JÖNKÖPING UNIVERSITY
School of Engineering

The Conditions for Digitalization in Warehousing within SME Contexts

A Qualitative Case Study of Barriers and Organizational Responses

PAPER WITHIN *Industrial Engineering and Management*

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JÖNKÖPING: *June 2026*

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This thesis was conducted at the School of Engineering, Jönköping University, within the subject area of Industrial Organization and Management. It forms part of the three-year Bachelor of Science in Engineering programme in Industrial Engineering and Management: Sustainable Supply Chain Management. The authors assume full responsibility for all opinions, conclusions, and findings presented in this work.

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Scope: 15 credits

Date: 2026-06-02

Acknowledgement

This thesis would not have been possible without the support and generosity of many people, and we are deeply grateful to all of them.

First and foremost, we would like to express our sincere gratitude to our supervisor, Hamid Jafari, for his guidance, encouragement, and thoughtful feedback throughout this process. His support has been invaluable in shaping this work.

We also extend our warmest thanks to Magnus Andersson and everyone at Holm Trävaror. From the very first day, we were welcomed with warmth and openness that set the tone for the entire project. Employees at all levels gave generously of their time and expertise, and the trust placed in us as students meant a great deal. The access we were given, to all warehouse sites, to honest conversations, and to the daily realities of the operation, is what made this study possible.

Finally, we want to acknowledge each other. Over years of studying together, we have built a collaboration grounded in trust, honest feedback, and a genuine drive to push the work forward, especially when it was hard. That foundation has been just as important to this thesis as any method or theory.

Date: 2026-06-02

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Abstract

Despite the growing availability of digital tools designed for warehouse environments, the gap between their formal adoption and embedding into operational practice remains wide and persistent. This gap is most acute in Small and Medium-sized Enterprises (SMEs), where structural constraints limit the organizational capacity to implement and sustain digital change. Existing research on warehouse digitalization has developed without systematic attention to firm size, while SME digitalization research has focused almost exclusively on manufacturing and production contexts. The intersection of warehousing, SMEs, and digitalization therefore remains underexplored. The purpose of this study was to examine the conditions shaping digitalization in warehousing within SME contexts. Two research questions guided the investigation: what barriers to digitalization exist in warehousing within SMEs, and how organizations respond to those barriers.

A qualitative, embedded single-case study was conducted at a Swedish SME distributing wood and wood-based materials across five warehouse sites. Empirical material was generated through document analysis, non-participant observations at three sites representing different levels of digital maturity, and six semi-structured interviews with warehouse operators and managers. Data were analyzed using thematic analysis. The Technology-Organization-Environment (TOE) framework served as the organizing analytical lens.

Fifteen barriers to digitalization were identified across the three TOE dimensions. Technologically, the most significant barriers concerned system misfit, data trust erosion, and the absence of compatible tools at the warehouse floor level. Organizationally, the functional adequacy of the existing manual system emerged as the primary mechanism preventing digital culture from developing, alongside structural overload, person-dependent operations, and implementation cycles that repeatedly encoded existing misfit into incoming systems. Environmentally, both identified barriers originated entirely outside the organization's capacity to address through internal means. All responses identified fell within the organizational dimension: governance decisions at go-live, the channeling of floor-level knowledge into operational decisions, and the redistribution of concentrated task responsibility.

Four contributions to existing understanding follow from the findings. The degree to which a barrier responds to organizational action appears to be structured by the TOE dimension in which it originates, a differentiation the framework does not currently establish. The mechanism through which digital culture fails to develop is identified as the functional adequacy of the manual alternative, rather than resistance to change. Integration readiness is better understood as an ongoing condition requiring active maintenance than as a threshold met once at adoption. Finally, the physical properties of the product and warehouse space define a boundary condition on what digitalization can achieve, a dimension not accounted for in established TOE constructs.

