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Optimized Internal Logistics for Non-Standard Parts

Master's Thesis in Production Engineering

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A Process Optimization Study About Redesigning Internal Logistics for Non-Standard Parts in a Truck Production Plant

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Abstract

This report focuses on optimizing internal logistics for non-standard parts in Volvo Trucks' production plant in Tuve. More specifically, the customer adapted (CA) materials are emphasized. The thesis aims to identify the issues in the current logistics flow and propose solutions to improve material availability, reduce lead times, and support production goals. Furthermore, the research covers the challenges induced by having a logistics flow with low-volume and customer specific components. By analyzing the root causes of delays, errors, and poor coordination, the study identifies areas for improvement, such as better information flow, system support, and quality control measures. Key findings suggest that addressing underlying issues like unclear material specifications, manual handling, and weak communication between departments can significantly improve the robustness of the CA material flow, leading to improved performance and better customer satisfaction. The proposed solutions include implementing real-time scanning systems, enhancing buffer management, and improving coordination across departments. This report shows the importance of adapting logistics systems to handle a high variability and ensure on-time deliveries of non-standard parts in a complex manufacturing environment.

Keywords: internal logistics, non-standard parts, process optimization, mass customization, lean production, production planning.

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Filip Kitevski, Mohamed Arkavazi, Gothenburg, January 2026

List of Acronyms

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

BOM	Bill of Materials
CA	Customer Adaptation
CBU	Complete Built Unit
FTT	First Time Through
FTY	First Time Yield
HF	Human Factors
IMC	Internal material coordinator
JIT	Just-in-Time
KPI	Key Performance Indicator
RCA	Root Cause Analysis
TL	Team Leader
VPS	Volvo Production System
VSM	Value Stream Mapping

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Introduction

This chapter presents the background, aim and scope of the project.

1.1 Background

Today's manufacturing industry is increasingly dominated by variants of adapted products from the customer, introducing complexity into production and logistical processes [1]. The Volvo Trucks Plant in Tuve, Gothenburg, has been producing trucks for the global market since 1927 [2]. Since then, the development of their trucks has been significant. The trucks are now more powerful, efficient, comfortable, safer and also more environmentally friendly [3]. Volvo has been since many years back given their customers the option to be able to customize their trucks in many different ways in order to increase customer satisfaction. Currently at Volvo Trucks, when a customer needs a certain specific truck application, it is the procurement engineer's responsibility to make sure that the Customer adaptation assembly stations get their specific parts within the planned lead time. Volvo is currently dealing with small volumes and short lead times to fulfill their customers' and market demands. One example is the CrewCab for their fire trucks, which is a double cabin. All of their projects are based on customer needs, where they adapt all the trucks for different types of applications [4]. Today, around 80% of all the trucks made have some type of Customer Adaption (CA) in them. Volvo's production system currently manages approximately 21,000 different parts, of which around 6,000 are classified as CA parts. A significant proportion of these CA parts are assembled directly on the main assembly line. However, for parts where on-line assembly is not feasible, a dedicated material flow is utilized to deliver them to the CA assembly station. Vehicles requiring customer Adaptations (CA trucks) proceed through the standard assembly process and exit the production line in a complete but non-final state. These trucks are then transferred to a buffer storage area, where they remain until their scheduled CA assembly time. At this stage, the outstanding CA parts are installed in accordance with customer specifications before the truck enters the final delivery flow.

Non-standard parts are another word for CA parts and are defined as parts that are not included in the standard bill of materials (BOM) for building regular trucks that are not CA modified. These parts may involve new procurement, design adjustments or modifications of existing components. Unlike standard parts, they are typically low-volume, customer-specific and sourced from multiple suppliers with varying lead times. Customer adaptations in manufacturing are often discussed under the concept of "mass customization", where the companies aim to combine efficiency from mass production with flexibility from customization. While this approach increases customer satisfaction, it also creates logistical complexity, especially in the handling of low-volume, non-standard components [5].

Since the CA could in principle be anything, the production requires many different types of non-standard parts depending on the customer's demands. In order for this system to work, Volvo needs to have a flow where the deliveries of the right parts get to the right assembly stations at the right time. The current flow does not achieve that, the reason for this is that many CA parts are delivered late from the suppliers and are also missing when counting. This is due to some material getting lost while it is sorted and handled for reasons such as materials being misplaced across storage areas or manually handled in ways that increase the risk of loss. Today, around 30-40% of the orders have at least 1 missing part. As mentioned earlier, the CA parts are often required in low volumes and could have long lead times from the supplier. Therefore, it is important that the material is handled correctly in order to minimize damaged and missing CA material, which in turn could lead to late truck deliveries. The production normally does not stop because of missing or late CA-material. However, the unfinished CA-trucks have to be stored at the end of the assembly line, which occupies valuable space. This is a significant problem for Volvo because storage space near the end of the main line is limited, employees report that at times, 10-20 CA trucks can be waiting simultaneously, which increases blockages for other trucks and impacts lead time and planning.

This means that parts are not available when required by the truck production schedule, which prolongs the process and increases the lead time, which in turn affects their customers. The delayed or missed part creates a direct bottleneck in the workflow. Even if the main assembly line can continue operating, the affected CA truck cannot proceed to its customer-specific assembly, which leads to waiting time in the buffer, re-prioritization of tasks and changes in planning. Volvo agrees on a delivery date with the customers and for this reason its important to get the material on time so that there are no delays.

Another important difference between the CA material flow and the standard part flow is that the standard flow is generally stable with established suppliers, predictable demands and also few disruptions. The CA flow on the other hand is characterized by unpredictability, multiple suppliers and higher error rates. This difference is one of the core motivations for the study, since it indicates that existing solutions designed for standard flows may not be sufficient for CA flows. Understanding this difference is important to identify why the CA flow suffers from recurring delays, whereas the standard flow does not. According to internal Volvo reports, the standard flow is generally stable and exhibits low error rates, while CA flows frequently suffer from missing or delayed parts. This highlights the need to investigate the CA material flow specifically. Addressing this issue is strategically important for Volvo. Inefficiencies in the handling of non-standard parts not only risk production delays but also lead to higher costs, increased workload for employees and also potential damage to Volvo's reputation as a reliable supplier of premium trucks. Inefficiencies in this context refer to deviations from planned lead times, unnecessary material handling and accumulation of large buffers. Reason for this is that Volvo has reported that the current buffer levels are high which takes up space that could have been used for other purposes instead of inventory which also costs, recurring shortages and communication gaps, each of which contributes to increased workload, longer throughput times than the one that are planned and higher operational cost. In order to build a more detailed understanding of how the CA flow currently works and also to identify the root causes to why the inefficiencies occur, mapping the existing flows of CA materials inside the plant is necessary since it is not fully mapped today. The CA material flow also involves multiple stakeholders that work towards the common goal of having a steady flow and regular deliveries to the customer where the deliveries are correct in terms of lead time and quality while at the same time making sure that the materials are at the right stations at the right time. These stakeholders are relevant in order to understand the causes of existing inefficiencies and errors from different perspectives. For example logistics workers experience challenges when parts do not arrive on time which impacts their ability to pick and deliver CA parts to assembly stations. By analyzing these perspectives, the study can reveal root causes of delays and handling errors. Currently the production goal is to send out 15-20 orders per day where each order contains a number of CA trucks that has to get delivered to the customers on time. From the customer's perspective, the demand is to get the deliveries on time.

1.2 Aim

The aim of this thesis is to improve the flow of CA materials at Volvo's Tuve to make sure that the production has the material at the right place at the right time in order to reduce the risk of delayed truck deliveries, support production goals, better meet customer demands and also to lower costs.

1.3 Scope and Limitations

This project is focused on finding the root causes of the current inefficiencies. Furthermore, the project focuses on improving those inefficiencies regarding the internal material flow in the factory. External processes taking place before and after the internal production are considered to be outside the scope of this thesis in terms of improvements. However, potential issues in these external processes may still be identified and documented. Only non-standard parts for the customer-adapted vehicles are considered, leaving regular standard material outside the scope.

1.4 Objectives and Research Questions

The research questions should be directly relevant to achieving the aim of the study. They should target the core aspects that are necessary for understanding and improving the current internal logistics of the CA material. Since the CA flow is only partially documented and is known to suffer from recurring delays, missing material, and inconsistent handling practices, it is first important to develop a detailed understanding of how the current flow functions by mapping the existing process, identifying bottlenecks, and also revealing deviations between planned and actual conditions. Without this baseline, it would not be possible to determine the root causes of the inefficiencies and develop improvements.

Based on the information above, the following research questions have been formulated to define the scope of this thesis.

- RQ1: What are the issues in the current flow of non-standard parts that prevent the right material from reaching the assembly station at the right time?

- RQ2: What solutions can be implemented in the logistics flow of non-standard parts to solve the current issues?

RQ1 is essential because the material flow of non-standard parts within the factory is only partially mapped, and delays, missing components, and inconsistent handling practices often occur. A clear understanding of the current logistics flow is necessary to establish a baseline and to identify where and why disruptions occur. Without a structured overview of the existing process, eventual improvements could address the symptoms of a problem rather than the underlying causes of a problem that prevent the right material from reaching the CA assembly station at the right time.

RQ2 builds on the findings from RQ1 by focusing on identifying and proposing solutions to the issues observed in the current logistics flow. By translating identified problems into concrete improvement measures, this research question directly supports Volvo's objectives of reducing delays, improving planning accuracy, and ensuring stable production flow.

1.5 Ethical, Societal and Sustainability Aspects

The main goal of this project is to ensure that the CA assembly receives its materials on time and that no material is missing when the truck is to be built. Achieving this goal may influence the number of transports and material handling processes, which in turn affect environmental, sustainability, and employment opportunities.

By increasing the efficiency of handling the non-standard parts for CA trucks, the total number of transports and handling activities could decrease. This would likely reduce the environmental impact, as fewer transports mean lower emissions and less energy consumption. It could also reduce the company's overall material handling costs.

However, a potential downside is that fewer transports and handling activities might also reduce the need for labor in these areas, potentially affecting employment. Hence, while the environmental and economic benefits are clear, the societal implications regarding job availability need to be considered carefully. For example, if fewer manual handling tasks are required, some workers may need to be retrained or reallocated to other functions within the plant. Involving personnel in higher-value activities is one way to mitigate this impact.

2

Theoretical Framework

The purpose of this chapter is to establish a theoretical foundation that motivates the choice of analytical areas and also explains how the theory is used to identify problems and guide improvement work in internal logistics systems. Efficient internal logistics plays an important role in enabling both reliable and flexible production, especially in manufacturing environments characterized by product variety and customer specific adaptations. Managing non-standard parts introduces additional complexity in terms of information handling, material flow, and stakeholder coordination [6]. To address the aim of this study, analyzing and improving the internal flow of customer adaptation materials at Volvo Trucks' factory in Tuve, this theoretical framework outlines the key concepts and models that explain why each analytical step in this study is necessary to understand and optimize the current system.

2.1 Role of Digital Tools and IT Support

Digital tools and information technologies play a central role in coordinating modern supply chains and internal logistics systems as well. Digital technologies can be implemented in various organizational tasks to improve the efficiency of supply chains [7]. This is especially important for complex production systems with many part variants. Such digital tools range from shared spreadsheets to advanced digital dashboards that visualize material status and orders. Furthermore, digitally pushed systems that offer real-time visibility and strong decision making are fast replacing the current traditional logistic systems[8]. From an analytical perspective, digital tools are used in this study to assess how information availability and accuracy affect logistics performance. By applying this theory, the analysis can identify problems such as unclear material status or weak system support. Furthermore, the same theory can guide improvement development by pointing out solutions that improve information exchange and reduce manual work, which are known contributors to inefficiency in logistics systems.

