment therefore includes elements of human-robot collaboration, where operators and automated systems work within the same process environment.

A key supplying unit to TA is VCBC in Olofström. VCBC is responsible for producing stamped body components and certain sub-assemblies that are delivered to Torslanda several times per day. The current material flow includes approximately 87 containers and around 2,000 items delivered three times per day, placing high demands on coordination between the supplying and receiving units.

The material flow includes several activities from production at VCBC to material usage in TA. The overall flow consists of production and stamping in Olofström, packaging and preparation of unit loads, transportation to Torslanda, unloading, temporary storage, internal transport to the Body Shop, line-side replenishment, and the return flow of empty load carriers.

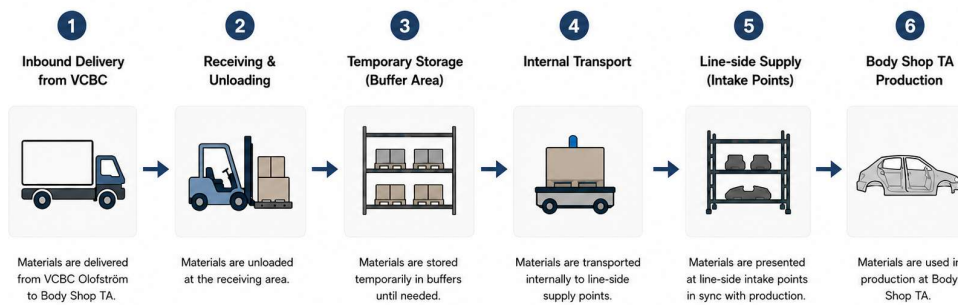


Figure 4.1: Simplified illustration of TA layout and material flow (authors’ illustration)

Figure 4.1 presents a simplified illustration of TA’s layout and material flow, developed based on internal layout documentation and observations. Internal layout material further shows that TA includes unloading areas, pallet storage, AGV ramps and designated intake points that support the internal logistics flow.

Together, these observations show that the material supply interface spans both inbound logistics from VCBC and internal logistics within TA, involving several connected activities and functions.

4.1.1 Production Conditions at VCBC

One important condition in the case is that production at VCBC is based on batch production rather than one-piece flow. During the interview with the Logistics engineer at VCBC, he explained that the stamping factory works according to a batch production logic, stating that “Stamping factory is different than a one-piece flow. Batch production saves money.” (Interview, Logistics Engineer, VCBC, 2026)

According to the interview, approximately 3,000 parts can be produced in one hour, which indicates that larger batch sizes are more efficient from VCBC’s production

perspective. Batch size is mainly influenced by coil size, machine setup times, takt requirements from Torslanda, planned train departures and available inventory levels in the receiving plant.

This shows that delivery quantities and packaging sizes are closely connected to upstream production conditions and are not only logistics decisions. The planning department at VCBC also adjusts the production plan based on weekly demand forecasts from Torslanda and daily inventory levels, which contributes to a relatively stable production pattern (Interview, Logistics Engineer, VCBC, 2026).

4.1.2 Observations From a Comparable Stamping Production Environment

Since no direct site observation was conducted at VCBC, observations from a comparable stamping factory were used as contextual support. The visit provided insight into batch-based stamping production, including high production volumes, long changeover times, limited production lines, high storage requirements and forklift-based material handling. These observations are therefore not treated as direct empirical evidence from VCBC, but as supporting context for interpreting the interview findings related to VCBC's production logic.

The visit showed that stamping production is characterized by high production volumes and a limited number of production lines. Since the factory operated with only a few stamping lines, production capacity had to be planned carefully. Changeovers between parts were an important condition, as production could not immediately switch from one part to another without setup time. This means that sufficient stock must be available to cover demand during changeovers and to ensure that outgoing material requirements can still be met while another part is being produced.

A large part of the factory area was used for storage. This included storage of coils, semi-finished parts, complete items and empty racks. The amount of storage observed indicates that batch-based stamping production requires buffers between production, handling and outbound logistics. Since large volumes of parts are produced and moved through the factory, storage and material availability become important conditions for maintaining flow.

The visit also showed that internal material handling was highly dependent on forklifts and load carriers. A large number of forklifts were used to move material, racks and completed items between production, storage and outbound areas. This suggests that packaging and load carrier design are closely connected to internal handling efficiency, as stamped parts must be stored, protected and transported in a way that supports high-volume production.

Overall, the observations helped explain why batch production and larger unit loads may be preferred from the supplying unit's perspective. High production volumes,

changeover times, limited production lines, storage requirements and the need for efficient handling all create conditions where larger batches and established packaging solutions can support production and transport efficiency. Although the visited factory was not part of the studied material supply interface, the observations supported the interpretation of VCBC's production logic described in the interview and helped contextualize why the current setup may be efficient for the supplying unit while creating challenges for the receiving unit.

4.1.3 Current Packaging and Delivery Flow

The current delivery setup between VCBC and TA is mainly based on pallet deliveries. On the other hand, TA benefits more from smaller unit loads packaged in small blue boxes. These blue boxes improve replenishment flow and are better suitable for line-side space utilization. According to the interview, packaging solutions are decided by a dedicated packaging department, while logistics and planning functions are responsible for delivery frequency and unit load planning. This indicates that packaging and delivery decisions involve several functions and are determined by one department alone.

The packaging setup is also influenced by practical transport requirements. The Logistics Engineer from VCBC explained that the packaging "has to fit in the container" (Interview, Logistics Engineer, VCBC, 2026). This means that pallet size, load carrier dimensions and delivery quantities must be aligned with transport and handling requirements at VCBC.

The interview also showed that current unit load principles have been in place for a long period of time. "Unit loads were agreed upon a long time ago, around 10 years" (Interview, Logistics Engineer, VCBC, 2026).

At the same time, the receiving unit operates under different conditions related to space availability, internal transport routes and frequent replenishment needs in TA. This creates a potential mismatch between the pallet-based delivery setup and the operational requirements of the receiving unit.

4.1.4 Coordination between VCBC and TA

The case also includes an important coordination interface between VCBC and TA. According to the interview, collaboration between the units is generally good and includes regular meetings and workshops. The Logistics Engineer described the relationship as constructive, stating that there is "good discussion" and that "we have the problems together" (Interview, Logistics Engineer, VCBC, 2026).

At the same time, the interview showed that the two units do not always assess the situation in the same way due to different operating conditions, objectives and performance measures between the supplying and receiving units. As a result, a

solution that appears beneficial for one unit's perspective may create challenges or costs for the other unit.

The Logistics Engineer also explained that “sometimes suboptimization is needed for the long term.” (Interview, Logistics Engineer, VCBC, 2026). This indicated that decisions may sometimes require one unit to accept short-term disadvantages in order to improve the material flow from a broader system perspective. The finding therefore shows that collaboration exists between the units, but that aligned decision-making remains important when changes affect both sides of the material supply interface.