Keywords: Digitization, Digitalization, Warehousing, Small and Medium-sized Enterprises, Barriers, Technology-Organization-Environment framework, Organizational responses, Embedding, Implementation governance

Glossary of Key Terms

Digitization	The technical conversion of analogue information into digital format.
Digitalization	The process through which digital technologies become embedded into organizational processes; altering how work is performed and value is created.
Warehousing	The physical and operational activities involved in the receipt, storage, handling, and dispatch of goods within a warehouse facility.
SME (Small and Medium-sized Enterprise)	A firm with fewer than 250 employees and an annual turnover not exceeding 50 million euros.
Barriers	Conditions that constrain or complicate the embedding of digital technologies into organizational and operational practice.

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1 Introduction

This chapter introduces the study by establishing the context and practical relevance of the research, identifying the gaps that motivate it, and presenting the purpose and research questions that guide it. The chapter further defines the scope and delimitations of the study and concludes with an outline of the thesis structure.

1.1 Background

The increasing complexity of global supply chains, evolving customer expectations, and the accelerating pace of technological change have made digitalization a central concern for organizations across industries and a defining operational challenge of the current era. Digital technologies reshape and offer new ways to streamline operations, improve transparency, and coordinate activities across increasingly distributed networks (Verhoef et al., 2021; Vial, 2019). As a result, digitalization is no longer simply a strategic option but an increasingly necessary condition for remaining competitive. The question is no longer whether to pursue digitalization, but how to respond to the process within existing operational and organizational constraints (Vial, 2019).

Warehousing sits at the heart of this challenge. As a domain responsible for the physical coordination, storage, and dispatch of goods across supply chains, warehousing is both operationally demanding and deeply human-dependent (De Koster et al., 2007). It relies on accumulated worker knowledge, continuous judgment, and physical workflows that have developed over time. These characteristics make warehousing one of the nodes in the supply chain where digital tools carry the most potential to improve performance, but also where embedding them into existing practice is most difficult (Winkelhaus & Grosse, 2020). Introducing systems into environments already structured around established routines and experience-based knowledge requires not only technical implementation but fundamental adjustments to how work is organized and decisions are made (Cichosz et al., 2020; Winkelhaus & Grosse, 2020).

A recurring pattern is that when digital tools are introduced into such environments, they do not simply replace manual practices, they are layered on top of them. This creates hybrid systems in which paper-based and digital processes coexist, and the intended benefits of digitalization are only partially realized (Moeuf et al., 2018; Münsberg et al., 2022). What this suggests is not a failure of technology per se, but a persistent mismatch between the logic of digital systems and the operational and organizational conditions into which they are introduced.

This mismatch carries real consequences. When digitalization stalls or delivers only partial benefits, organizations continue to carry the costs of manual processes, inventory inaccuracies, delays in order fulfilment, and dependence on individual workers whose knowledge cannot easily be transferred or scaled (De Koster et al., 2007; Winkelhaus & Grosse, 2020). These

costs are not abstract; they affect delivery performance, customer relationships, and organizational resilience.

These challenges take on a sharper form when warehousing is considered within the context of Small and Medium-sized Enterprises (SMEs). While larger organizations can draw on dedicated IT functions, specialist expertise, and formalized structures to support digital initiatives, SMEs operate under structurally different conditions (Moeuf et al., 2018). Limited budgets, concentrated decision-making, and lean organizational structures mean that digitalization initiatives must compete directly with daily operational demands and are often pursued without the internal capabilities that implementation requires (Moeuf et al., 2018; Müller et al., 2024). At the same time, SMEs face the same external pressures for efficiency, reliability, and digital integration as their larger counterparts (Winkelhaus & Grosse, 2020). The pressure to digitalize is shared, but the conditions under which SMEs must respond to it are structurally different. In warehousing specifically, those conditions interact with an already complex operational reality.

1.2 Problem Statement

Warehousing has proven to be one of the most resistant domains to digitalization (Winkelhaus & Grosse, 2020). Despite the availability of tools designed specifically to support warehouse operations, the gap between their adoption and their integration into operational practice remains wide and persistent (Winkelhaus & Grosse, 2020; Münsberg et al., 2022). Understanding what produces this gap, what conditions shape whether digitalization progresses or stalls in warehouse settings, is therefore both a practical and a research problem of considerable consequence. The following section examines this problem across three dimensions: the practical scale of the challenge, the gap in existing research, and the methodological limitations of prior studies.