2.2 Human Factor in Logistic Environments

Human Factors (HF) play a central role in determining performance, reliability, and safety in logistics environments. In systems handling non-standard parts, operators face even more complexity in terms of irregular part sizes, varied handling requirements, and also increased decision-making load. These conditions increase the influence of a human's physical and cognitive limitations on the work they can perform. Cognitive load increases when operators must constantly clarify irregular labels or manage exceptions in handling. This also increases the probability of mistakes and slower decision-making. Research explains that the human factor is considered to be one of the main uncertainties in logistics processes and a factor that makes logistics operations more complex [9]. Non-standard parts often require awkward lifting and handling due to irregular shapes or weights. Logistic systems optimized solely for throughput risk increase physical strain and fatigue among workers. These symptoms directly correlate with declines in precision, slower task execution, and an elevated risk of material damage. When systems are designed without ergonomic principles in mind, operators face higher physical workloads, which leads to an increased risk of mistakes, material damage and inconsistent process execution. This shows the need for a design that is human centered with approaches that consider both cognitive and physical demands [10]. In addition to these physical and cognitive constraints, weak information flow increases the risk of human error by forcing operators into reactive decision making. One approach shown to reduce the risk of human errors is the use of information supporting technologies, such as pick by vision and scanning-based validation systems. Research in augmented reality supported order picking has shown that visual guidance systems can reduce picking errors by up to 75% compared to traditional paper based picking methods [11]. While these technologies do not fully eliminate the human factor, they significantly decrease reliance on memory and manual verification. In this study, human factor theory is used analytically to identify situations where the responsibility shifts from structured processes to individual operators. Indicators such as manual checks or reliance on experience signal increased human dependency and increased error risk. The same theory also supports developing improvements by motivating solutions that aim to reduce errors caused by the human factor through validation mechanisms.

2.3 First Time Through (FTT) in Production and Logistics

First Time Through (FTT), which is often reported in literature as First Pass Yield (FPY) means the share of units that successfully complete a process without rework, repair or correction on their first pass [12]. As a quality and process stability indicator, FTT captures how much rework and hidden corrective work a production or logistics flow requires and therefore serves as a direct measure of process robustness and hidden costs as well. FTT has both theoretical and practical implications for internal logistics. Theoretically, a high FTT indicates that process inputs, information flows and handling operations are aligned so that defects are minimized. High FTT reduces rework, shortens lead times and also stabilizes downstream operations. In complex product flows, such as handling non-standard parts for customer adapted assembly, FTT becomes informative because each mispick, mislabel or damaged part often leads to additional corrective handling and also delays that affect the material flow. From a modeling and prediction standpoint, increasing FTT can improve planning by predicting the probability of first pass success across a sequence of operations. This is particularly relevant in environments with variable material quality and frequent custom parts. By predicting the FTT in advance, manufacturers can make reasonable production planning decisions, including deciding if extra production quantities are needed and allocating resources to control costs and risks [12]. In summary, FTT is a compact indicator of process quality and hidden cost in production and internal logistics.

2.4 Buffer and Inventory Management in Logistics

Buffers are build-ups of inventory that are placed between process steps. They are essential for collecting variations in process effectiveness. Essentially, this means that they are necessary for certain processes, both upstream and downstream, to be able to have as much up-time as possible [13]. The decision to hold a buffer is typically a trade-off between process reliability and the cost of space for holding the buffer. In this study, buffer theory is used to assess whether inventory is working as a planned separation between process steps or as an indication of remaining process variability. Large or unstable buffers, indicate uncertainty in upstream processes, unreliable information, or low FTT. The theory also supports improvement development by highlighting that long-term improvements are better achieved by reducing variability than by adding more buffers [13].

2.5 Information Flow and Information Systems in Internal Logistics

Effective information flow is central to stable and predictable internal logistics. In complex production environments with high product variety and customer-specific configurations, such as the CA flow for non-standard parts at Volvo, material availability and flow stability depend on the accuracy, timeliness, and coordination of information exchanged between departments. Research shows that information systems that are reliable significantly improve synchronization across the supply chain and also reduce operational uncertainty [14]. Information flow enables communication between planning, picking, kitting, and assembly processes. Without accurate information such as material location and picking status, internal logistics relies on assumptions and manual workarounds. This is highlighted through the concept of supply chain visibility which refers to the ability to observe and interpret relevant supply chain data in real time [15]. Non-standard parts introduce more complexity due to unique configurations, irregular demand patterns, and additional handling steps. Information system help reduce this complexity through structured communication and standardized processes. Weak information not only creates operational disruptions but also limits an organization's ability to identify root causes. When information is delayed, departments respond reactively and focus on solving the current recurring issue rather than addressing underlying causes. Research shows that integrated information improves cross-functional understanding and supports systematic problem solving [14]. In this thesis, information flow theory is used to identify breakdowns such as delayed updates, missing confirmations, or weak system support as well that prevents proactive decision making. Poor information leads to the organization shifting into reactive modes where the focus is to solving immediate issues rather than addressing root causes. In summary, effective information flow and reliable systems are critical for ensuring stable, predictable internal logistics. Strengthening information flow, visibility, and system integration is therefore essential for reducing variability, improving coordination, and also enabling systematic problem solving across functions.

2.5.1 Product Structures and Specification Lists in Internal Logistics

Sprint and product data that represent variant-specific product information used in material handling, picking, and logistic operations are central for efficient supply chain management. Research has shown that poor quality master data disrupts logistic processes by increasing throughput times and also creating inconsistencies [16]. Poor sprint and product data can also result in higher error rates during picking and handling, as well as incorrect storage placement. Incomplete master data has been shown to cause operational inefficiencies and delays in order fulfillment, which leads to the delivery reliability, operational costs, and customer satisfaction being affected. Besides this, studies indicate that errors accumulate over time if the data is not regularly validated and updated [17].

By implementing continuous data quality practices such as automated validation and master data supervision, the occurrence of errors can be reduced, and the efficiency of logistic operations can be increased [16]. Standardizing and validating data at the source will ensure that the information used across the supply chain is accurate and consistent which will minimize the need for corrective work and also improve the overall operational performance [18]. In this study, product structure theory is used to identify whether errors and deviations originate from quality issues rather than physical handling alone. The same theory also supports improvement development by highlighting the importance of continuous data validation and standardized data management practices as well.

2.6 Synthesis of Theoretical Framework

This section integrates the theoretical areas presented in this chapter into one analytical framework that is used throughout the study. The purpose is not only to describe relevant theory but to also clarify how it is applied in practice to analyze the current CA material flow, identify root causes to existing problems, and support the development of improvement proposals.

The framework is primarily used to analyze the current state of the CA flow (RQ1). The observed problems are analyzed using several theoretical perspectives at the same time. Information flow theory is used to investigate whether problems are caused by delayed, incomplete, or unclear information, weak system support, or poor data quality. Human factor theory is used to identify situations where operators must rely on experience or manual checks, which increases the risk of errors. First Time Through (FTT) is used to highlight process steps where repeated corrections indicate low process stability. Buffer and inventory theory is used to interpret large or unstable buffers. The framework is also used to support root cause analysis by linking symptoms to underlying mechanisms.

Finally, the framework guides the development and evaluation of improvement proposals (RQ2). Proposed solutions are assessed based on their expected impact on information reliability, error reduction, FTT and buffer dependency. Table 2.1 summarizes the integrated analytical framework and shows how each theoretical area is used in the study.

Table 2.1: Synthesis of theoretical framework.

Theory Area	**What the theory focuses on**	**How it is used in this study**
Information flow and IT systems	Reliable and timely information supports stable logistics	Identify missing or delayed information and propose better system support
Product structures and master data	Correct product data are needed for accurate picking and assembly	Identify errors caused by incorrect or incomplete sprint data and improve data quality
First Time Through (FTT)	High first-pass success reduces rework and delays	Identify rework and returns and develop solutions that prevent errors
Buffer and inventory management	Buffers absorb variability but also hide problems	Analyze buffer size and time and reduce buffers by improving flow stability
Digital tools and decision support	Digital support reduces manual work and uncertainty	Propose scanning, validation, and improved decision support
Process management and standardization	Standardized work increases predictability	Identifies unclear routines and proposes clearer, more consistent ways of working

3

Methods

This chapter describes the methodological approach used in the study. The project started with analyzing the current state in parallel with the stakeholder insights. This was done in order to acquire the stakeholders perspectives, the current issues, and bottlenecks with the current flow as an answer to research question 1. Root cause analysis was then performed on the addressed issues that revealed potential solutions. This was analyzed and used to answer research question 2, which leads to a future state solution. Figure 3.1 below illustrates a roadmap for the method of this project.

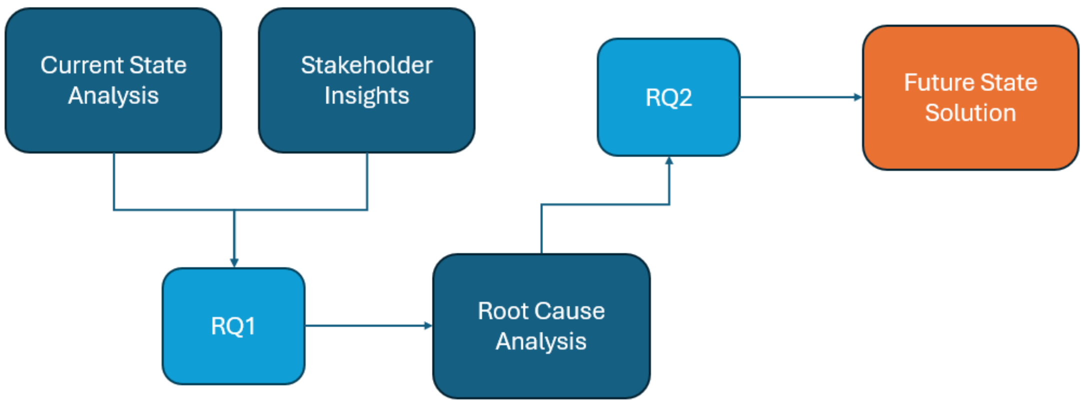


Figure 3.1: Method roadmap.

3.1 Current State Analysis

In parallel with the literature study, the current state of the CA material flow in the factory was mapped. This included the physical flow of material from the point it gets delivered to the goods receiving until it arrives at the CA docks, the underlying reasons for delays and deviations, the time the material spent at each station, storage, and buffer, relevant roles that affect the material flow, and how each station communicates with the other. Thus, the material planning process will be explained. This analysis aimed to explain why materials do not always reach the correct station on time, which process steps contributes to variation, and also if incomplete information flows affect it. In this study, the current state analysis also included an examination of the digital systems and operational roles that influence the CA material flow. This was necessary because both the information flow by systems and the decision making and operational execution carried out by roles, were identified as major contributors to variation, delays, and also limited predictability in the material flow. Therefore, system functions and role responsibilities are treated as analytical components throughout the results chapter. Detailed descriptions of each system and role can be found in Appendix D and C.

3.1.1 Process Mapping and Material Flow Analysis

Mapping the existing flow is a useful method for describing and understanding material flows[19]. Material flow mapping provides visibility into logistics performance and highlights bottlenecks. Value Stream Mapping (VSM) is a central Lean tool used to visualize all process steps, identify waste, and clarify cross-department interactions [20]. For internal logistics involving non-standard parts, process mapping helps identify inefficiencies, unnecessary handling, and unclear responsibilities, which directly supports RQ1 of this thesis that involves identifying the current flow and its issues. Mapping of a flow can not only reveal the physical path of materials but also highlight gaps in communication and coordination between involved departments. A detailed process map can therefore create what is required to later connect causes of delay to specific process steps.

Two existing maps created during a kaizen, a structured continuous improvement workshop, were used as the basis for this work. However, these maps were incomplete and did not show the full flow of CA material, and were therefore further developed into a new and improved map. The map was then complemented with on-field studies where stations in the actual flow were visited. Certain stations were excluded since including them would have made the thesis too extensive. All people who work with the relevant stations were interviewed to investigate where they get all the materials from, where they send their handled materials, what the current bottlenecks are, what systems they use, and which departments they collaborate with. The questions were formed in a way to get a better understanding of how each station is involved in the CA flow and what challenges they face. Most often, the interviews were conducted with each station's team leader (TL). However, regular ground workers could sometimes also give an answer to the interview questions. The questions can be seen in appendix A.