5

Analysis

This chapter analyzes empirical findings presented in Chapter 4 by relating them to the theoretical framework. The purpose of the analysis is to explain how the current material supply interface between VCBC and TA is shaped by coordination mechanisms, material flow conditions and the interaction between actors, resources and activities.

The chapter is structured in three parts. First, the coordination mechanisms between VCBC and TA are analyzed to understand how information sharing, joint decision-making, collaborative planning and responsibility distribution influence packaging, delivery and replenishment decisions. Second, the material flow is analyzed through the actor, resource and activity layers in order to identify how different priorities, physical resources and logistics activities affect the performance of the material supply interface. Finally, the ARA analysis integrates these dimensions to show how operational misalignment, coordination challenges and material flow trade-offs emerge through the interaction between actor priorities, resource configurations and connected activities.

By analyzing the case in this way, the chapter moves from separate observations of coordination and material flow toward a system-wide understanding of the challenges in the VCBC-TA interface. This provides the basis for discussing improvement opportunities that consider both the supplying and receiving units, rather than evaluating packaging or replenishment solutions from one unit's perspective only.

5.1 Coordination Mechanisms and Supplier Relationships

This section analyses how coordination and supplier relationship theory help explain the current challenges between VCBC and TA. It focuses on coordination mechanisms that influence decisions related to packaging, delivery configurations and replenishment principles.

5.1.1 Coordination Barriers

The empirical findings show that coordination between VCBC and TA is not absent, but that current coordination practices appear to be more focused on maintaining the existing flow than on jointly developing the material supply interface. Regular meetings, workshops and information sharing support daily operations and help create planning visibility between the units. However, these mechanisms do not necessarily ensure that packaging, delivery and replenishment decisions are evaluated jointly from the perspective of both the supplying and receiving unit.

A key coordination challenge is that responsibilities for packaging, production planning, transport and internal logistics are distributed across several functions. Packaging decisions are influenced by transport-container requirements and established unit load principles, while the consequences of these decisions are experienced in TA through space constraints, handling requirements and replenishment needs. This creates a situation where decisions made in one part of the flow can create operational consequences elsewhere, without there being a clear mechanism for evaluating the total effect on the material supply interface.

The findings also indicate that the two units operate under different operational logics. VCBC is influenced by high-volume batch production, changeover times, transport efficiency and the need to maintain sufficient stock, while TA is affected by limited line-side space, internal transport routes and frequent replenishment requirements, making coordination more complex.

5.1.2 Information Sharing

The theory on information sharing emphasizes that supply chain actors need access to relevant information in order to reduce uncertainty and coordinate planning decisions. In the empirical case, information sharing is present in the planning process between VCBC and TA. The production plan at VCBC is adjusted based on weekly demand forecasts from Torslanda and daily inventory levels, which supports a relatively stable production pattern. This indicates that VCBC does not plan production in isolation but uses information from the receiving plant to guide production and delivery planning.

The empirical findings therefore support the theoretical view that information sharing can improve coordination by increasing visibility across the supply chain. Forecasts and inventory information help VCBC understand future material requirements and adjust production according to the needs of the receiving unit. In this sense, information sharing contributes to reducing uncertainty in the material supply interface.

However, the findings also show that information sharing alone is not sufficient to ensure aligned packaging and delivery decisions. Although forecasts and inventory

levels are shared, packaging and delivery decisions are still influenced by several separate functions, including packaging, logistics and planning. This means that shared information does not automatically lead to aligned decisions across the interface. The main issue is therefore not only whether information is available, but whether the information is used jointly when evaluating packaging, unit load size, delivery frequency and replenishment principles.

Overall, the empirical case shows that information sharing supports planning visibility between VCBC and TA, but that it needs to be connected to decision-making processes in order to improve system-wide performance. Information sharing can reduce uncertainty, but it does not by itself resolve differences in objectives, constraints and responsibilities between the supplying and receiving units.

5.1.3 Joint Decision Making

The theory on joint decision making emphasizes that coordination requires more than sharing information. When several actors influence the same material flow, decisions need to be aligned so that improvements are evaluated from a system-wide perspective rather than from separate functional interests.

In the empirical case, the need for joint decision-making is visible in how packaging and delivery-related responsibilities are divided. Packaging solutions are handled by a dedicated packaging department, while logistics and planning functions are responsible for delivery frequency and unit load planning. This means that decisions affecting the same material supply interface are spread across several functions.

The division of responsibilities can create fragmented decision making. A packaging solution may be suitable from a transport or production perspective, but still create challenges for space utilization, internal handling or replenishment in the TA. Therefore, the issue is not only which solution is technically possible, but how alternatives are evaluated and by whom.

The empirical findings show that joint decision making could strengthen coordination by creating a shared basis for evaluating changes. Packaging size, delivery quantities, replenishment principles and cost consequences need to be considered together, since these decisions affect both the supplying and receiving unit. In this case, joint decision making would support a shift from local evaluation of separate decisions toward system-wide evaluation of the material supply interface.

5.1.4 Collaborative Planning

The theory on collaborative planning emphasizes that supply chain actors should not only exchange information, but also jointly develop and adjust plans over time.

This is especially important when future changes in production, packaging or replenishment affect more than one unit.

In the empirical case, collaborative planning is relevant because the material flow depends on several planning conditions that must be aligned. VCBC creates production plans according to batch production logic, coil size, setup times, takt requirements, train departures and inventory levels. At the same time, TA must manage space limitations, internal transport routes and frequent replenishment needs.

The findings suggest that planning exists, but that it is mainly connected to production and delivery stability rather than continuous development of the material supply setup. The current unit load principles have been in place for around ten years, which indicates that packaging and delivery configurations may not have been regularly re-evaluated as operational conditions changed.

Collaborative planning could therefore help the units move from maintaining an established setup toward proactively evaluating future material supply solutions. This would involve planning packaging size, delivery frequency, repacking needs and replenishment logic together before changes are made. In this way, collaborative planning would support long term adaptation of the material flow rather than only short term coordination of existing deliveries.

5.1.5 Coordination Contracts

The theory on coordination contracts explains how rules, agreements and incentives can be used to align decisions between actors. In this thesis, the concept is relevant not as a formal legal contract, but as a way to understand whether VCBC and TA have shared principles for evaluating material supply decisions.

In the empirical case, the current setup appears to be shaped by long-established standards and historical agreements. The unit load principles remained unchanged for approximately ten years and the packaging setup is influenced by existing transport and handling requirements. Although these arrangements indicate a degree of coordination through established routines, they may no longer be fully aligned with the current operational requirements of the material supply interface.