The practical scale of the problem is significant. Research consistently shows that organizations introducing digital tools into warehouse environments encounter a persistent disconnect between the presence of those tools and their contribution to operational performance. Zaman et al. (2023) find, for instance, that Warehouse Management System (WMS) adoption does not automatically translate into improved supply chain performance. This finding points not to technological failure but to the difficulty of integrating systems into operational environments already structured around established routines and physical workflows. These frictions are not evenly distributed. Within SME contexts, structural constraints systematically shape which tools are pursued and how far implementation can realistically go. Limited development resources, difficulties managing complex systems, and the absence of dedicated internal expertise together push organizations toward the cheapest and least disruptive options, leaving deeper operational transformation structurally out of reach (Moeuf et al., 2018; Müller et al., 2024). Consistent with Vial (2019); the distance between what digitalization could offer and what organizations are actually able to achieve in practice is therefore not a matter of ambition, but of the structural conditions under which implementation must occur.

The research landscape surrounding this problem has developed along two largely separate trajectories, and neither has reached the intersection where this study sits. Research on warehouse digitalization has grown considerably, but it has done so without systematically accounting for firm size as a variable (Winkelhaus & Grosse, 2020; Perotti et al., 2022). Meanwhile, research on SME digitalization has focused almost exclusively on manufacturing and production contexts, leaving warehousing largely unaddressed as a setting in its own right (Moeuf et al., 2018; Müller et al., 2024). As such, research at the intersection of these two areas remains strikingly thin, a gap that neither trajectory has moved to address systematically. The result is a body of literature that describes what digitalization in warehousing could look like, without adequately examining the conditions under which it actually unfolds in organizationally constrained settings.

The methodological design of prior studies further reinforces this gap. Warehouse-focused research on digitalization has often been conceptual or framework-oriented, with limited empirical grounding in everyday warehouse practice. When empirical studies have been conducted, they have frequently relied on quantitative methods, which are less suited to explaining how digitalization is experienced, adapted, and enacted in daily work (Winkelhaus & Grosse, 2020; Perotti et al., 2022). At the same time, qualitative studies of digitalization have often examined the phenomenon at a broader organizational or supply chain level. These studies commonly focus on large, internationally active firms with more formalized resources and digital capabilities (Cichosz et al., 2020). As a result, close field-based qualitative research in real warehouse settings remains limited, particularly in studies that are sensitive to the organizational conditions shaping digitalization in SMEs.

Taken together, these three dimensions point to a consistent and consequential gap: the conditions shaping whether digital tools become integrated into warehousing remain underexplored, and the SME context in which those conditions are most acute remains the least examined.

1.3 Purpose and research questions

Addressing this gap requires an empirically grounded examination, one conducted close enough to operational practice to capture how those conditions actually manifest. This study is therefore exploratory and descriptive in nature, aiming to develop situated understanding rather than test pre-established hypotheses. The purpose of this study is as follows:

The purpose of this study is to examine the conditions shaping digitalization in warehousing within SME contexts.

In this study, digitalization is understood as a process, one that may progress to the point where it changes ways of working and adds operational value, or one that stalls, leaving tools present in name without becoming integrated in practice. Fulfilling this purpose requires addressing two analytically distinct dimensions in sequence: the conditions shaping whether digitalization progresses must first be established empirically before organizational responses to those conditions can be examined.

The first dimension concerns the conditions that constrain or complicate the integration of digital tools into organizational and operational practice. Barriers in this study are understood not as conditions that prevent adoption outright, but as conditions that shape how far integration can progress once tools are introduced. This distinction, elaborated in the theoretical framework, is central to how the first research question is framed:

RQ1: What barriers to digitalization exist in warehousing within SMEs?

The second dimension builds on the first. Once the conditions shaping digitalization have been empirically established, it becomes possible to examine how organizations respond to them. The second research question therefore requires the first and cannot be addressed independently of it:

RQ2: How do organizations respond to existing barriers to digitalization in warehousing within SMEs?

Together, the two questions reflect a sequential logic grounded in Vial's (2019) framework: conditions producing the embedding gap must first be established before organizational responses to those conditions can be meaningfully examined.