When the relevant data for each station was gathered, the software Microsoft Visio were used to create an overview map to visualize the flow of materials between all the stations. This is important to get a clear overview of the CA material flow in order to address inefficiencies.

3.1.2 Physical Flow and Factory Layout

Physical material flow refers to the movement, storage, and handling of components within the plant. An optimized layout minimizes unnecessary transportation, reduces distances, and prevents bottlenecks which is relevant for the CA flow[21]. Furthermore, optimizing internal routes and buffer zones increases resource efficiency and leads to a smoother flow, which is important to reach the aim of this thesis.

3.1.3 Information Flow and Communication

Efficient internal logistics is not only about physical movement but also about how information travels through the organization. Material and information flow are interdependent, and deficiencies in information, such as incomplete, incorrect, or delayed communication between department have been shown to cause rework and time delays [22]. Therefore, mapping information flows provides an understanding of who communicates what, when, and how, which directly supports RQ1 (current issues). Since the CA process is highly dependent on internal digital systems, the mapping of information flow was made with an inventory of the systems used at each station. The analysis also included how different roles use these systems in practice, as variations in usage affects how and when information is shared. Full system descriptions are available in Appendix D.

3.1.4 Time Data

To quantify a process's performance requires time measurements such as lead time, waiting time, and handling time. In low-volume, high-variation flows, like the one this thesis covers, time data can provide insights into where delays accumulate and how they impact throughput time. By systematically measuring time across each step in the material flow, delays can be identified. This is essential for determining where in the process time losses occur and also how they contribute to material not reaching the assembly station on time. This step directly supports RQ1 and can give a baseline for proposing improvements for RQ2.

For the completion of the project, time studies were conducted to quantify how long materials stay in different stations of the flow and to identify deviations between planned and actual arrival times. Since delays in one step affect the downstream processes, especially CA assembly, these measurements were essential for understanding how variation in one station spreads through the system. This includes the whole internal time from when the materials arrive at the goods reception until they are received by the CA-assembly. Nine chassis were selected and tracked from goods receiving to the end of CA assembly. For each chassis, timestamps were extracted from Volvo's Production tracking system and the Internal Material Tracking System. These timestamps made it possible to calculate:

- Processing time from goods receiving to warehouses.
- Picking and delivery times from each warehouse to a specific kitting station called 41200.
- Waiting time in the 41200 buffer.

- The total lead time from goods receiving to CA.

To understand why deviations occurred, time measurements were combined with observations and interviews. While work in process (WIP) levels could also be measured, time-based measurements were prioritized because they directly reveal where lead time variation arises.

For this, nine chassis were chosen to be tracked. The time the material was in each storage and station is important to be able to address inefficiencies in the flow. However, Volvo has no good way to track the time each material is spent in each storage. Therefore, the information had to be collected manually in various ways. In this section, the time studies are explained in the different parts of the material flow. The different sections of the material flow are described using the station names, as listed in Section 4.1. The purpose of the time studies is to understand how long materials remain at each station and in the buffers. This is relevant because longer buffer times and high buffer levels can indicate where delays occur and where the material flow slows down or stops, which may prevent material from reaching the assembly station on time. By identifying where material is held up, the study also provides insights into space usage. The data could be used to address inefficiencies and deviations from how the flow actually should be.

3.1.4.1 Goods Receiving to Warehouses

For the time studies between the goods received at the different warehouses (W01, W03, W05 and B2U08), Volvo's Production Tracking System were utilized. Refer to figure 4.1 for the names of the different warehouses.

3.1.4.2 Picking Stations to CA-assembly

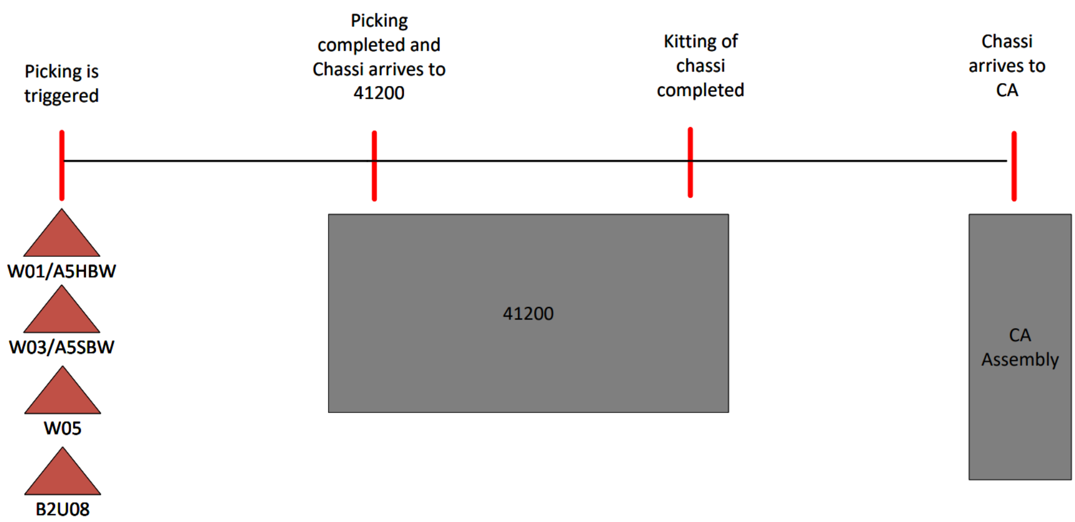


Figure 3.2: Figure of time studies from picking stations to CA-assembly.

To measure and calculate the time for the materials from the picking stations to the CA-assembly, nine chassis that were to be built in the CA-assembly were tracked. Each of the chassis had at least one belonging pallet in the 41200 kitting station. The time that each chassis was packed at the kitting station and the time that the chassis started at CA assembly were noted. These times were extracted from Volvo's Production Tracking System, where the workers in the CA-assembly note when they start and finish at CA assembly. This time essentially describes how long the pre-packed material for each chassis stays at the 41200 buffer before it is used. The noted time can be seen in table 4.1.

The timestamps when each material is picked at the picking stations for the 41200 kitting are more complicated. Volvo's Internal Material Tracking system was used to extract data for when picking order is triggered at the different warehouses' picking stations. A picking order is triggered when it is released in the system and becomes visible in the operator's picking list. Additionally, in the same system, the delivery time of each package picked and delivered could be seen. The times that the first and last materials of each chassis were delivered were noted. Since the packages are delivered to 41200's buffer, it was assumed that the 41200 picking station received the material at the same time as the delivery time stamp. This is essentially the time that they could start to pick the materials for each chassis.

The latest and earliest time stamp of material picked for each chassis were then extracted, which can be seen in tables 4.1, 4.3, and 4.4. This was done to receive an overview of how much the time can differ for each chassis and also to analyze the difference between the planned time for a chassis to be build with the actual time.

3.1.5 Transport Distances

The transport distances were measured between stations following the material flow. The routes were identified by consulting the relevant workers, and the distances were then measured in AutoCAD. The measured distances were then incorporated into the flow map created in Visio. Since the Production Extended Logistic Center (PELC) area is outside of the Tuve plant, the distance between the PELC and the factory was not taken into account.

3.2 Stakeholder Insights

Stakeholders influence how CA material is handled. These include all logistics personnel, planners, assemblers, and quality engineers. Stakeholders are defined as any group or individual that affects or is affected by an organization's objectives, which in this case is the CA material [23]. The stakeholder interviews aim to gain their insights to understand how their responsibilities and perspectives influence the performance of the process. All stakeholders in the CA flow work towards the same objectives: to ensure stable material availability, accurate deliveries, and efficient assembly. However, since each role contributes to the flow in different ways, they encounter different challenges and have unique insights into where and how inefficiencies arise. In the CA material flow relevant to this thesis, each stakeholder has its own priorities. Logistics wants predictable deliveries, assemblers need the right parts on time, and the planning department focuses on scheduling accuracy. Furthermore, it is worthwhile to emphasize that a stakeholder analysis can help to understand the root cause of a problem and see whether a solution is reasonable and implementable.

Parallel to the current state analysis, stakeholders were identified from each station within the CA flow. In the initial round of interviews, the questions focused on understanding the stakeholders' roles, the systems they use, and how communication between departments functions.

In this stage, however, the purpose of the interviews was to identify the current issues and shortcomings within the CA flow, why they occur, how they affect the process, and to gather ideas for improvement.

The interviews were semi-structured and followed an interview template, which can be found in Appendix B. The questions from the template were used to guide the interviews, followed by relevant follow-up questions to clarify and further develop the stakeholders' responses.

3.3 Root Cause Analysis

To reach an improvement that solves a problem from the root, it is necessary to identify why certain problems occur. The Five Whys technique is a structured method for root cause analysis (RCA). RCA is central for helping organizations to reduce waste in the form of variations and systematic defects. RCA enables organizations to determine why an event of failure occurs and which corrective measures are relevant to prevent the same problem from occurring in the future [24]. These types of analysis will be used to answer RQ1 and RQ2.

A RCA was conducted in order to identify the underlying causes of the large buffers between 41200 and CA. In this case, large buffers were treated as an indicator of process instability since they occupy valuable floor space and also tie up inventory capital. This was done with the "5 Whys" approach, which involves asking "why" iteratively to uncover the root cause of a problem. This approach does not only reveal the causes of the problem's symptoms but is also especially helpful to prevent the same problems to arise again.

Information for the RCA was gathered by structured interviews with production planners, operators at both 41200 and CA, and logistics technicians. Furthermore, to understand the underlying problem, the number of pallets in the buffer were counted once a week.

This step also contributes to Research Question 1 by identifying underlying causes for inefficiencies. The final identified chain of causes for the problem is presented and discussed in section 4.3.

3.4 Analysis of Returns

To analyze the CA material flow and to determine the error rate, data regarding material handling and returns were collected and evaluated. The main objective of this analysis was to understand how often materials were wrongly delivered to the CA-assembly and how many were returned to the storage area (41200).

3.4.1 Data Collection

The data was extracted from one of the Volvos's material handling system over a period of nine consecutive weeks (weeks 36–44). The following parameters were retrieved for each week:

- Number of parts handled at the 41200 picking station.
- Number of returned materials from the CA-assembly.
- Number of returns.
- Calculated an error rate essentially describing the percentage of returned materials in relation to the number of handled parts.

For each week, the error rate was calculated using the following formula:

$$\text{Error rate} = \frac{\text{Returned materials from CA}}{\text{Parts handled at 41200}} \tag{3.1}$$

4

Results

This chapter will cover the results derived from this project. The results are based on process mapping, time studies, transport distance measurements, and analysis of information flow and sprints. Together, these results establish a baseline for identifying issues and deviations in the existing logistics process.

4.1 Current State

This section presents the results of the current state analysis of the internal logistics and material handling processes. The analysis aims to provide a overview of how material, information and time currently flows through the system. By mapping processes, analyzing time data, transport distances, information flow and sprint activities as well, this section establishes a baseline for identifying inefficiencies and also areas for improvement.

4.1.1 Mapping

Before the goods arrive at the goods receiving department, which is connected to the factory, there are many steps in logistical planning. The truck order, which is placed by the customer, is first and foremost handled by a CA offering department that works with the CA design and engineering department to see whether the truck customization is feasible or not. The CA offering department then gives feedback to the customer with a solution and price. If the price is accepted by the customer, the required materials are ordered for the plant. Figure 4.1 illustrates the current flow of CA materials within the factory after the materials arrive at the goods receiving department. Most materials arrive at the goods reception from suppliers. If pallets arrive with incorrect labels, they are redirected to the repack station; otherwise, they are transported by truck to their designated storage areas (W01, W03, or W05).

For W01 and W03, the truck delivers materials to a conveyor system, while materials for W05 are delivered directly by truck. From there, materials from W01 and W03 are conveyed to the picking stations, where they are picked for their respective chassis. For W05, the same principle applies, but deliveries are made by truck instead of conveyor. Subsequently, W01 materials are moved via conveyor to their designated square, while W03 and W05 materials are transported to their respective squares by truck. The picking stations get their picking orders triggered based on the material's need time. The picking orders arrive by digital systems to the respective picking stations.