The main issue is that the consequences of packaging and delivery decisions are distributed across both units. A solution may reduce effort or cost in one part of the flow while increasing space requirements, handling effort or replenishment complexity in another. Without clear shared evaluation criteria, it becomes difficult to assess whether a solution improves the total system or only shifts problems between units.

Coordination contracts could therefore be understood as internal agreements or decision rules for how changes should be evaluated. These could define which performance measures should be considered, how costs and benefits should be assessed across both units and when existing packaging or delivery principles should be re-considered. In this case, such shared rules would support more consistent decision-making and reduce the risk of local optimization.

5.1.6 Collaborative Value Creation

The theory on collaborative supplier relationships emphasizes that value is not created only through the exchange of materials but also through how well the relationship supports the operations of both parties. In the empirical case, the current pallet-based setup can be understood as creating value for VCBC because it supports batch production, transport efficiency and established handling routines. However, this value is reduced if the same setup creates additional handling, space constraints or replenishment challenges in TA. This shows that value creation should be evaluated according to the total effect on the material supply interface, rather than from the perspective of one unit alone.

The empirical findings therefore indicate a need for mutual adaptation. Both units have to adjust parts of their activities, resources or routines to improve the overall fit between them. For VCBC, this could involve evaluating whether packaging sizes, unit load configurations or delivery quantities can be adapted to better support downstream handling. For TA, it could involve assessing how internal logistics, storage areas or replenishment routines can be adjusted to make alternative material supply solutions feasible.

This does not mean that one unit should fully adapt to the needs of the other. Rather, the case shows that improvements require a balance between VCBC's production and transport conditions and TA's requirements for space efficient and stable material supply. Collaborative value creation therefore depends on the ability of both units to evaluate solutions jointly and adapt the material supply setup in a way that improves total system performance.

Overall, the empirical findings support the theory by showing that collaboration creates value when it leads to practical adaptation across organizational boundaries. In this case, the main value creation opportunity is not simply reducing cost or handling effort in one unit, but improving the fit between production, packaging, transport, receiving and line-side replenishment.

5.2 Material Flow Analysis

This section analyses the current material flow between VCBC and TA through the three dimensions of the ARA model: activities, resources and actors. The purpose is to examine how the current material supply system is configured and to identify key mismatches, constraints and interdependencies in the VCBC-TA interface. Table 5.1 summarizes the main actors, resources and activities identified in the material supply interface. The table is used as a starting point for the ARA analysis.

By structuring the analysis according to these dimensions, it becomes possible to assess how packaging solutions, replenishment principles, operational conditions and coordination practices jointly shape the performance of the material flow.

Actors	Resources	Activities
<ul style="list-style-type: none"> • VCBC production • VCBC planning • VCBC logistics • VCBC packaging department • TA logistics • TA production-line operators • VCBC finances • TA finances 	<ul style="list-style-type: none"> • Pallets & large unit loads • Blue boxes • Containers & trains • Unloading ramps • Pallet storage • AGV ramps • Intake points • Floor space in TA • Inventory levels • Forecasts & delivery information • Packaging standards & agreed unit load principles • IT support and replenishment signals 	<ul style="list-style-type: none"> • Stamping/batch production at VCBC • Packaging & unit load preparation • Transport to Torslanda • Unloading • Temporary storage • Internal transport • Line-side replenishment • Coordination meetings & planning

Table 5.1: Actors, Resources and Activities in Material Supply Interface Between VCBC and TA

5.2.1 Actor Layer

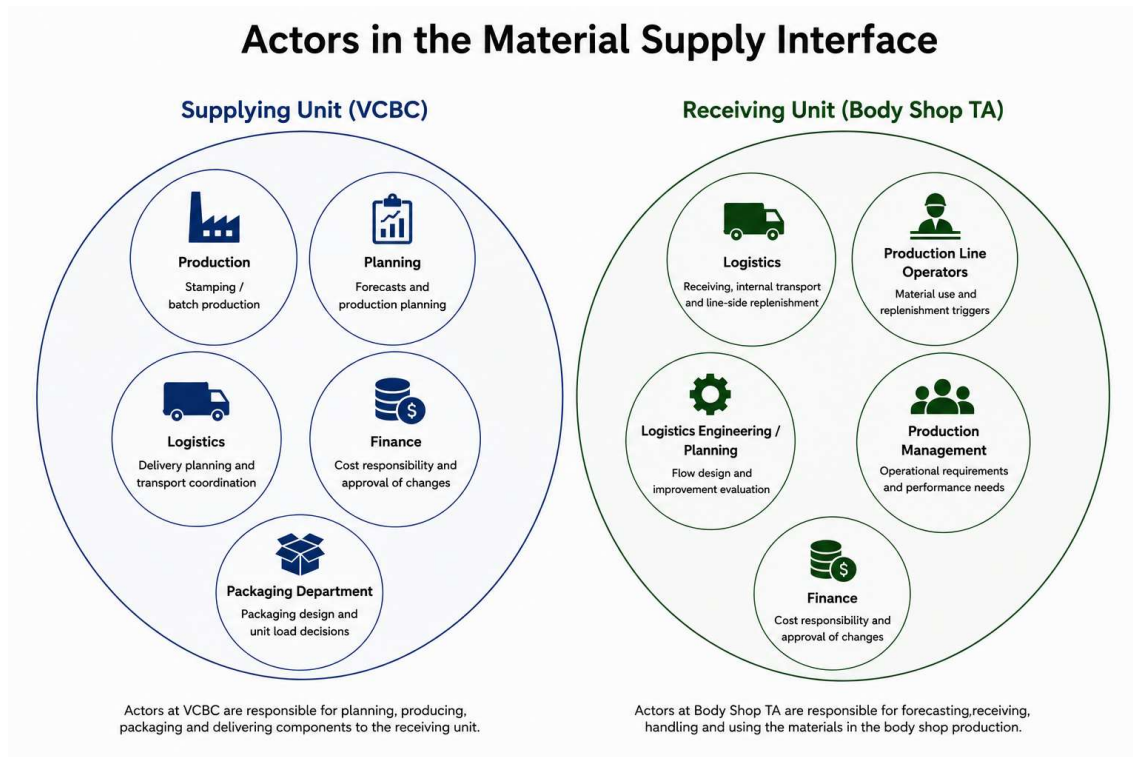


Figure 5.1: Actors in the material supply interface.

In this case, the material flow between VCBC and TA involves several actors with different responsibilities and objectives. As shown in Figure 5.1, key actors include production, logistics, planning and packaging departments at VCBC, as well as logistics personnel and production operators in TA.