1.4 Scope and Delimitations

This study is bounded in three principal ways that the reader should bear in mind when interpreting its findings and assessing their transferability.

The empirical investigation is conducted within a single company operating in Sweden. No claims of statistical generalizability are made, and findings should be understood as analytically rather than universally transferable. Country-specific regulatory, cultural, and market conditions that may shape digitalization in other national contexts are not addressed. The analytical focus is on the organizational and operational conditions surrounding digitalization, not on the technical characteristics of the tools and systems involved. Where specific technologies appear in the empirical material, they are treated as contextual factors shaping those conditions rather than as subjects of technical analysis in their own right.

The study is further delimited to warehousing as its operational domain. Broader supply chain processes, including upstream procurement and purchasing activities, downstream distribution, and any manufacturing or production operations, fall outside the scope of the research. Finally, while digitalization carries inherent sustainability implications, among them reduced paper consumption, improved resource efficiency, and more transparent supply chain coordination, sustainability is not a primary analytical focus of this study, and its implications are not systematically examined here.

1.5 Outline

This thesis is structured across six chapters. The following descriptions aim to orient the reader to the content and purpose of each chapter, and Figure 1 presents an overview of the thesis structure.

Chapter 1: Introduction introduces the background and motivation for the study. It positions digitalization within the specific context and concludes with the study's purpose, research questions, and delimitations.

Chapter 2: Theoretical Framework establishes the analytical foundation of the study. It defines digitalization, introduces the Technology-Organization-Environment (TOE) framework, discusses the characteristics of warehousing in SME contexts, and concludes by deriving the analytical constructs.

Chapter 3: Methodology presents the research design and methods. It justifies the qualitative embedded single-case study design and describes the use of data collection tools. The chapter concludes by describing the thematic analysis process and addresses research quality.

Chapter 4: Results presents the empirical findings, beginning with the case context. The findings are then organized into three parts: the barriers shaping digitalization, the organizational responses, and participant orientations.

Chapter 5: Discussion interprets the findings in relation to the theoretical framework and the research questions. It discusses the findings in relation to the working conceptual model, presents theoretical and practical implications, and reflects on the methodological choices.

Chapter 6: Conclusion summarizes the study's main findings and answers the research questions. It highlights the overall contribution of the thesis and concludes by reflecting on what the study shows about digitalization as an organizational process in SME warehouse operations and identifies directions for future research.

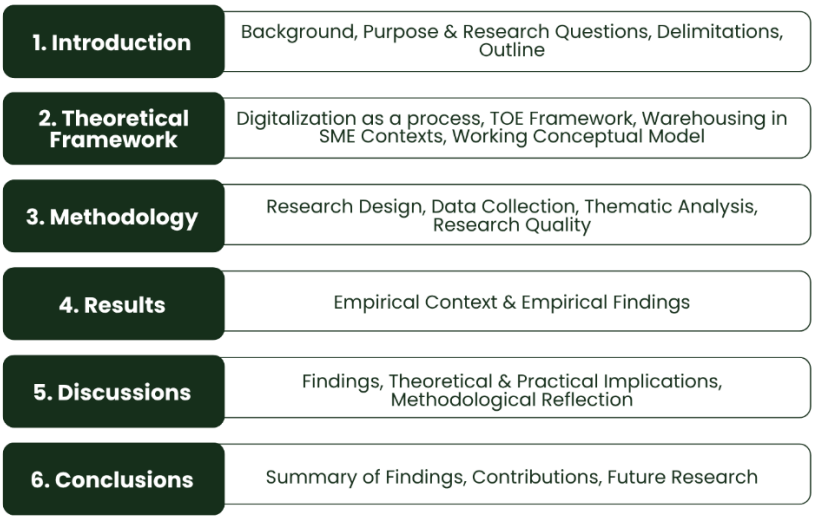

Figure 1: Thesis Outline Overview

2 Theoretical Framework

This chapter establishes the theoretical and conceptual foundation of the study. First it defines digitalization and introduces the Technology-Organization-Environment (TOE) framework as the organizing lens. Further, it examines the operational and organizational characteristics of warehousing within SME contexts. Drawing on these foundations, the chapter derives the working conceptual model.