Afterward, all materials are transported by truck to the 41200 kitting area, where they are sorted for each chassis. In the 41200 area, materials are assembled into pallets for each order and later stored in a buffer area until needed at the CA assembly station.

Some materials also originate from the PELC area, an external storage facility outside of Tuve used for overflow storage. Deliveries from PELC are express shipments, triggered by material coordinators when a specific material is required for an order but is not available in the regular factory storage. PELC also supplies materials to B2U08, a storage area for large items that cannot fit in the main factory. Materials in B2U08 either go directly to the CA assembly when needed or to the LB storage, which handles only hook lifts and turntables. From LB, materials are then sent straight to the CA assembly.

Finally, the painting storage delivers paint directly to the CA assembly station.

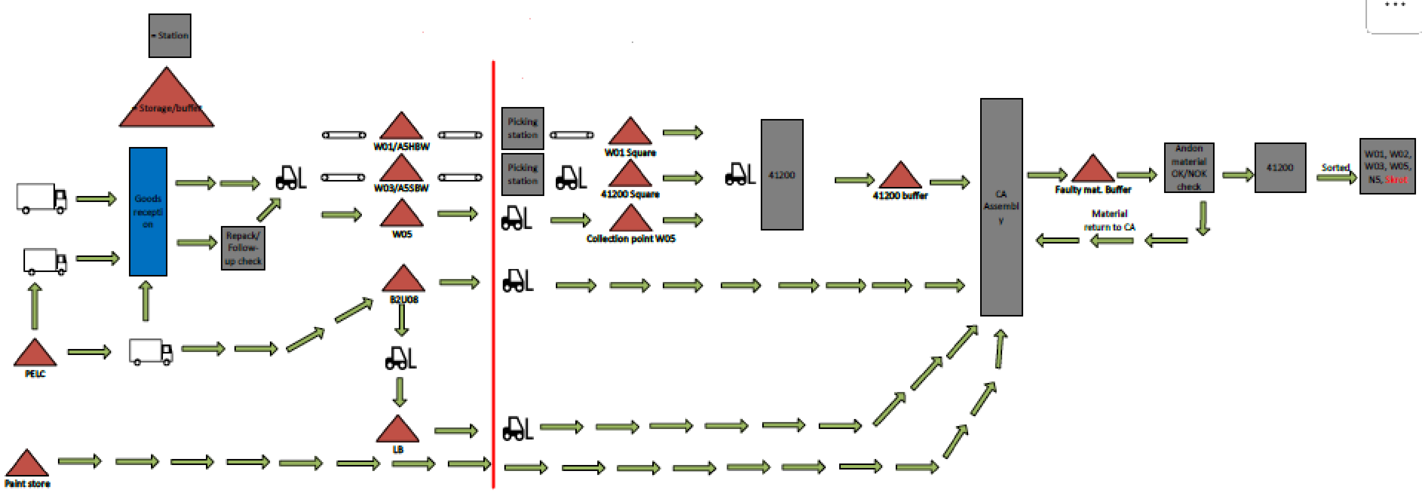


Figure 4.1: Material flow.

The mapping also revealed that several steps in the CA flow depend directly on specific systems and role responsibilities. For instance, picking activities are triggered and guided by the internal material tracking system, while CA planning is dependent on the update frequency of the production tracking system. Communication between roles such as ANDON C, 41200 staff, and CA assembly is also largely dependent on how each role uses system information.

4.1.2 Time Data

By tracking nine different chassis, tables 4.1, 4.3, and 4.4 could be created. The tables contain time stamps of when material arrives at the different stages shown in figure 3.2. Table 4.1 shows the times of when the picking orders are triggered at the different storages (W01, W03, and W05), when the first and last material arrives to the 41200 station and the time of when the chassi kit is completed at 41200 as well.

Table 4.1: Overview of times from picking stations to 41200 kitting station.

Chassi	Trigger of Pick	First Mat. 41200	Last Mat. 41200	Done at 41200
381779	2025-09-27 14:12	2025-09-27 14:46	2025-09-30 13:27	2025-10-02 13:27
382043	2025-10-01 17:51	2025-10-01 20:11	2025-10-01 20:11	2025-10-06 12:27
382011	2025-10-01 16:44	2025-10-01 17:20	2025-10-06 17:38	2025-10-06 12:48
382018	2025-10-01 16:44	2025-10-01 17:20	2025-10-06 17:38	2025-10-06 12:49
382082	2025-09-24 07:18	2025-09-24 09:12	2025-09-25 07:56	2025-10-06 12:54
382298	2025-10-06 16:22	2025-10-06 17:03	2025-10-06 17:03	2025-10-07 07:29
382286	2025-10-06 16:10	2025-10-06 17:03	2025-10-06 17:03	2025-10-07 07:59
381650	2025-09-25 16:23	2025-09-25 16:36	2025-09-29 15:42	2025-10-08 10:00
382077	2025-10-01 20:15	2025-10-01 21:51	2025-10-01 21:51	2025-10-08 10:14

The trigger of the pick is the time when the picking orders are released at the picking stations. Usually, this time is around the time that the truck is starting its main production on the main line. However, this time can vary between chassis depending on the amount of materials and what kind of material. If a chassi is going to need much more CA material at the CA assembly or at the main production line, the trigger of the pick is manually made earlier to make sure that the needed material is available on the need time. This could be a reason for a larger buffer of material at 41200. Table 4.2 below illustrates that chassis 381779, 382082, and 382077 are deviated from the standard trigger of pick time, where CBU (Central Built Unit) refers to the main production line.

Table 4.2: Deviation of trigger for the picking.

Chassi	Trigger of Pick	CBU Planned Time	CBU Actual Time
381779	2025-09-27 14:12	2025-09-29 08:05	2025-09-29 12:29
382043	2025-10-01 17:51	2025-10-01 13:14	2025-10-01 19:28
382011	2025-10-01 16:44	2025-10-01 08:45	2025-10-01 14:03
382018	2025-10-01 16:44	2025-10-01 09:57	2025-10-01 14:53
382082	2025-09-24 07:18	2025-10-01 21:10	2025-10-02 10:03
382298	2025-10-06 16:22	2025-10-06 09:51	2025-10-06 15:39
382286	2025-10-06 16:10	2025-10-06 08:05	2025-10-06 14:17
381650	2025-09-25 16:23	2025-09-25 23:27	2025-09-26 14:44
382077	2025-10-01 20:15	2025-10-03 19:38	2025-10-04 08:29

Furthermore, table 4.3 below shows the planned and actual date of when the CA assembly station will start building the truck and also the planned and actual time of which the material is at the 41200 buffer until it arrives at CA assembly. Planned CA-assembly start and the actual start were compared with the time each chassi is completed at 41200 from table 4.1. The time from when the kit was completed at 41200 until the actual CA-assembly start essentially describes the time the kit was stored in the buffer. The 41200 area is operational both in the day and evening shifts. Therefore, one workday equals 15.7 effective hours.

An anomaly seen in the data in table 4.3 is chassi 381650, which kit was used earlier than both the planned, and the actual CA-assembly start. However, tracking the kit back in table 4.1, it can be seen that the first and the last material were at the 41200 kitting station before the CA-assembly start times. This indicates the possibility that the employees forgot to mark the kit as done when it actually was completed. Another possible reason is that the CA-assembly process was started earlier knowing that all materials were not included in the kit. However, according to the data, each of the items should be received by 41200 days before the actual CA-assembly start.

Table 4.3: Comparing planned and actual times from completed kit to use point.

Chassi	Plan. CA Start	Act. CA Start Time	41200 - Plan. CA	41200 - Act. CA
381779	2025-10-03	2025-11-03 10:27	25,6h	359,3h
382043	2025-10-08	2025-10-14 10:20	42,3h	92,6h
382011	2025-10-07	2025-10-13 08:29	26,2h	75,3h
382018	2025-10-07	2025-10-08 07:25	26,2h	26,8h
382082	2025-10-07	2025-10-08 11:00	26,1h	29,9h
382298	2025-10-10	2025-10-16 14:12	62,2h	115,6h
382286	2025-10-10	2025-10-22 09:56	61,7h	174,6h
381650	2025-10-01	2025-10-03 06:19	-46,4h	-50,0h
382077	2025-10-08	2025-10-21 07:23	12,7h	139,2h

Table 4.4 shows the planned and actual CA-assembly end time, as well as the planned and actual times each chassis is in the CA-assembly. The planned CA end times are set when the production order is released in the factory. It is extracted from CO-Pilot and does only contain dates, not times. When the CA-assembly is finished, the actual end time is noted by the operators and noted in CO-pilot. The table also shows the planned time that the chassis should be built and the actual time the chassis needed to be built. For calculating this, data from table 4.3 is used. The time for the actual CA start to end is effective time, meaning that breaks, weekends, and non-working hours are not included. In the CA assembly area, only the day shift is operational. Therefore, one workday equals 7.75 hours.

Table 4.4: Planned and actual times for CA-assembly.

Chassi	Plan. CA End	Act. CA End	Plan. Start - Plan. End	Act. Start - Act. End
381779	2025-10-09	2025-11-05 09:16	38.75h	13,9h
382043	2025-10-13	2025-10-17 12:21	31h	24,25h
382011	2025-10-08	2025-10-16 06:46	15,5h	21,55h
382018	2025-10-08	2025-10-13 16:04	15,5h	30,37h
382082	2025-10-07	2025-10-08 14:46	7,75h	2,4h
382298	2025-10-13	2025-10-17 10:40	15,5h	5,23h
382286	2025-10-10	2025-10-22 12:02	7,75h	1,5h
381650	2025-10-03	2025-10-06 13:31	23,25h	13,47h
382077	2025-10-13	2025-10-22 11:57	30h	11,3h

For the time that each material is picked at the picking stations for the 41200 kitting station is more complicated since each picking station has different ways of "ordering" material. Time stamps for when the material was picked at the picking stations were extracted. From there, it was assumed that the time stamp for the latest picked part from each chassi was the actual time that the 41200 kitting station received all the required material, and they could start the kitting process. The time it took for the 41200 kitting station to kit the chassi-pallets could then be calculated. The figure 3.2 illustrates an overview of the time studies from picking stations to CA-assembly. Table 4.5 shows the amount of hours each chassi were late and an average on the hours.

Table 4.5: Number of hours the selected trucks were late.

Chassi	Number of hours late to CA assembly
381779	166,08h
382043	34,22h
382011	1,97h
382018	8,47h
382082	14,48h
382298	37,23h
382286	64,82h
381650	15,62h
382077	70,85h
Average	45,87h

4.1.3 Transport Distances

Figure 4.2 below shows the flow map with the measured transport distances between the stations.

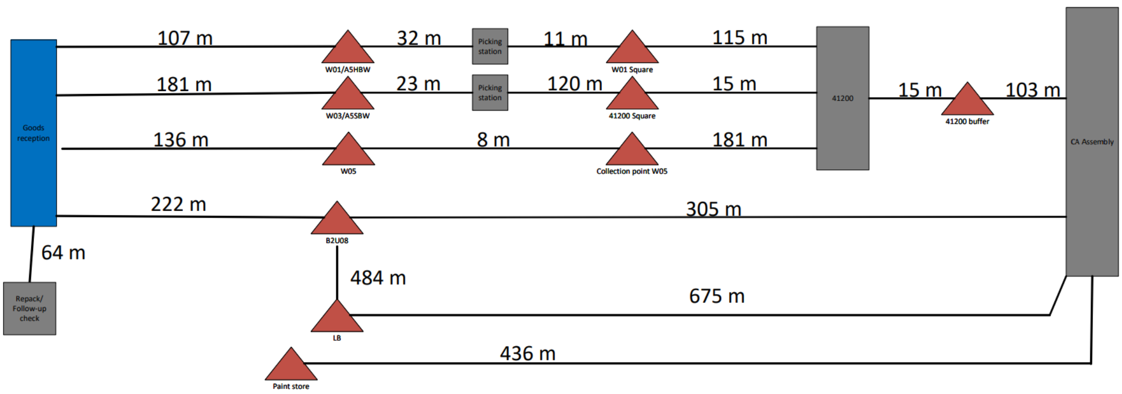


Figure 4.2: Transport distances.