The empirical findings show that the actors in the VCBC-TA interface are closely interdependent because their responsibilities and decisions rely on one another. VCBC production, planning and packaging departments shape how materials are produced, packed and delivered, while TA logistics and production actors depend on these decisions to perform unloading, internal transport, storage and line-side replenishment. At the same time, responsibilities for the material supply interface are distributed across several functions and units. Production planning, packaging decisions, transport arrangements, internal logistics, replenishment and financial approval are all handled by different actors. This means that no actor has full ownership of the entire flow and improvements require coordination across actors whose decisions affect each other. This reflects the theory by Gadde (2002), which explains that supplier and receiving units in modern supply chains are highly dependent on each other and therefore cannot be managed as separate functions.

Another actor related challenge is that VCBC and TA actors operate with different

priorities and objectives. VCBC is influenced by high-volume batch production and transport efficiency, while TA is more directly affected by internal handling, replenishment frequency and flexibility. This difference in objectives creates a risk of local optimization, where each unit makes decisions based on its own operational conditions rather than the performance of the overall system. Arshinder et al. (2008) argue that insufficient coordination may lead to misaligned decisions between supply chain actors, which may reduce flow efficiency and create operational problems downstream.

The actor layer is also influenced by separate budgets between functions and units. Even when a change could improve the material flow, implementation may be difficult if one actor carries the cost while another receives most of the benefits. This creates a coordination challenge, since packaging and replenishment improvements need to be justified across several actors rather than within one isolated budget.

The actor layer also shows that VCBC and TA are not disconnected actors, but interdependent units with an ongoing working relationship. The empirical findings indicate that the actors communicate through regular meetings and workshops and the relationship was described as generally positive. The statement that "We have problems together" suggests that the actors recognize the nature of the challenges in the material supply interface. However, this shared understanding does not remove the fact that the actors have different responsibilities, priorities and decision making authority. The statement that "sometimes suboptimization is needed for the long term" indicates that the actors are aware that improvements may require one unit to accept short term disadvantages. However, turning this awareness into practical changes depends on whether the actors can agree on how costs, benefits and responsibilities should be distributed.

Overall, the actor layer shows that the logistics challenges are not only technical or operational, but also organizational. VCBC and TA are dependent on each other, but operate under different goals, constraints and decision making structures. While collaboration between the actors appears relatively strong, stronger alignment of objectives, responsibilities and incentives is needed to support system-wide improvements rather than local optimization.

5.2.2 Resource Layer




























Unit	Physical Resources <i>Tangible assets used in the material flow</i>	Non-Physical Resources <i>Intangible assets enabling and controlling the flow</i>
 VCBC <i>Supplying Unit</i>	 Pallets  Blue Boxes  Containers & Trains  Unloading Areas	 Packaging Standards & Unit Load Principles  IT Systems & Planning Systems  Information Exchange  Delivery Information
 Interface / Shared Resources <i>Between Units</i>	 Pallets  Blue Boxes  Containers & Trains  Unloading Areas	 Packaging Standards & Unit Load Principles  IT Systems & Planning Systems  Information Exchange  Delivery Information
 Body Shop TA <i>Receiving Unit</i>	 Temporary Storage / Buffer Areas  AGV / Forklift / Tow Train  Floor Space  Line-Side Space	 Inventory Information & Levels  Operational Capacity  Line-Side Needs & Sequence  Quality & Process Requirements

Figure 5.2: Resources in the material supply interface.

In the case of VCBC and TA, the resource layer includes both physical and non-physical resources as shown in Figure 5.2. The main physical resources include pallets, blue boxes, transport containers, unloading areas, pallet storage, handling equipment and floor space. The main non-physical resources include forecasts, inventory information, packaging standards, unit load principles and planning routines. These resources are closely connected because the way one resource is designed or used affects how other resources function.

A central resource in this case is the pallet based unit load. From VCBC's perspective, pallets appear to support high volume batch production, transport requirements and established handling routines. Since production is organized in batches and large quantities are delivered to Torslanda several times per day, larger unit loads can reduce the number of handling and transport movements required for a given volume of material. The pallet based setup can therefore be understood as a resource that supports upstream production and transport efficiency.

However, the same resource creates constraints in TA. Large pallets require floor space, storage capacity and suitable handling equipment. In TA, where line-side space and internal transport routes are limited, the pallet based setup can create challenges for unloading, temporary storage, internal movement and replenishment

to the point of use. This shows that the value of a resource depends on the context in which it is used.

Blue boxes represent a possible resource adaptation in the material supply interface. Since they are already used in other parts of the production system, they are not a completely new resource, but an existing alternative that could potentially be adapted to this flow. Smaller load carriers could support more compact line-side presentation, reduce the amount of material stored close to production and improve flexibility in replenishment.

At the same time, blue boxes cannot be evaluated as an isolated packaging resource. A change from pallets to blue boxes would affect several connected resources, including transport containers, handling equipment, storage areas, replenishment routes and planning routines. Smaller unit loads may require more frequent replenishment, different handling equipment or redesigned delivery routes, such as milk runs. Therefore, the usefulness of blue boxes depends on whether the wider resource structure can be adapted to support them. Blue boxes should therefore not be understood as a simple replacement for pallets, but as a resource adaptation that would require changes in the surrounding resource structure. If smaller unit load carriers were introduced, the benefits would depend on whether transport containers, handling equipment, storage areas, replenishment routes and planning routines could also be adapted to support them.

Floor space is another critical resource. In TA, limited floor space affects how much material can be stored, how easily load carriers can be moved and how materials can be presented close to the point of use. The current pallet based setup places pressure on this resource because large unit loads require storage and buffer space before they are consumed. This means that packaging decisions are directly connected to the use of space in the receiving unit.

The non-physical resources also influence the material flow. Forecasts, inventory information, replenishment signals and planning routines support daily coordination between VCBC and TA by helping VCBC plan production and delivery quantities. Packaging standards and unit load principles create stability in the current setup, but they may also limit adaptability if they are not regularly reviewed against current operational requirements. These resources therefore support the existing flow, but may not be sufficient for evaluating broader changes to packaging, replenishment and handling across both units. This means that non-physical resources, such as planning routines, inventory signals and established packaging standards, not only support the current material flow, but they also influence how easily the system can be changed.

Overall, the resource layer analysis shows that the main challenge is not one single resource, but the fit between several interconnected resources. The current resource

setup also seems to be better adapted to VCBC's production conditions than to the operational needs of TA. This creates a mismatch between the supplying and receiving units, where resources that improve efficiency in one part of the flow reduce efficiency in another.