2.1 Connection Between Theoretical Framework and Purpose

The purpose of this study required two foundational theoretical decisions. The first was to establish what digitalization means in this context: not as a technical event or a strategic outcome, but as an organizational process through which digital tools become embedded into how work is performed and value is created (derived from Vial, 2019). This conception defines what progression means throughout the study and establishes how barriers are understood. The second was to identify a framework capable of organizing the multi-dimensional conditions that shape whether that process progresses. The TOE framework (Tornatzky & Fleischer, 1990; Baker, 2012) provides this structure, directing analytical attention to the technological, organizational, and environmental conditions that together determine whether embedding occurs in practice.

Because dedicated research at the intersection of warehousing, SMEs, and digitalization remains limited, the constructs derived from these foundations draw on adjacent fields and synthesize their findings in relation to the specific context this study inhabits. Figure 2 illustrates how the theoretical foundations relate to the study's purpose.

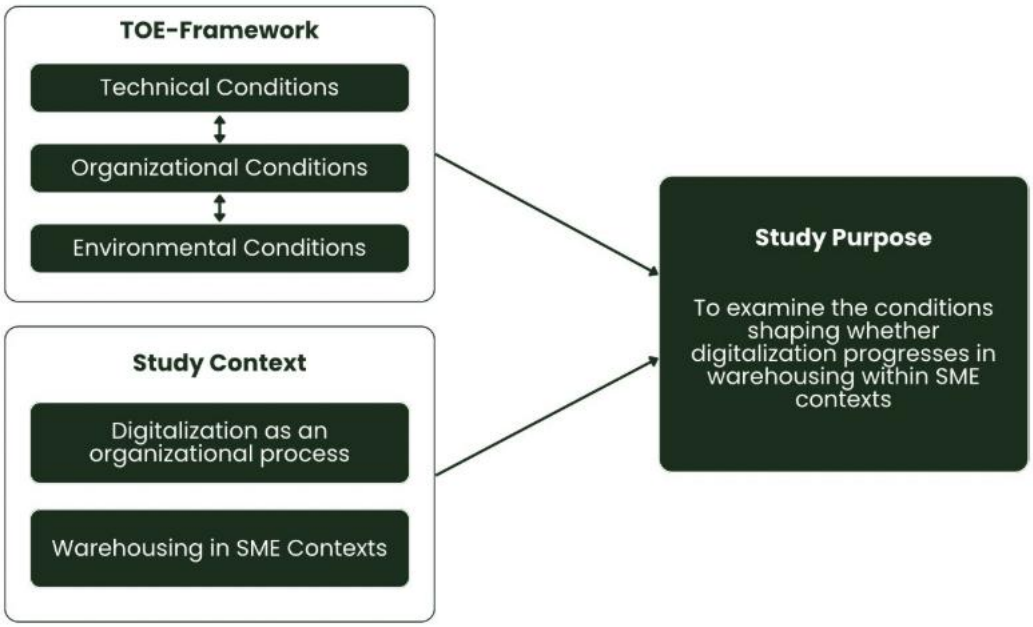

Figure 2: Connection Between Theoretical Foundations and Purpose

2.2 Digitalization as an Organizational Process

Digitalization is understood in this study as the process through which digital technologies become embedded into organizational processes: altering how work is performed and value is created (Stolterman & Fors, 2004; Vial, 2019). This definition rests on a foundational distinction drawn by Stolterman and Fors (2004) between digitization; the technical conversion of analogue information into digital format, and digitalization as an organizational phenomenon with social, structural, and behavioral dimensions. The difference matters analytically: digitization is a technical precondition, while digitalization is a process whose progress depends on organizational and operational conditions that vary significantly across contexts.

Vial's (2019) framework concerns digital transformation as a broader organizational phenomenon, but the organizational logic it surfaces remains directly applicable. Central to this perspective is the distinction between the introduction of digital tools and their embedding into organizational practice. Digitalization typically disrupts established routines and structures, and the introduction of digital tools does not in itself constitute digitalization. The more consequential question is whether those tools become embedded into how an organization coordinates, decides, and operates. Adoption and embedding are not equivalent: a tool can be introduced without meaningfully changing how work is organized or decisions are made, and it is precisely at that gap between the presence of a digital tool and its operational integration, that digitalization most frequently stalls (Vial, 2019; Zaman et al., 2023).