4.1.4 Information Flow

The information flow within the CA material process starts with customer order and ends with final assembly at the CA stations, involving several systems, departments and decision points. Unlike standard material flow, the CA flow is dependent on engineering evaluations, purchasing decisions and the availability and traceability of non-standard parts. Since each step of the process depends on timely and accurate information, the efficiency of the CA flow is determined by the physical movement of material and how information is generated, shared, updated and acted upon across the organization. The information flow in the CA process is also highly dependent on systems, and several key systems were identified during observations and interviews. These systems control visibility, material tracking, picking triggers, and deviation handling. A full list of systems is provided in Appendix D.

The process begins when a customer submits a request for a customized truck. The CA offering department receives the order and sends it to the CA design and engineering department for feasibility assessment. CA design evaluates the request by modeling the proposed solution in CAD and determining whether the customization is technically possible. This step also includes cost estimation and checking whether the required parts exist or need to be sourced from suppliers. The information produced in this step is central input for the rest of the flow, as it defines which unique parts must be procured and when they are needed in production.

Once the assessment is completed, CA design and engineering returns the proposed solution to CA offering, who communicates the cost and technical feasibility back to the customer. The next step is to communicate the order to the purchasing department. If the required parts are frequently used or already known by Volvo, the internal system places the order automatically, if it is a rarer or unique material, it is the buyer's responsibility to find relevant suppliers and order it. This stage includes lead time confirmation, cost agreements, and supplier delivery plans. The material then arrives at the goods reception, which registers the delivery and performs initial quality checks. The material is then sent forward to the respective picking station or, in some cases, the repack station in case the pallets arrive with incorrect labels. If issues regarding quality or the material itself arises the goods reception forwards it to the material coordinator or the quality engineer, depending on what the problem is. Once the materials are available in the storage areas, the picking system notifies operators when materials should be picked based on need time and production sequence. Problems that may arise here are missing materials or technical issues with the systems. In that case, they contact either the Internal Material Coordinator (IMC) or Andon, who handles material shortages, and if they cannot find the material in the plant, they send it further to the material coordinator. If there are system issues, they contact the logistics engineers. When the materials have been picked, they get delivered to a buffer area, and the 41200 station gets notified so that they may get the material when they need it.

When the material is kitted in pallets, the pallets are stored in a buffer between 41200 and the CA assembly station. When a chassis is going to be built in the CA assembly station, the required materials are ordered, and a forklift delivers the materials to the CA. The CA planning department determines when each chassis is going to be built. The planning is very uncertain, which can mean that some chassis are planned in sequence on short notice. This is due to the fact that the CA assembly can only work with trucks that are completely finished from the main production line. A large percentage of the trucks that roll off the line need to be fine-tuned before they can be deemed to be finished. The time of this fine-tuning can be from a few minutes to a few weeks and the CA planning is often not noticed until right before the truck is finished. Therefore, the CA planning can be hard to perform. If there are some missing materials in the CA assembly, the teamleaders should involve ANDON, who from there should cover the material shortage. If they cannot cover the material shortage, they get in touch with the material coordinators. Some materials are stored at the PELC area outside the factory, and they have express deliveries in case any material needs to be urgently delivered. If the deliveries to CA contain more materials than necessary, the excessive materials are returned by ANDON.

4.1.5 Sprints

Specification lists (Sprints) that include all the materials each truck needs to be built are used at Volvo. For customer-adapted trucks, the sprints can vary significantly due to the many possible differences a truck can have. The construction of the sprints is time-consuming. Therefore, existing sprints are copied and reused, with only the details specific to the new truck being modified. When doing this, faults can occur because details are missed. The faults often involve smaller details, such as missing screws etc. However, it can still halt the operative processes at the CA assembly, possibly delaying the truck's delivery.

4.2 Stakeholder Insights

The stakeholder analysis focused to identify the key actors involved in the CA flow in order to understand their perspectives on the current process. The findings from the interviews provided insights into the daily challenges, bottlenecks and improvement needs experienced by each stakeholder.

The stakeholders included in the analysis were selected based on their direct involvement and relevance to the CA flow. These roles represent the key functions that influence, or are influenced by the customer adaption process. From material handling and planning to design, assembly and problem solving.

4.2.1 Material Coordinator

The material coordinator highlighted lead times as one of the main challenges in the current CA flow. Due to Volvo's policy of releasing production plans only six to seven weeks ahead which makes it difficult to predict future material needs. This short planning horizon leads to scheduling issues which creates situations where suppliers must be pressed for faster deliveries or additional transport, which in turn increases costs. Furthermore, some materials are only available in large batches even when only small quantities are needed which leads to unnecessary buffers at the PELC area.

Although the overall situation is manageable, the coordinator emphasized that the tight planning window often complicates the work. Additional training in some balances could help to reduce errors. To ensure a smoother process, timely material deliveries and better workplace organization were identified as key requirements. As an improvement suggestion, the coordinator mentioned more frequent 5S training at the stations to prevent smaller parts from being misplaced.

4.2.2 CA Design

For the CA design team, most issues are administrative or related to design errors. Because the department is responsible for a wide range of components, from frame lengths to clamping brackets, the scope of work is extensive and system support is limited. Common problems included minor design flaws, such as misplaced holes or clashes between parts, for example an air tank conflicting with a clamping bracket.

The impact of these issues varies, smaller errors can often be managed directly by the CA team, while major mistakes may require several days or even weeks to correct. The team experiences high expectations from both upstream and downstream departments, those before rely on their input while those after expect everything to function without issues.

Due to heavy workload and limited time, improvement work is often not prioritized. However, the department actively listens to feedback from the assembly line and implements updates whenever possible. There is also an ongoing, larger improvement initiative focused on reducing lead times and response times within the CA process overall.

4.2.3 CA Planning

The CA planning function reported that the most frequent issues is that vehicles gets stuck in the assembly stage, which directly affects First Time Through (FTT) performance. Since CA handles complex process for highly customized trucks they are often constrained by the limited technical knowledge or unclear requirements which leads to delays and increased workload.

The planner noted that there is a lack of coordination between the CA offer, engineering and design departments before an order is confirmed. As a result, the planning team often works reactively, trying to resolve problems as they arise rather than preventing them. Limited time and resources makes it difficult to address root causes, and the planner expressed a need for a cross functional team to handle operational problem solving.

Planning is typically done one week at a time, with daily adjustments due to the unpredictable production. Material shortages also occur frequently due to mismatches between the picking list and the actual availability of the material which often is caused by errors in the preparation phase.

To improve the process, the planner suggested stronger collaboration across departments, better validation of orders before approval and increased focus on addressing recurring FTT issues. Many of the problems are linked to the human factor, approving too many non-standard solutions or lacking competence to identify inconsistencies in the orders.

4.2.4 ANDON

The ANDON operator primarily deals with material shortages, often caused by incorrect data in the Sprint system or misplaced items on the shop floor. These are typically smaller components, such as cable ties or minor fittings. The root cause highlighted were the frequent human error which include miscounting, incorrect registration or simply misplaced materials.

These shortages increases the lead time and cause inefficiencies, as operators are unable to continue their work when parts are missing. Although the ANDON operators generally have sufficient tools and information to perform their tasks, they identified areas for improvement in material handling and returns.

Suggested improvements from ANDON were to implement scanning systems for kitting to ensure more accurate material picking since it is currently done manually with picking lists. ANDON also highlighted increasing buffer stock for standard materials within the CA assembly. It was also recommended to transfer some buffer responsibilities from station 41200 to 40260 (CA assembly buffer station) to improve availability directly at CA assembly.

4.2.5 CA Assembly

Within CA assembly, the most common challenges relate to material shortages, Sprint system errors and delays caused by vehicles not arriving on time, al of which affect FTT performance. A significant contributing factor is the lack of experience within the preparation and design departments, as many skilled employees have recently retired. The introduction of new truck models has further increased complexity, and design teams sometimes struggle to foresee assembly feasibility.

These challenges result in increased lead times, additional work hours and poorer ergonomic conditions. The assembly operators expressed that support functions could provide greater assistance in solving these recurring problems.

To improve the process, they suggested more careful recruitment to ensure that the competence matches the role requirements, both in office and on the shop floor. Increased focus on training was also mentioned, for example ensuring backup operators are available for critical roles such as forklift drivers to prevent stoppages when key staff are absent.

4.2.6 Logistics Engineering

Several recurring issues were identified where most were related to material shortages, incorrect or missing sprint information and also preparation errors in logistics planning. Old articles that are reactivated without complete data and also sprint changes that are not communicated were found to be common root causes. These lead to materials being sent to the wrong warehouse or missing preparation entirely.

To improve the process, the logistics engineer brought up the importance of clearer communication between the department that creates the sprint changes and logistics engineering. Especially when it comes to where materials should be delivered and in what form for example kitted or loose. Another improvement suggested was to allow CA to manage and kit their own materials especially for high frequency items such as screws and bolts in order to reduce preparation errors.

4.2.7 Warehouse Staff - 41200

The main challenges that were reported were uneven production pace, limited workspace, frequent material shortages and incorrect parts. The small kitting area and limited buffer space often force them to rearrange pallets in order to make space which leads to waste of time. Unclear or outdated specifications also lead to incorrect kitting and costly returns.

These issues increases lead times and physical workload, as staff often needs to handle heavy materials in poor conditions. The team expressed that the most important need is to receive the right material, in the right quantity, at the right time. An improvement suggestion that were brought up was digital picking tools. Currently all the kitting is done manually with a picking list which increases the risk of picking the wrong material or quantity. Digital picking tools such as handheld scanners and mobile pick lists could improve the efficiency and accuracy. Furthermore, they suggested that CA should consistently use updated specifications to prevent unnecessary rework and material waste.

4.2.8 Warehouse Staff - W01

Common issues reported by the staff at W01 included materials being too heavy to handle safely, multiple article stored in the same pallet and also uncertainty about which material and quantity to pick. These problems often occur because material controllers order parts without full knowledge of their packaging or physical form.

These issues affects both quality and lead time as they lead to incorrect picks, system workarounds and increased manual handling. The staff brought up the need for materials that are easy to pick and properly labeled with clear and timely information. They suggested improved packaging, kit labeling and a more predictable and balanced picking flow to reduce errors. Chassis-based picking was also proposed as a way to streamline the process and enable better planning.

4.2.9 Warehouse Staff - W03

The staff at W03 reported issues with incorrect material in bins, mechanical failures such as broken crane and also picking mistakes caused by fatigue or human error. These problems are often rooted in outdated storage infrastructure and occasional mistakes from suppliers or the repack department. They suggested introducing a scanning solution to verify picks in real time which would reduce human error and also ensure correct quantities are picked.

4.2.10 Warehouse Staff - W05

The W05 team reported that their most common problem is that materials cannot be found or are located incorrectly due to missing or unregistered items in the system and also lost or detached labels. These issues cause delivery delays and impact the production flow.

The staff suggested implementing a more direct material flow to the station, reducing the number of intermediate stations. They also brought up the importance of accurate scanning and registration of all materials, a process that currently works well and should continue to be maintained,

4.2.11 Synthesis and Summary of Stakeholder Analysis

The findings from the stakeholder interviews were evaluated to identify recurring problems affecting material availability and lead times in the CA flow. The focus of the synthesis is on connecting observed problems to their underlying root causes and also potential solutions.

Across the interviews, several recurring problems were identified, including deficiencies in information flow, manual work steps and coordination challenges between departments.

Issues regarding design related errors and material shortages were also raised. While these challenges have a clear impact on the CA flow, they primarily originate from suppliers or upstream engineering processes. Since this thesis focuses on internal logistics processes, these aspects fall outside the defined scope. They are therefore acknowledged in the analysis but will not be included in the improvement area. Table 4.6 below presents a synthesis of the key stakeholder insights, the main issues identified and their implications for the performance of the CA flow in relation to the system requirements.