5.2.3 Activities Layer

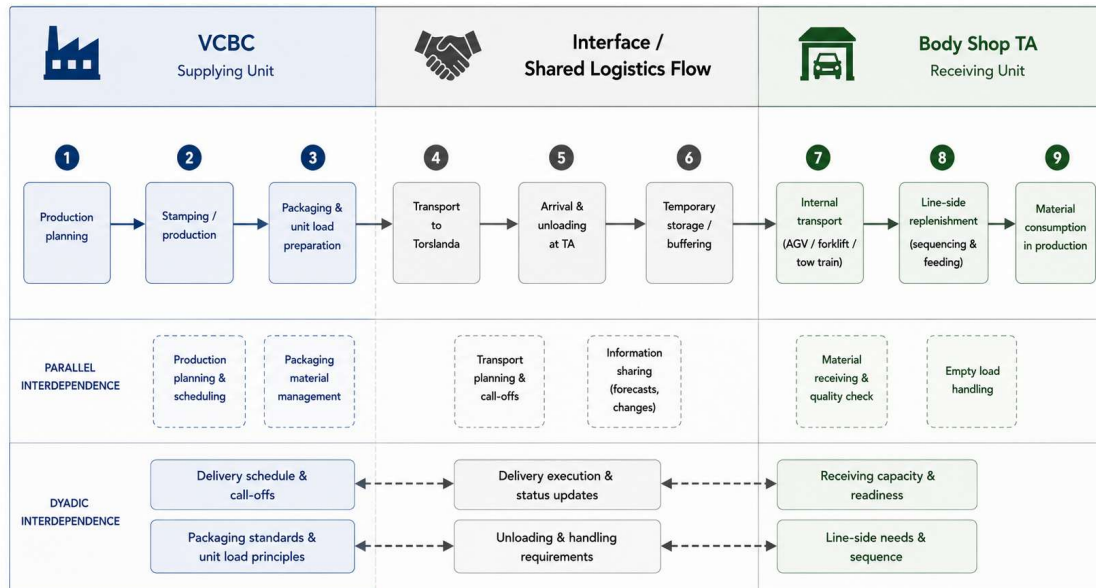


Figure 5.3: Illustration of serial, parallel and dyadic activities in the material flow

In the VCBC-TA interface, the activity layer consists of the connected operations required to move material from production at VCBC to use in TA. The main activities are shown in Figure 5.3. The flow starts with stamping and batch production at VCBC, followed by packaging and unit load preparation. Materials are then transported to Torslanda, unloaded, temporarily stored and internally transported before reaching the final production line through line-side replenishment. These activities are mainly sequentially connected, since the output of one activity becomes the input for the next.

A central activity-layer challenge is the mismatch between the batch-oriented activities at VCBC and the flow-oriented activities in TA. At VCBC, stamping production is organized around high-volume batch production, where larger production volumes and established unit loads support production and transport efficiency. In TA, however, material supply depends on frequent replenishment, limited line-side space and continuous material availability. As a result, activities that are efficient upstream may create handling, storage and replenishment challenges downstream.

According to the concept of sequentiality, downstream activities depend on the outputs of preceding activities, meaning that changes in upstream processes directly

influence downstream operations (Håkansson et al., 2009). Packaging and unit load preparation are especially important because they influence how material can be transported, unloaded, stored, moved internally and replenished to the line.

The current replenishment logic also makes the downstream flow relatively reactive, since replenishment is triggered when inventory reaches predefined levels rather than through a fully standardized and scheduled replenishment cycle. This resembles the reorder point logic described in Chapter 2. Reorder point systems can create instability and inefficiencies in manufacturing environments, particularly when material demand is highly dependent on production processes. In contrast, milk run systems and scheduled replenishment are often better suited for flow-oriented production because they create predictable deliveries and reduce unnecessary vehicle movements.

Overall, the activity layer shows that the main challenge is the alignment between upstream and downstream activities. Improvements to the material flow would therefore require changes to be evaluated across the full sequence of activities, rather than only within production, packaging, transport or replenishment separately.

5.3 ARA analysis

Challenge	Actor dimension	Resource dimension	Activity dimension
Operational Misalignment	VCBC prioritizes batch production & transport efficiency while TA prioritizes handling efficiency, line-side space & frequent replenishment	Pallets fit VCBC's production & transport logic better than TA's line-side needs	Upstream activities shape downstream activities
Coordination Challenges	Actors communicate through meetings & workshops, but responsibilities, budgets & decision authority are divided.	Alternative resources, such as blue boxes, require adaptation of transport containers, storage areas, handling equipment & replenishment signals.	Changing packaging would affect several activities.
Material Flow Trade Offs	VCBC & TA actors may evaluate the same solution differently because costs & benefits are distributed unevenly.	Larger pallets support upstream efficiency, while smaller blue boxes may support compact line-side presentation & flexibility.	Smaller unit loads may require more frequent replenishment or redesigned delivery routes.

Table 5.2: Key material flow challenges in the case

Table 5.2 shows that the main challenges in the VCBC-TA interface are not linked to one ARA dimension alone. Instead, each challenge involves a combination of actor priorities, resource configurations and connected activities. The table is therefore used as a basis for analysing how these dimensions interact and create system-level effects in the material supply.

The previous sections analysed the material supply interface between VCBC and TA through the separate dimensions of activities, resources and actors. According to the ARA model, these dimensions are closely connected and should not be analysed independently since actors, resources and activities influence one another through activity links, resource ties and actor bonds (Gadde & Snehota, 2000). This means that material flow performance is not affected by individual activities, resources or decisions, but also by how these different parts of the system interact. In this case, the findings indicate that several inefficiencies emerge through mismatches between actors, resources and activities rather than from isolated operational problems.

5.3.1 Operational Misalignment

One central ARA-level challenge in the case is the misalignment between actor priorities, resource configurations and activity requirements. The misalignment can be understood as a chain of interaction between the ARA dimensions. Actor priorities at VCBC influence the design of packaging resources, particularly pallet based unit loads and delivery quantities. These resources then shape downstream activities such as unloading, temporary storage, internal transport and line-side replenishment in TA. The issue is therefore not only that VCBC and TA have different operational conditions, but that these actor priorities are embedded in resources and then transferred into activity constraints downstream.

This is visible in the current packaging and delivery setup. Packaging decisions are influenced by VCBC actors such as production, logistics and the packaging department, whose conditions are closely connected to batch production, transport efficiency and existing unit load principles. As a result, the pallet-based setup supports upstream production and transport requirements, but creates different effects in TA, where limited floor space, frequent replenishment and line-side accessibility are more important. Large pallets therefore do not only function as packaging resources, but they also shape how material must be unloaded, stored, moved internally and replenished to production. From an ARA perspective, the challenge is therefore not the pallet setup in isolation, but the way actor priorities, packaging resources and downstream activities are interconnected without being fully aligned across the material supply interface.