However, not all research converges on this understanding of digitalization. Verhoef et al. (2021), drawing on a multi-disciplinary review, position digitalization as one phase within a three-stage progression toward digital transformation. They specifically defined it as the use of digital technologies to alter existing business processes in the direction of greater efficiency and customer value. In their framework, the deeper organizational changes are properties of digital transformation, the most pervasive phase, rather than of digitalization itself. This distinction has intuitive clarity in strategic contexts where business model change is the primary concern. For the purposes of this study, however, such framing is analytically limiting. The warehousing environments examined here are not pursuing business model reinvention; the question is whether digital tools become embedded in how daily work is organized and executed. Treating this as a sub-transformation phenomenon would obscure precisely the organizational and operational dynamics this study seeks to examine. Vial's (2019) conception, in which embedding itself is the consequential outcome, and the gap between tool adoption and organizational integration is the central analytical concern, is therefore better suited to the context and purpose of this research.

Proceeding from Vial's (2019) conception, the distinction made between adoption and embedding shapes how barriers are understood throughout this framework. Barriers are not conditions that prevent the adoption of digital tools outright, but conditions that constrain or complicate their embedding into organizational and operational practice (derived from Vial, 2019). Many organizations have introduced digital technologies without achieving the corresponding changes in coordination, decision-making, and work practice that embedding requires (Münsberg et al., 2022; Zaman et al., 2023). The gap between tool presence and

embedding is therefore not exceptional; it is rather a norm, and understanding what it produces is of great relevance.

Equally relevant is how organizations respond to the conditions that create it. Organizational responses to digital disruption can be understood as a constitutive dimension of digitalization itself; organizations do not passively experience the embedding gap but rather develop responses to it (Vial, 2019; Cichosz et al., 2020). This is through adjusting structures, reallocating resources, and adapting practices in ways that shape whether embedding progresses over time. It is this response dimension, alongside the conditions that produce the gap, which ought to be examined.

This concern takes on particular weight in warehousing, where the operational characteristics of the work, its physical complexity, reliance on human judgment, and depend on accumulated experience, define a context in which embedding is both consequential and difficult to achieve. It is this intersection that the following sections examine.

2.3 Warehousing in SME contexts

Warehousing occupies a specific position within supply chains that carries direct analytical significance for understanding digitalization barriers. As a domain responsible for the receipt, storage, handling, and dispatch of goods across variable product assortments and demand conditions, its operational effectiveness depends on continuous coordination between inbound flows, inventory control, and outbound processes (De Koster et al., 2007; Faber et al., 2013). By this logic, digital tools are rarely introduced into a simple or stable environment; they must integrate with a system of interdependent activities already operating under pressure and variability (Winkelhaus & Grosse, 2020). Where product assortments are broad and demand patterns unpredictable, standardization becomes structurally difficult (Faber et al., 2013; Münsberg et al., 2022). The coordination demands of warehousing do not diminish when digital tools arrive; they define the conditions under which embedding must occur, and without sufficient standardization of the processes those tools must support, embedding cannot progress (Münsberg et al., 2022).

Alongside coordination complexity, warehousing is defined by a deep reliance on tacit knowledge and human judgment. Workers routinely make operational decisions about product placement, picking sequences, and spatial navigation that draw on personal familiarity with the physical environment and accumulated understanding of how the operation functions in practice (Münsberg et al., 2022). This knowledge is largely informal, not captured in documented procedures or formal systems, yet it is precisely what keeps operations running smoothly. Winkelhaus and Grosse (2020) identify human factors, including skills, tacit knowledge, and worker-technology interaction, as among the least systematically studied dimensions of warehousing despite their operational significance. Where decisions rest on knowledge that exists outside of systems, digital tools must align with practices that are deeply integrated in routines and largely invisible to system designers, a challenge that is structural rather than incidental to warehousing (Winkelhaus & Grosse, 2020; Münsberg et al., 2022).