Table 4.6: Synthesis of stakeholder analysis.

Area	**Issues identified**	**Root cause**	**Potential solutions**
1. Material planning	Reactive planning and frequent rescheduling	Short planning horizon (6–7 weeks), limited order validation before approval	Earlier cross-functional validation of CA orders, improved coordination between CA offer–engineering–design
2. System support (Sprint)	Incorrect or outdated material information	Unclear ownership of Sprint changes, reactivated articles with incomplete data	Clear responsibility for Sprint updates, improved change communication routines
3. Material picking and kitting	Incorrect picks and missing material	Manual picking lists and human error	Digital pick lists and scanning systems
4. Warehouse layout and buffers	Material shortages and misplaced items	Limited buffer space and materials stored far from CA assembly	Relocation of buffers closer to CA assembly and increased buffer for standard items
5. Design and preparation	Design errors causing assembly stoppages	High workload, limited system support, insufficient design validation	Stronger feedback loops from assembly, prioritization of recurring design issues.
6. CA assembly and planning	Assembly stoppages and poor FTT	Late or missing material and design infeasibility	Increased support from planning and engineering.
7. Communication and coordination	Information gaps between departments	Unclear roles and responsibilities between departments.	Clear and consistent communication routines and defined handovers between departments.

4.3 Root Cause Analyses

Three root cause analyses were conducted to identify the source of the primary issues. The first RCA is about the material not being present in the CA assembly when needed. Referring to figure 4.3 below, the red boxes are the main problem. The orange boxes are causes of the problem, but are also a problem in themselves. And the blue boxes are causes.

The selection of problems in this section is based on information gathered from sections 4.1 and 4.2.

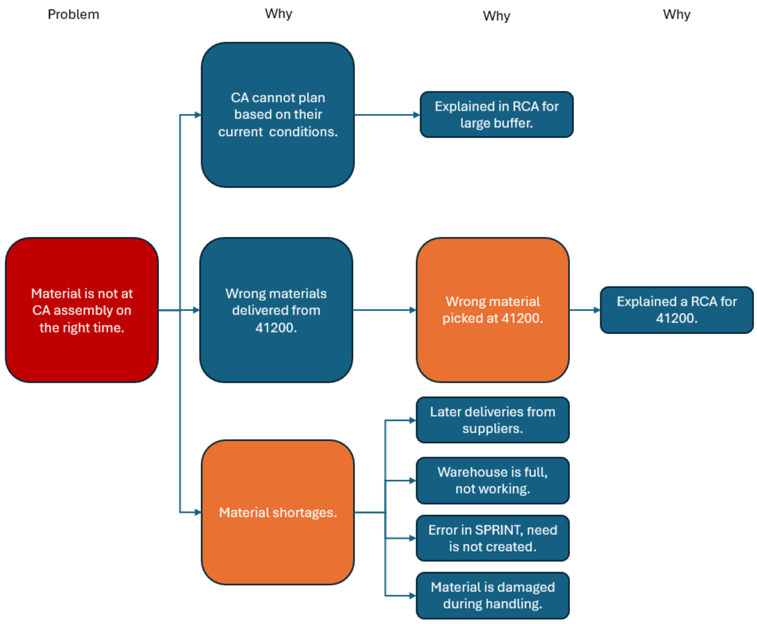


Figure 4.3: RCA of material not at the CA assembly on time.

The results of the root cause analysis for the problem of a large buffer at 41200 can be seen in figure 4.4 below. By talking to the involved stakeholders, it was concluded that the order picking normally is triggered one week before the need time. For truck variants, that require more CA material that are either assembled on the main production line or in the CA assembly, the order picking is usually manually rescheduled earlier. This is necessary because the CA assembly cannot plan production in the sequence of the trucks' delivery dates. The reasons for this is that the assembly line has a low FTT and several heavy vehicles can not be built one after another, even though the delivery date says they should. Both of these reasons lie outside of this thesis's scope since they regard the main production line and not the CA-material flow. However, the main reasons for the low FTT and the fact that several heavy vehicles cannot be built consecutively on the CBU (Completely Built Unit) line are further detailed in Figure 4.4.

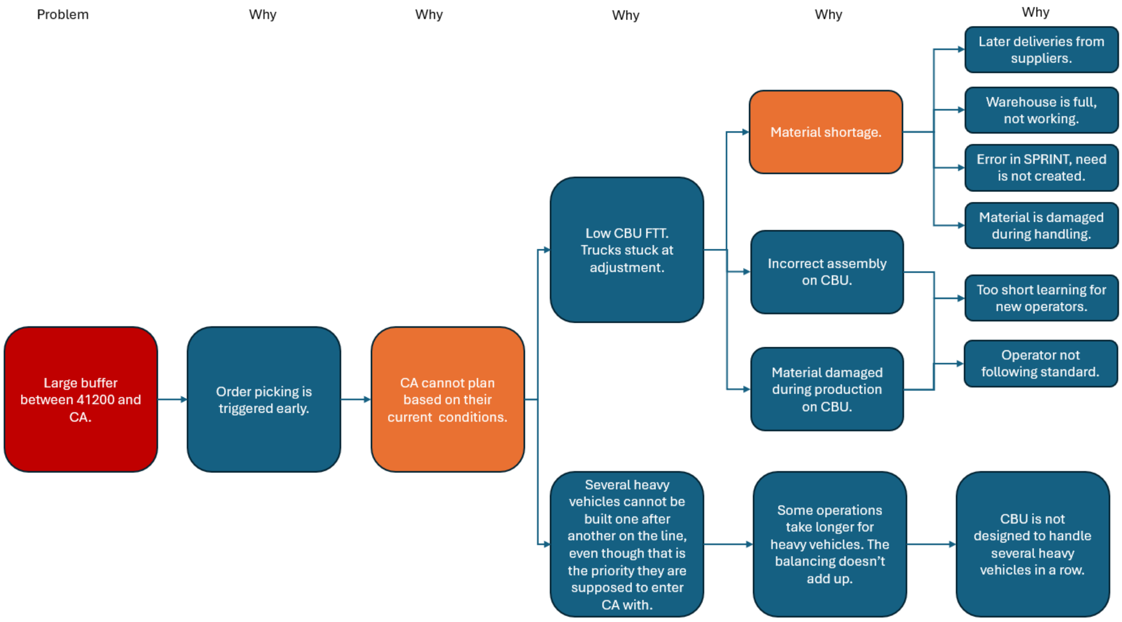


Figure 4.4: RCA of large buffer at 41200.

Subsequently, a RCA for the wrong material picked at 41200 is presented in figure 4.5

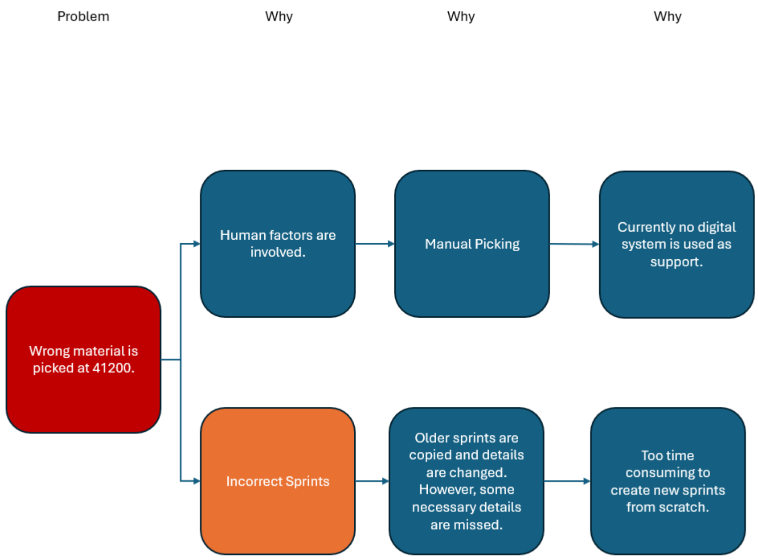


Figure 4.5: RCA of wrong material picked at 41200.

4.4 Analysis of Returns

To analyze the material flow, information about returned materials to the storages were extracted. These materials have wrongly arrived to the CA-assembly. The most common reasons for this were that the CA-assembly received too many of a material or that the material is completely wrong. The extracted data showed how many materials have been returned and how many returns were created. To clarify, the operators create one return for several materials with the same part number. Table 4.7 below, compiles the data for nine weeks and an error rate is calculated. The error rate describes the percentage of how many of the picked materials at 41200 are returned to the storages. %

Table 4.7: Number of parts handled at 41200, materials returned, returns from CA, and error rate.

Week	Parts Handled at 41200	Returned materials from CA	Number of returns	Error Rate
36	2087	84	44	4%
37	1929	16	3	0,8%
38	3189	6	4	0,2%
39	1889	5	5	0,3%
40	3991	60	21	1,5%
41	1606	7	5	0,4%
42	1554	546	107	35%
43	2062	109	35	5,3%
44	2575	3	2	0,1%
Total	20 884	836	226	0,4%

It can be concluded from the table that the average error rate during these weeks is 4% which essentially means that every 25th material that is picked is wrongly done so. Another thing that can be observed in the table is that there is a large variation in the number of returned materials from CA. This is due to the return handling process. The operators handle returns as time permits. Therefore, material can spend some time at the CA-assembly until available time is allocated. The downside of this is that material is planned to be in the storages, available for picking. However, in reality a material shortage can occur at the picking stations since the material is wrongly located at the CA-assembly and not returned yet. This is especially true for part numbers that have a low frequency in production, since the chances are higher that no additional quantities of those parts are available in the storages. An important reason for the high number of returns is that old design specifications are reused for new trucks. Another reason is the human factor where more material than needed is picked for the CA-assembly.

4.5 Improvements

This section presents the proposed improvements for selected problem areas identified in the current CA material flow. The improvement areas were selected based on the findings from the mapping, time studies, stakeholder insights and root cause analysis.

Not all identified problems were addressed with improvement proposals in this thesis. Some issues such as design related errors, supplier related material shortages and low FTT performance in the main assembly line, were found to have a clear impact on the CA flow. However these problems are outside of the defined scope of the study and would require wider or long term initiatives. They are therefore acknowledged in the analysis but not treated further in the improvement section.

The selection and prioritization of the improvement areas were based on the impact on the CA material flow and also the feasibility within the scope of the project and time frame as well. Priority was given to areas where recurring problems were observed and also where the improvements could realistically reduce errors and unnecessary buffering. As a result, the proposed improvement focus on kitting station 41200, sprint related improvements, buffer reduction and also planning.

4.5.1 Scanning Solution 41200

During the analysis of the current kitting process at the 41200 station, it became apparent that a major source of errors comes from the manual handling of picking lists. Operators currently rely on a printed list to identify and collect the required CA parts, which increases the risk of deviations such as picking the wrong article, missing items or picking incorrect quantities. These errors are strongly linked to the high variety of CA parts, the low degree of standardization and the reliance on manual verification.

To reduce the impact of the human factor and increase picking accuracy, a scanning based solution is proposed. Instead of using paper based picking lists, operators would work with a handheld digital device. The device displays the picking list digitally and guides the operator through the kitting process step by step. Each article on the list must be scanned before it can be confirmed, ensuring that the correct article and quantity are picked. Currently there are no bar codes on the articles delivered to 41200 so this is required in order to implement the scanning solution which may be time consuming and costly.

When the operator scans an item, the system automatically checks whether the scanned article matches the expected part number. When the correct article and quantity is scanned, the system marks it as completed and automatically moves on to the next line on the list. If an incorrect article is scanned, or if the operator attempts to pick more items than required, the device immediately alerts the user with an error message. This prevents incorrect parts from entering the kitted pallet and significantly reduced the risk of deviations later in the CA assembly process.