This indicates that the operational misalignment is not caused by one single decision or resource, but by the way the material supply setup has developed around different operational logics in the two units. A solution that is efficient for VCBC in terms of batch production, loading and transport utilization may create additional handling, space and replenishment requirements in TA. The misalignment therefore reflects a system-level challenge, where improvements need to consider how actor priorities, packaging resources and logistics activities affect each other across the full material supply interface.

5.3.2 Coordination Challenges

From an ARA perspective, the coordination challenge is that decisions about material supply interface must align actors, resources and activities at the same time. The previous sections show that VCBC and TA are already connected through communication, shared material flows and daily planning routines. However, the challenge lies in coordinating changes that affect several dimensions simultaneously. Packaging changes, for example, require agreement between actors, adaptation of connected resources and adjustment of downstream activities.

The findings suggest that the relationship between VCBC and TA is generally col-

laborative, with regular meetings and discussions. As described in the empirical data, the relationship is constructive and there is a shared understanding that the units "have the problems together". However, this collaboration takes place within a system where the two units still operate according to different priorities, budgets and operational conditions. The coordination challenge is therefore not a lack of communication, but the difficulty of justifying changes when the effects are distributed unevenly across the material supply interface.

This is especially visible when considering the costs and benefits of packaging improvements. A packaging change that better supports TA's needs may create additional costs or work for VCBC. At the same time, the current setup may already involve hidden costs for TA, since the packaging and replenishment setup does not fully fit TA's operational requirements, the receiving unit may experience additional handling, space constraints and replenishment effort. A packaging change may therefore be understood not only as creating new costs for VCBC, but also redistributing the burden across the interface. This makes financial approval challenging if improvements are evaluated through separate functional or unit-level budgets rather than according to their overall effect on the material supply interface.

The coordination challenge is also influenced by historical decision structures. Existing packaging principles and unit load configurations have developed over time and become embedded in production, transport and handling routines. As a result, the current setup provides stability, but it may also reduce adaptability when operational requirements change. Larger changes become difficult because several connected actors, resources and activities would need to be adapted at the same time. The findings therefore do not suggest a lack of collaboration, but rather that collaboration alone is insufficient when objectives, budgets, responsibilities and operational constraints remain partly separated. The main issue is therefore not the absence of coordination, but that existing coordination mechanisms may not be sufficient for managing cross-functional changes to packaging, replenishment and material handling.

5.3.3 Material Flow Trade Offs

The material flow trade-off shows that there is no simple best solution for the packaging setup. The current pallet-based setup should not be understood as wrong, since it supports VCBC's high-volume batch production, transport efficiency and established handling routines. At the same time, smaller load carriers such as blue boxes are not automatically better, even if they may better support TA's need for compact line-side presentation, flexibility and reduced space usage.

Reducing unit load size may initially appear to be a packaging issue, but such a change would also influence transport planning, delivery frequency, replenishment activities and inventory levels. Smaller load carriers may improve accessibility and reduce floor space requirements in TA, but they would likely increase replenishment

frequency and affect transport efficiency upstream. This illustrates how activities and resources are interconnected, where improvements in one part of the system may create new requirements in another. Pallets may support upstream production and transport efficiency, while blue boxes may reduce some downstream constraints, but each alternative creates different consequences across the material supply interface.

The trade-off is therefore not only between large and small unit loads. It is a question of how well the packaging solution fits the surrounding material supply system. From an ARA perspective, a change in unit load size would affect actors, resources and activities at the same time. Therefore, blue boxes should not be evaluated as an isolated packaging improvement, but as part of a wider adaptation of replenishment, handling, transport and coordination across the VCBC-TA interface.

Overall, the integrated ARA analysis shows that the challenges in the material supply interface cannot be explained through isolated problems related to actors, resources or activities alone. Instead, the findings show that the different layers are closely connected, where decisions made by actors shape resource configurations, which in turn influence how activities are carried out throughout the material flow. Several mismatches can be identified between the operational conditions at VCBC and TA, especially regarding packaging, replenishment and production logic. Since activities, resources and actors are closely interconnected, improvements in the material flow require a system-wide perspective where decisions are coordinated across both units rather than optimized locally. This supports the supply chain management perspective that overall system performance should be prioritized over local efficiency (Mentzer et al., 2001; Lambert & Cooper, 2000).

6

Discussion

The findings of this thesis show that the material supply challenges between VCBC and TA are not only related to packaging configurations or replenishment methods, but rather stem from the interaction between different operational conditions, objectives and decision-making structures across the material supply interface. Although several inefficiencies related to material handling, space utilization and replenishment were identified, the findings suggest that these challenges cannot be fully understood as isolated logistics problems. Instead, they reflect a broader coordination challenge where locally rational decisions may create inefficiencies elsewhere in the system.

From a supply chain management perspective, these findings show the importance of evaluating logistics performance from a system-wide rather than local perspective. Decisions that support production efficiency and transport utilization at VCBC may create operational constraints in the receiving environment at TA. The discussion therefore focuses on how the identified challenges could potentially be addressed through stronger system-wide coordination, more adaptive decision-making processes and improved alignment between operational requirements.

6.1 Managing Operational Misalignment

The findings suggest that future material flow improvements should primarily focus on managing the operational misalignment between VCBC and TA. The analysis shows that the current material supply setup is based on different operational priorities, where VCBC prioritizes production stability, transport efficiency and batch production, while TA operations require material accessibility, limited line-side inventory and smooth internal flow. As a result, logistics solutions that support upstream efficiency may simultaneously create operational constraints downstream.

One improvement opportunity may therefore involve increasing the involvement of TA in packaging and material flow decisions at VCBC. Since downstream operations experience the practical consequences of packaging and delivery configurations, earlier involvement may improve the ability to identify solutions that better balance transport efficiency, floor-space utilization and replenishment requirements across

the interface.

At the same time, the findings suggest that future improvements should avoid isolated optimization of either unit. Full adaptation to TA's operational requirements may reduce upstream efficiency at VCBC, while maintaining current logistics principles risks preserving downstream inefficiencies. Future material flow improvements may therefore benefit from a stronger system-wide perspective where logistics decisions are evaluated according to their combined effect on production stability, transport efficiency, handling effort and material accessibility across the material supply interface.

6.2 Managing Coordination in an Interdependent System

The findings further suggest that improving material flow performance may depend on stronger coordination between VCBC and TA. Although collaboration between the units appears constructive, the analysis indicates that current coordination mechanisms are mainly focused on maintaining stable operations rather than jointly developing the material supply setup. Since packaging, replenishment and transport decisions influence several interconnected activities, fragmented decision-making increases the risk of suboptimization.

One improvement opportunity may involve more structured and continuous cross-functional evaluations of packaging and replenishment principles involving logistics, planning and packaging representatives from both units. Since current packaging solutions have remained relatively stable over time despite changing operational conditions, recurring evaluations may improve the ability to reassess whether existing logistics principles continue to support current material flow requirements.

The findings also suggest that future improvements may benefit from stronger joint decision making processes when evaluating logistics changes. Information sharing currently supports planning visibility between the units, but visibility alone does not necessarily ensure aligned decisions.

Improvements may therefore depend less on increasing the amount of information exchanged and more on improving how information is jointly used when evaluating packaging size, delivery frequency and replenishment principles. Information needs to be communicated at the right time and in the correct way for it to be effective.

At the same time, coordination improvements involve trade offs. Changes that improve material accessibility and replenishment efficiency in TA may create additional planning effort, handling complexity or transport challenges at VCBC. Since costs and benefits are distributed unevenly across the material supply interface, future

improvements may benefit from clearer evaluation criteria where logistics changes are assessed according to their total system impact rather than separate operational objectives.

In this context, coordination contracts may support stronger coordination by providing shared principles for how logistics changes should be evaluated across functions. Improvements that reduce handling effort, space constraints or replenishment complexity in TA may create additional costs or workload at VCBC, making approval difficult when costs and benefits are assessed separately. Clearer coordination principles may therefore help align logistics and finance functions by creating a broader basis for evaluating costs, benefits and operational consequences across the material supply interface. Rather than assessing changes according to separate budgets or local objectives, such mechanisms may support decision-making based on total system impact.

Such an approach may also improve coordination across involved functions, including finance departments, by enabling decisions to be evaluated from a system-wide perspective when assessing and approving logistics changes.

6.3 Material Flow Trade Offs and Resource Adaptation

The findings suggest that future material flow improvements should focus on selective adaptation of packaging and replenishment solutions rather than broad standardization. Existing pallet based configurations appear well adapted to VCBC's production and transport conditions, but less aligned with the operational requirements of TA, where larger unit loads contribute to floor space constraints, handling effort and replenishment complexity.

One improvement opportunity could therefore involve identifying material categories that create the greatest operational challenges at TA and selectively testing alternative packaging configurations for these materials. This may include smaller packaging quantities, partial pallet solutions or pre divided blue box replenishment for selected components. Rather than replacing current packaging standards entirely, the objective would be to identify where alternative packaging creates the greatest improvement in material accessibility and flow efficiency without causing excessive disruption upstream. Since such improvements are more limited in scope while potentially creating significant operational benefits, they may also be easier to justify and approve across involved functions, including finance departments, compared to broader system-wide changes.

Another improvement opportunity may involve adapting replenishment principles according to material characteristics. Materials creating space constraints or high handling effort may benefit from more frequent replenishment in smaller quantities,

while more stable materials continue under existing replenishment logic. Pilot testing packaging and replenishment changes simultaneously may also improve understanding of how inventory levels, handling effort and logistics workload are affected before larger implementation decisions are made.

However, the findings suggest that no logistics solution is universally optimal. Smaller packaging may improve accessibility and reduce floor space utilization but may simultaneously increase replenishment frequency, transport complexity and handling effort. Future improvements should therefore focus on balancing trade offs between transport efficiency, production stability, material accessibility and logistics effort across the entire material supply interface rather than optimizing individual activities independently.

7

Conclusion and Implications

7.1 Managerial Implications

The purpose of this thesis was to analyze the logistics flow between The Body Shop, TA, and their supplier Volvo Cars Body Components, VCBC, from a system-wide perspective and identify improvement opportunities for the material supply interface. By studying replenishment principles, delivery configurations, and coordination practices, the study aimed to understand how logistics decisions influence material flow efficiency, material availability, and production stability across the two units. The findings fulfill the purpose by identifying key operational constraints, interdependencies and opportunities for improving the material supply interface between VCBC and TA.

The first research question concerned how the current material, packaging, and delivery flow between VCBC and TA is designed and operated. The findings show that the material supply interface is characterized by high delivery frequency and large material volumes, where packaging solutions are mostly adapted to production and transport efficiency at VCBC, which adopts a batch production system whereas TA only has line-side production with consumption-based replenishment. This creates strong interdependencies between packaging size, replenishment frequency and line-side material availability. While the current setup supports production and transport conditions at VCBC, it also creates operational challenges in TA.

The findings therefore suggest that Volvo Cars should continuously evaluate whether existing packaging and delivery configurations remain aligned with the operational requirements of both units. More regular cross-functional assessments of packaging and material flow solutions could improve the ability to identify operational mismatches and adapt logistics configurations as production conditions evolve.

The second research question focused on how differences in operational conditions and objectives between VCBC and Body Shop TA influence packaging, replenishment and material flow efficiency. The findings show that the two units operate under different operational priorities. VCBC focuses on production efficiency, transport utilization and batch-oriented production, while TA prioritizes material accessibility, line-side space utilization with smaller unit loads and stable replenishment close

to production. As a result, logistics and packaging solutions that support efficiency in the supplying unit can create inefficiencies in the receiving unit.

Improvements should focus on reducing operational misalignment by increasing the involvement of TA in packaging and material flow decisions. Earlier involvement of downstream operations may improve the ability to identify solutions that better balance production efficiency, transport utilization, handling effort and material accessibility across the interface. Furthermore, logistics decisions should be evaluated from a system-wide perspective rather than through isolated optimization of either unit.

The study therefore concludes that operational misalignment between interdependent units contributes to challenges in material handling, replenishment and logistics flow performance. This indicates how important it is to evaluate logistics decisions from a system-wide perspective rather than through local optimization.

The third research question examined how coordination mechanisms influence the alignment of packaging, delivery and replenishment decisions between VCBC and Body Shop TA. The findings show that coordination between the units is constrained by fragmented decision-making, differences in operational priorities and limited integration of logistics requirements between units. Although there is some information sharing, the study identified opportunities for improved information sharing, collaborative planning, joint decision-making, and coordination contracts. Through the ARA perspective, the study demonstrates how actors, resources and activities are closely interconnected, meaning that decisions made in one unit influence performance elsewhere in the material flow. Consequently, limited coordination contributes to operational misalignment and reduces the ability to optimize the material supply interface.

Stronger coordination could be achieved through more structured collaborative planning, recurring cross-functional evaluations and stronger joint decision-making processes involving logistics, planning and packaging functions from both units. Improvements should focus not only on increasing information sharing but also on improving how shared information is jointly used when evaluating logistics changes. In addition, clearer coordination principles and shared evaluation criteria could support decisions based on total system impact rather than separate operational objectives.