Introducing a scanning-based picking approach would therefore provide several benefits such as:

- Higher picking accuracy by eliminating manual verification.
- Reduced risk of missing or incorrect CA parts, which currently leads to delays.

- Improved traceability, as each scanned item generates a digital record.
- Lower cognitive load for operators, enabling more consistent performance.
- Better alignment with Lean principles, as errors are detected at the source.

Overall, the scanning solution improved the robustness of the kitting process by ensuring that only correct and complete CA material packages are sent to the CA assembly station. This contributes directly to improving the reliability and efficiency of the internal CA material flow.

4.5.2 Reducing the 41200 Buffer

Referring to figure 4.4, the main reason lying behind the large buffer at 41200 is the low FTT percentage from the assembly line. The CA planners can not use the trucks that are stuck at the adjustment and therefore need to deviate from the original CA plan. Even though improvements within the main line are outside the scope of this thesis, it would be good to understand that the CA assembly is dependent on the main line. This is the main reason to why a larger buffer is necessary.

However, if the CA planning can determine which trucks are going to be built in the assembly in the next few days the buffer could be reduced. A suggestion would be to move the trigger of pick forward in time by two days. Essentially, this means that the picking stations, including the 41200, have three days to prepare a kit before the needed time in the CA assembly. This would in theory lower the amount of stored material in the buffer by 40%. Furthermore, table 4.3 shows that neither of the tracked chassis was used by the CA earlier than the planned time. However, there could be deviations from this.

The storages that provide material to 41200 can perform chassis picking instead of the current part number picking. This would mean that the material received by 41200 is already sorted by chassis, the operational time at 41200 would be lowered significantly, meaning that it would be enough to start preparing the chassis three to four days before their need time. Chassis picking refers to the process of collecting and supplying all parts and components required for a chassis assembly from the storage areas to the 41200 kitting station. The problem with chassis picking at w01 and w03 is that it is not easily implementable since the pallets with materials would be required to go down and up to the storage several times to complete one chassis. This is time-consuming. Whereas currently, one part number is ordered down, and the required number of parts is extracted for a number of chassis.

By moving forward the trigger of the pick, some of the materials that are late from suppliers may have time to get to the storage in time, resulting in no material shortage. However, at the same time, it could mean that material errors are not fixed in time before the intended need time in CA.

Furthermore, an additional picking station at W01 would make fast chassis preparation possible and also simplify both chassis picking and overall picking planning.

Currently, the W01 station handles both standard and non-standard parts, so a separate station would make it easier to prioritize picks according to the plan. However, the costs of adding a new station are high, and the investment may not be justified since it would improve flow efficiency but would not address the underlying issues.

4.5.3 Reducing Number of Returns from CA

By implementing a scanning solution and digital picking list at 41200 the human factor could be minimized, leading to the correct amount of material being picked, and fewer returns from CA will be handled. Additionally, many times, the material specification lists that are prepared by the CA design and engineering department are not updated. This means that the wrong materials are picked, and then there will arise a need to return these materials.

Additionally, today, a significant part of frequently used materials is delivered directly to the CA assembly in batches. A suggestion for improvement here is to make sure that this spare part storage is regularly updated, meaning that outdated materials are replaced with new, frequently used materials.

4.5.4 Reducing Sprint Faults

Whether to put resources into reducing sprint faults or not is controversial since it is time consuming to create new sprints for every truck. Implementing an improvement in creating every new sprint from scratch would mean a significant increase in workload for the department that handles the sprints. However, it would also lead to fewer process disturbances in the material handling and the CA-assembly. Further analysis is required to determine whether it is economically feasible for the company to allocate additional resources to the sprint creating department to prepare sprints from scratch.

4.5.5 Cross-Functional Team for Root Causes

Stakeholder interviews revealed that information gaps between departments were a major issue, leading to poor communication regarding Sprint changes, unclear responsibilities, and reactive problem solving. Although cross-functional meetings already take place 1–2 times per week, they currently lack clear ownership. As a result, discussions often focus on immediate issues rather than systematically identifying and addressing underlying root causes.

An improvement proposal is therefore to assign ownership to a role or coordinator that is responsible for driving the cross-functional work. This person would ensure that meetings follow a structured process, that root causes are identified, and that actions are followed up across departments. This approach strengthens preventive problem solving without requiring the formation of a separate full time department which would cost money and resources. By establishing clearer accountability and leadership, recurring issues can be resolved more effectively and prevented from reappearing in the future.

4.6 Comparisons Between Current State and Proposed Improvements

A major Kaizen activity was conducted at Volvo with the objective of identifying all existing faults and assigning them to their respective departments. A total of 1012 faults were identified. Figure 4.6 below shows an overview of this.

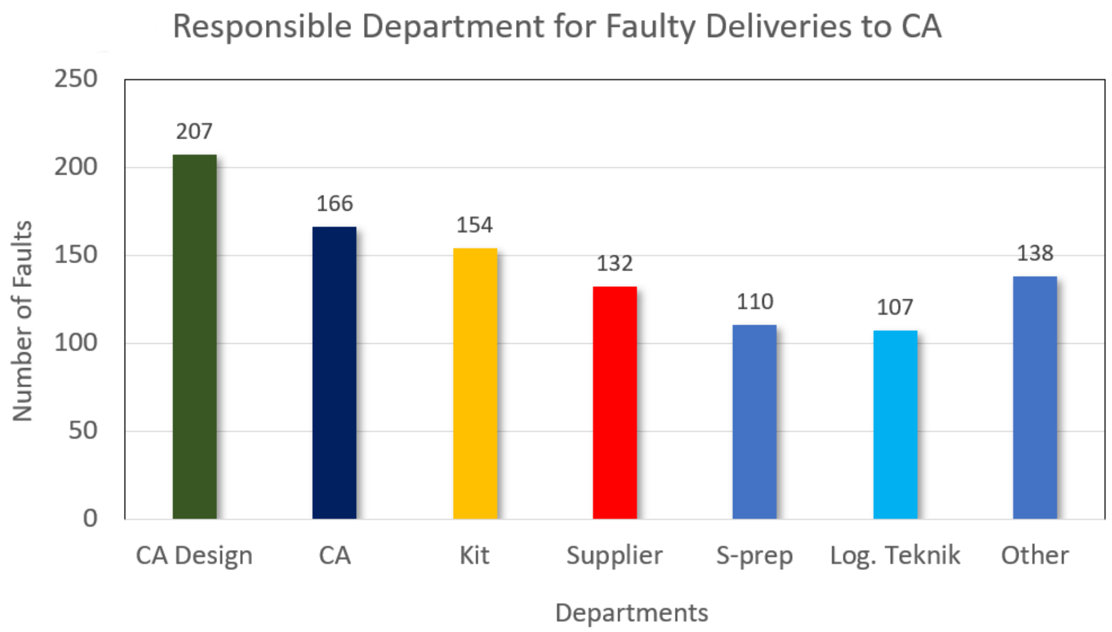
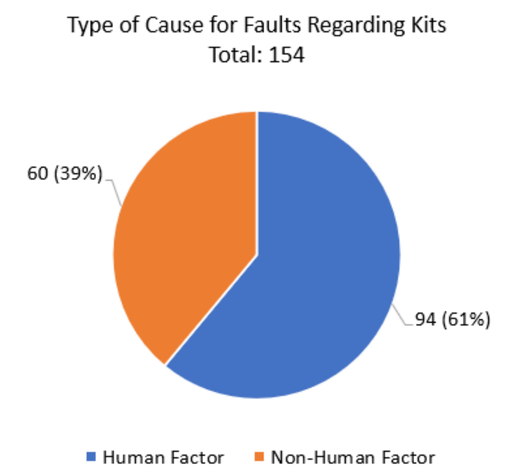


Figure 4.6: Overview of number of faults assigned to each department.

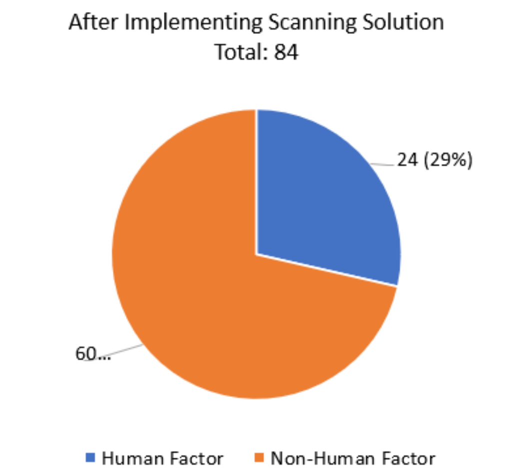
4.6.1 Scanning Solution

As seen in figure 4.6, 154 faults are due to the kits from the kitting area. Of those 154 faults, 97 were attributed to human factors. According to research on augmented reality and vision-supported picking systems, scanning-based solutions can reduce human factor-related errors by up to 75% [11]. Applying this potential reduction to the identified faults suggests that the total number of faults in the kitting could decrease from 154 to approximately 84, which represents an overall reduction of kit-related errors to about 45%. The graphs in figure 4.7 below illustrate the differences.

Furthermore, the scanning solution is expected to reduce the number of returns that comes from the CA assembly which will lead to lowered return handling costs. However, it is not currently possible to measure how much of a reduction since no data exists on what proportion of these returns can be attributed specifically to human factor related errors.



(a) Type of cause.



(b) After implementation.

(c) Total reduction of kits errors.

Figure 4.7: Overview of number of faults assigned to the kitting department.

4.6.2 S-prep Improvement

From the Kaizen, a total of 1012 faults were identified, where 269 came from sprint errors. By improving the Sprints by coming up with new and updated ones, instead of copying old ones, the number of sprint faults can be reduced. This would lead to fewer disturbances in the CA assembly. However, creating a new sprint will be time-consuming and, therefore, costly.

The S-prep improvement is also expected to reduce the number of returns since sprint-related errors are one of the underlying causes. However, it is not currently possible to measure how much of a reduction in this case as well since no data exists on what proportion of these returns can be attributed specifically to sprint errors.

4.6.3 Reducing the 41200 Buffer

By moving the trigger of pick forward by two days through enhanced planning, the buffer at 41200 could, in theory, decrease by 40%. This means that the average pallets in the buffer would go from 116 to 70. This would also affect the costs for occupying space since this would also decrease by 40%. However, doing this could result in that materials are not available when they are needed. Additionally, picking earlier would give more time to fix eventual disturbances, such as, damaged and missing materials.

5

Discussion

This chapter will discuss the results presented in the previous chapter. The discussion focuses on explaining the underlying reasons that drive the observed behavior in the internal flow of non-standard parts that is covered in this thesis.

5.1 FTT Creating Planning Uncertainty

The findings show that a low FTT rate is a central factor that is influencing the instability of the CA material flow. FTT measures the percentage of trucks that roll off the line are fully complete and assembled correctly. Therefore, a low FTT implies that a large share of trucks requires additional work after leaving the main production line. The CA sequence can therefore not follow the sequence the trucks are built on the main line.

A low FTT creates uncertainty regarding when individual trucks are available to enter the CA assembly. This affects the ability to plan and maintain a stable sequence in the CA assembly. Even if the build sequence is prepared in advance, changes can be made depending on available trucks, available material, and prioritization order.

Trucks that have rolled off the main assembly line and gotten stuck at the adjustments can take long time before they are deemed to be completely built. Often, the planning department does not get any forecast on when the trucks can leave the adjustment department. All this indicate that the planning department have to operate in a reactive manner with late information. Therefore, the FTT can be also seen as a Key Performance Indicator describing how much the CA planning and the internal material flow is affected.

5.2 CA Assembly Sequencing

As mentioned in the section above, the uncertainty in truck readiness after the main production line makes it difficult to stick to the predefined CA assembly sequence. The findings in this study show that CA planning frequently needs to adjust priorities based on which trucks are actually available. This environment reduces the effectiveness of the forecast driven approach Volvo strives for. As a result of this, the CA assembly requires a high degree of flexibility, which in turn places pressure on internal logistics to ensure that material is available regardless of which truck is prioritized. This explains why a large buffer at 41200 is a solution for the planning problem. A different solution for this problem is to have a buffer of trucks between the adjustment and the CA assembly. However, it is not decided whether this is worth it or not, since that buffer would require a large space.