The fourth research question focused on what improvement opportunities could support a more efficient and coordinated material supply interface between VCBC and TA. The findings show that improvements should focus on both logistics design and coordination mechanisms. Smaller unit loads and more adapted packaging may improve line-side accessibility, ergonomics and space utilization in TA, especially when supported by more flow oriented replenishment principles and increased delivery frequency for selected components. The study also shows that stronger coordination

between units, including improved information sharing, collaborative planning and improved alignment of operational priorities, could contribute to a more efficient and stable material flow. However, improvements should not be implemented in isolation, since packaging size, replenishment logic and logistics resources are inter-dependent.

Future improvements should focus on selective adaptation rather than broad standardization. Alternative packaging concepts should primarily be tested for material categories that create the greatest operational challenges at TA. In addition, replenishment principles should be adapted according to material characteristics, with space-constrained materials supplied more frequently in smaller quantities where appropriate. Pilot testing packaging and replenishment changes simultaneously may also provide valuable insight into their effects before larger implementation decisions are made. Finally, future improvements should focus on balancing trade-offs between transport efficiency, production stability, material accessibility and logistics effort across the entire material supply interface.

Overall, this thesis demonstrates that improved material flow between VCBC and Body Shop TA cannot be achieved through isolated logistics decisions alone. Instead, efficient material supply requires a system-wide perspective in which packaging solutions, replenishment principles, logistics resources and coordination mechanisms are aligned across both units. By improving coordination and adapting logistics solutions to the operational conditions of both VCBC and TA, Volvo Cars has the opportunity to support a more stable, efficient and flow-oriented material supply interface.

7.2 Future Research

The recommended improvements were not tested or implemented during the study. Future research could therefore focus on implementing and evaluating the suggested solutions in practice in order to assess their effects on material flow efficiency, coordination and production stability.

Further research could also investigate the long-term impacts of reduced unit load sizes and alternative packaging concepts on inventory levels, transport efficiency and line-side operations.

Quantitative studies and simulation-based research could complement the qualitative findings of this study and provide a more detailed evaluation of potential trade-offs. In addition, the development of relevant key performance indicators (KPIs) could support the measurement and evaluation of the proposed improvements and provide a structured basis for monitoring their long-term effects.

Bibliography

Albrecht, M. (2010). *Supply Chain Coordination Mechanisms: New Approaches for Collaborative Planning*. Berlin: Springer.

Araujo, L., Gadde, L.-E., & Dubois, A. (2016). Purchasing and supply management and the role of supplier interfaces. *IMP Journal*, 10(1), 2–24.

Arshinder, Kanda, A., & Deshmukh, S. G. (2008). Supply chain coordination: Perspectives, empirical studies and research directions. *International Journal of Production Economics*, 115, 316–335.

Boysen, N., Emde, S., Hoeck, M., & Kauderer, M. (2015). Part logistics in the automotive industry: Decision problems, literature review and research agenda. *European Journal of Operational Research*, 242(1), 107–120.

Castillo, I., & Peters, B. A. (2002). Unit load and material-handling considerations in facility layout design. *International Journal of Production Research*, 40, 2955–2989.

Costantino, F., Di Gravio, G., Shaban, A., & Tronci, M. (2014). The impact of information sharing and inventory control coordination on supply chain performances. *Computers & Industrial Engineering*, 76, 292–306.

Dubois, A., & Gadde, L.-E. (2002). Systematic combining: An abductive approach to case research. *Journal of Business Research*, 55(7), 553–560.

Dubois, A., & Araujo, L. (2007). Case research in purchasing and supply management: Opportunities and challenges. *Journal of Purchasing and Supply Management*, 13(3), 170–181.

Fussone, R., Cannella, S., & Framinan, J. M. (2025). Push vs pull replenishment policies in symbiotic supply chains. *IFAC PapersOnLine*, 59(10), 226–231.

Gadde, L.-E., & Snehota, I. (2000). Making the most of supplier relationships. *Industrial Marketing Management*, 29(4), 305–316.

Gadde, L.-E., & Snehota, I. (2019). What does it take to make the most of supplier relationships? *Industrial Marketing Management*, 83, 185–193.

Håkansson, H., Ford, D., Gadde, L.-E., Snehota, I., & Waluszewski, A. (2009). *Business in Networks*. Chichester: Wiley.

Hanson, R., & Finnsgård, C. (2014). Impact of unit load size on in-plant materials supply efficiency. *International Journal of Production Economics*, 147, 46–52.

Jonsson, P., & Mattsson, S.-A. (2009). *Manufacturing Planning and Control*. Maidenhead: McGraw-Hill Education.

Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in the social sciences. *Nature Reviews Methods Primers*, 2, 73.

Lambert, D. M., & Cooper, M. C. (2000). Issues in supply chain management. *Industrial Marketing Management*, 29(1), 65–83.

Lee, H. L., Padmanabhan, V., & Whang, S. (1997). The bullwhip effect in supply chains. *Sloan Management Review*, 38(3), 93–102.

Mentzer, J. T., DeWitt, W., Keebler, J. S., Min, S., Nix, N. W., Smith, C. D., & Zacharia, Z. G. (2001). Defining supply chain management. *Journal of Business Logistics*, 22(2), 1–25.

Ouyang, Y. (2007). The effect of information sharing on supply chain stability and the bullwhip effect. *European Journal of Operational Research*, 182(3), 1107–1121.

Pålsson, H., Finnsgård, C., & Wänström, C. (2013). Selection of packaging systems in supply chains from a sustainability perspective: The case of Volvo. *Packaging Technology and Science*, 26(5), 289–310.

Prenekert, F., Hedvall, K., Hasche, N., Eklinder Frick, J., Abrahamsen, M. H., Aramo-Immonen, H., Baraldi, E., Bocconcelli, R., Harrison, D., Huang, L., Huemer, L., Kask, J., Landqvist, M., Pagano, A., Perna, A., Poblete, L., Ratajczak-Mrozek, M., & Wagrell, S. (2022). Resource interaction: Key concepts, relations and representations. *Industrial Marketing Management*, 105, 48–59.

Gustaver, M. (2020). A Chalmers University of Technology Master's thesis template for L^AT_EX. Unpublished.

Schmid, N. A., & Limère, V. (2019). A classification of tactical assembly line feeding problems. *International Journal of Production Research*, 57(24), 7586–7609.

Uhernik, I. F. (2021). The impact of internal logistics on the performance of manufacturing companies: A review article. *Challenges of the Future*, 6(1), 17–36.

Van Weele, A. J., & Rozemeijer, F. (2022). *Procurement and supply chain management* (8th ed.). Cengage.

Wänström, C., & Medbo, L. (2009). The impact of materials feeding design on assembly process performance. *Journal of Manufacturing Technology Management*, 20(1), 30–51.

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF SUPPLY AND OPERATIONS MANAGEMENT
CHALMERS UNIVERSITY OF TECHNOLOGY

Gothenburg, Sweden 2026

www.chalmers.se



CHALMERS