5.3 Early Material Picking

The analysis of the internal material flow shows that earlier material picking is established as a deliberate response to the uncertainty caused by low FTT and unstable CA sequencing. By picking and kitting material well in advance, it is aimed to ensure that material is available whenever a truck becomes ready for CA assembly, even if changes to the planning occur. This leads to increased buffer levels. However, this behavior can be seen as a strategy to improve the flow and reduce the risks of unavailable material rather than a planning inefficiency. Delaying picking until closer to the planned CA assembly time would increase the risk of material shortages and CA assembly stoppages. Early picking will therefore act like a protective mechanisms that shifts uncertainty from assembly to inventory. This is reasonable, since errors in the assembly process could result in greater operational losses than the cost of storing excess material.

5.4 Buffer Sizing

As explained in the previous section, the large buffer at the 41200 picking station can be understood as the consequence of low FTT with planning uncertainty and early material picking as well. Rather than being the root cause of inefficiency, the buffer helps manage uncertainty and variability.

From a lean logistics perspective, such buffers are typically regarded as waste. However, the findings of this study suggest that under the current operating conditions, the buffer plays an important stabilizing role by giving the CA assembly breathing room from disturbances. At the same time, the buffer introduces several disadvantages, such as increased space utilization and more difficult material traceability.

This can be explained as a basic trade-off. If the buffer would be reduced without first fixing the underlying problems, it would probably lead to increased operational risk. The buffer should therefore not be seen as a problem on its own, but rather as a sign of deeper issues in the current system.

5.5 Discussion in Relation to the Research Questions

In relation to the research questions, the discussion shows that the issues in the current CA material flow cannot be fully solved by improving internal logistics alone.

The issues mainly comes from production quality (FTT) and planning uncertainty, which are outside the scope of this thesis. The proposed improvements in chapter 4 can therefore be seen as attempts to reduce uncertainty and improve information reliability, rather than solving the issues.

5.6 Method Discussion

This study was conducted as a case study focusing on internal logistics for non-standard parts within Volvo Trucks. A case study approach was considered to be suitable since the aim was to gain a deep understanding of the current logistics processes, identify inefficiencies and propose improvements as well.

The methodological approach combined both qualitative and quantitative methods, including process mapping, time data analysis, transport distance measurements, stakeholder interviews and root cause analysis. This combination made it possible to study the CA material flow from multiple perspectives. Interviews and on site observations were particularly valuable when it came to capturing practical challenges and decision making processes that are not fully visible in system data or documentation. However, qualitative methods are influenced by the perceptions and also experiences of participants, which introduces a degree of subjectivity.

Some of the applied methods contributed more directly to answering the research questions than others. For example, analyses related to information flow, planning and FTT were central for identifying root causes of missing material and large buffers. In contrast, the analysis of transport distances provided limited insights. While mapping physical distances is common in logistics studies and initially appeared relevant, the results indicated that transport distances was not a driver of the observed inefficiencies in the CA material flow. Instead variability, information uncertainty and replanning had a much greater impact. Therefore, the time and effort that were spent on transport distance analysis could have been redirected toward methods that captured uncertainty and variability more clearly. Alternative approaches could have included deeper analysis of waiting times or replanning frequencies. Those methods may have provided additional insights of uncertainty spreads through the systems and also how it affects the material availability. However, the transport distance analysis can be justified as a part of the current state mapping. At the early stages of the study, it was not fully clear which factors would prove to be most critical, and the analysis helped confirm that geographical factors were not a main cause of inefficiencies.

Another limitation of the methodology is that the proposed improvements were developed based on analysis and theoretical reasoning rather than implementations and testing. While the solutions are considered to be feasible within the studied context, their long term effects under changing production conditions were not evaluated. Future research could therefore focus on implementing the proposed solution and also conducting follow up studies to validate their impact.

Overall, the chosen methodology was appropriate for achieving the aim of the study and also for developing an understanding of the current internal logistics system. At the same time, the methodological reflections highlight the importance of evaluating the relevance of applied methods during the research process. The insights that were gained form both effective and also less effective methods contributed to narrowing the focus and also strengthening the conclusions of the study.

5.7 Discussion of Ethical Aspects

The proposed improvements for this project involve several considerations related to ethical concerns. Increasing the efficiency by implementing the scanning solution and through improved information flow could potentially lead to a decrease in manual handling and stress, which can positively affect ergonomics and lower cognitive stress for operators. Furthermore, it can also minimize the human-factor-related errors when picking materials which in turn would decrease the returns from the CA-assembly, further decreasing the workload. However, these kind of efficiencies may also reduce the need for certain manual tasks which raises ethical concerns around available job opportunities. Therefore, it is important to secure that the current workforce will have other work tasks if the improvements were to be implemented.

6

Conclusion

This thesis investigated the internal logistics flow for non-standard parts at Volvo Trucks' Tuve plant. The increasing degree of customized trucks has introduced significant complexity into material handling and planning, and the current system shows recurring problems with missing material, large buffers, and unstable lead times. The aim of the study was to identify issues that prevent material availability to minimize the risk of delayed truck deliveries, and increase the robustness of the CA material flow.

The two research questions that guided the work are:

- What issues prevent the right material from reaching the assembly station on time?
- What solutions can be implemented to solve these issues?

To answer the above stated research questions, a current state analysis was performed, including process mapping, time studies, stakeholder interviews, analysis of returns, and root cause analysis.

6.1 Findings Related to Research Question 1

The results show that the problems in the CA material flow are caused by how the overall system works, rather than by individual process steps. The time studies showed a very large and unstable buffer at 41200. Kits can remain there for anything from a few hours to several weeks. This means that the buffer is a result of the uncertainty, early picking, and bad planning reliability.

The study also identifies quality issues in the CA flow, such as wrong picking, missing parts, and incorrect kits, which lead to returns and rework. These issues create additional handling and coordination work and increase the workload for the operators. However, the analysis indicates that these quality issues comes from underlying problems such as unclear or outdated specifications, manual picking routines, and weak system support, rather than being the main drivers of instability in the flow.

Furthermore, the information flow between departments is poor and also dependent on manual routines. As a result, deviations and errors are often discovered late, which leads to the organization having to work reactively rather than proactively. The root cause analyses confirm that large buffers, early picking, and frequent re-planning are short term compensations used to handle low predictability, rather than sustainable solutions to the underlying problems.

6.2 Findings Related to Research Question 2

Based on the identified root causes, the thesis proposes several improvement measures. These focus on improving accuracy, predictability and coordination in the CA material flow. The key proposals include implementing a scanning and validation solution at the 41200 kitting area in order to reduce picking errors and returns as well which will improve the quality of specification lists and also claryfing cross-functional routines.

Together, these measures aim to reduce the need for manual workarounds and create a more stable and predictable material flow.

6.3 Limitations and Future Research

This study focused only on the internal logistics flow at the Tuve plant and only on non-standard parts. Future research should extend the analysis, including issues in FTT from the main assembly line and the CA planning department. Additionally, the proposed improvements have not been implemented. Future follow-up studies should evaluate their effects over time. This study can serve as a foundation for future research by providing a structured analysis of the internal logistics flow for non-standard parts, which can be further developed and applied in other production contexts.

6.4 Final Conclusion

In conclusion, the main challenges in the CA material flow are not caused by customization itself, but by a logistics system that is not fully adapted to handle high variability and high volume. By improving information flow, increasing First Time Through, and reducing dependence on buffers and early picking, there is strong potential to create a more predictable and efficient logistics process

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A

Questions current state analysis

- How does this station operate, and what are its main functions in the process?
- How does this station contribute to or impact the CA flow?
- Where do you receive your materials from, and where do you send them after handling?
- What are the main bottlenecks or challenges you experience at this station?
- Which systems or tools do you use to manage operations here, and what are the reasons for using them?
- Which other departments or teams do you collaborate with, and for what purposes?

B

Stakeholder Interview Template

- What are the most common problems or bottlenecks you encounter in the current flow?
- What do you think are the main causes of these problems?
- How do these challenges affect lead time, quality, or workload?
- Do you have any ideas on how the CA parts flow could be improved?

C

Role Explanations

- Material coordinator: Responsible for CA material flow. Acts as the link between suppliers and the Tuve plant. Does not handle purchasing but ensures that materials are delivered on time, in the correct quantities, and according to requirements by collaborating with the affected departments such as purchasing which determines what materials are needed and CA assembly for when the material is needed and in what quantity.
- Quality technician: Supports the CA department by working with root cause analyses when it comes to quality issues. Follows vehicles throughout the process, from the customer order stage to the point when the vehicles reach the assembly line.
- Goods reception: Primarily oversees the inbound material flow but also assists with daily operational tasks to ensure smooth handling of incoming deliveries.
- CA design engineer: Responsible for the design and development of new CA solutions, including updates and improvements to existing setups.
- CA planning: Operational planner responsible for ensuring that production work is carried out on the correct vehicles and according to planned schedules. Follows each chassis from main production to the CA process and onward to customer delivery.
- ANDON: Covers imbalances or disruptions in the assembly line. Handles material shortages and supports the CA area when issues occur that affect the workflow.
- CA assembly: Responsible for assembling and delivering customer-adapted trucks. Ensures that each vehicle is built according to specific customer requirements.
- Warehouse staff 41200: The staff at 41200 are responsible for preparing material kits for each chassis. They collect all necessary components into one kit which is then delivered to CA assembly when production starts. Their work is very connected to CA since they receive material orders directly and also coordinate with transport and material coordinators.

- Warehouse staff W01, W03, W05, B2u08: Responsible for picking materials based on orders for the CA area. Ensures that all required materials are collected and delivered efficiently.

- IMC (Internal Material Coordinator): Performs a similar role to the Andon function but focuses on non-CA materials. Ensures that material availability and flow are maintained in other areas.

- Transport coordinator: Manages truck deliveries of materials in and out of the PELC area. Coordinates inbound and outbound logistics to secure timely and efficient transport operations.

- Repack: Responsible for repacking materials into packaging that complies with Volvo's internal handling standards. Ensures that all materials are transferred into approved containers to facilitate internal logistics and efficient material flow.

- Logistics engineering: Responsible for balancing truck operations to ensure that material handlers have reasonable and efficient work times. The team also works on development projects related to upcoming production upgrades. In collaboration with team leaders, they manage the placement and integration of all incoming parts to ensure optimal use of factory space and smooth material flow.

D

System Explanations

- System for Incoming Materials: Used to monitor incoming materials, truck schedules, and chassis assignments. It provides visibility of what materials are needed, what has arrived, and when shipments are expected.
- Production Tracking System: Tracks truck locations and planning, showing where each chassis is and identifying material shortages or delays.
- Picking System Tracking: Manages picking and transport tasks, generating pick lists and tracking where materials are stored and retrieved.
- Internal Material Tracking System: Monitors material movement within the factory, from goods reception to storage and picking. It provides pallet tracking, picking history, and triggers for material deliveries.
- Data Visualization Tool: Used for data analysis and visualization, gathering information from systems like the production tracking system to show material flow and upcoming needs within the next 48 hours.
- Specification System: Displays detailed vehicle specifications, allowing users to check each truck's specific configuration.
- Documentation Portal: Provides access to work documentation and task instructions.
- Drawing & Specification System: Contains article specifications and drawings used for production and assembly reference.
- Packaging & Order Tracking System: Similar to the picking system, it tracks the number of packages per chassis, required packaging types, and orders placed by CA.
- Issue Reporting System: Used for reporting errors and issues in the production or logistics process.
- Access Portal: Provides access to sprints and other digital work environments.

- Article Database: Holds article specifications and technical details.
- Assembly Planning System: Shows which parts and components are to be assembled on each specific vehicle.
- Work Order System: The system used to record and manage specific work operations.
- Design Tool: Used to visualize the truck design and plan component placements.
- Quality Management System: Displays assigned jobs and quality-related tasks for the user.

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