Digital tools including Warehouse Management Systems (WMS), Enterprise Resource Planning (ERP) systems, and barcode-based identification technologies have been developed to address precisely the information handling and coordination demands described above (Zaman et al., 2023). Their introduction does not resolve these challenges, however; it reframes them. What was previously managed through informal coordination and accumulated experience must now be accommodated within system logic, requiring fundamental realignment of how activities are organized and decisions are made. The difficulty of embedding is not incidental to warehousing but stems directly from the operational characteristics that define it. Whether this realignment can be achieved depends on the organizational conditions the firm brings to the process (Winkelhaus & Grosse, 2020; Cichosz et al., 2020).

In an SME context, these conditions are structurally constrained in ways that bear directly on the digitalization. Concentrated decision-making, limited human and financial resources, and lean organizational structures mean that digitalization initiatives must compete with operational priorities and are filtered through limited managerial bandwidth (Moeuf et al., 2018; Müller et al., 2024). SMEs typically lack the dedicated IT expertise, change management capacity, and specialist functions that larger organizations draw on when implementing and sustaining new systems (Moeuf et al., 2018). Crucially, these constraints do not introduce entirely new challenges to warehousing digitalization, but instead, they reduce the organizational capacity to respond to the ones that warehousing's characteristics already produce. This is therefore not simply an additive problem; SME conditions interact with the operational complexity of warehousing in ways that make the organizational conditions for digitalization more difficult to establish and sustain (Moeuf et al., 2018; Müller et al., 2024).

2.4 The Technology-Organization-Environment framework

The Technology-Organization-Environment (TOE) framework, developed by Tornatzky and Fleischer (1990), provides a structure for examining the conditions shaping adoption of technological innovation within organizations. The framework proposes that adoption decisions are based on three contextual dimensions: the technological context, referring to the technologies available to the organization and their characteristics; the organizational context, capturing internal resources, structures, and capabilities; and the environmental context, encompassing external pressures, industry conditions, and inter-organizational relationships. Critically, the framework operates at the organizational rather than individual level, making it suited to studies concerned with firm-level conditions rather than individual responses to specific tools (Tornatzky & Fleischer, 1990). While originally developed to examine adoption decisions, TOE has since been extended to examine the broader conditions shaping how technologies are implemented and become embedded in organizational practice (Baker, 2012).

In this study, TOE serves as the organizing lens through which the conditions shaping digitalization in warehousing within SME contexts are examined. Rather than treating technological, organizational, and environmental conditions as separate and independent factors, the framework directs analytical attention to their interaction, recognizing that it is the

combination of conditions across all three dimensions, rather than any single factor, that shapes whether digitalization progresses toward embedding in practice.

2.5 Analytical Constructs

The preceding sections establish the theoretical foundations from which the study's working conceptual model is derived: digitalization understood as an organizational embedding process, the TOE framework as the organizing lens, and warehousing within SME contexts as the domain in which the study is situated. The following section synthesizes literature across the three TOE dimensions, deriving ten analytical constructs that together constitute the working conceptual model presented at the close of the chapter. The resulting constructs capture both constraining conditions and conditions that may facilitate organizational responses to them. Because research at the intersection of warehousing, SMEs, and digitalization remains limited, the constructs are developed through a synthesis of adjacent literature and the specific context of this study.

2.5.1 Technological Conditions

Warehousing environments present a specific and well-documented technological challenge for digitalization. The operational complexity of warehouse settings, with interdependent inbound, storage, and outbound flows, means that introducing a new digital tool into one part of the operation can create ripple effects across others (Winkelhaus & Grosse, 2020; Perotti et al., 2022). The literature identifies this as a process standardization and data integration problem. Cichosz et al. (2020), examining digitalization among logistics service providers, find that the complexity of underlying processes is the top-ranked barrier, and that insufficient process standardization and data integration are the central conditions producing it. Where data structures, workflows, and system linkages are insufficiently developed, the operational benefits that digitalization promises cannot be realized even when tools have been formally adopted.

Münsberg et al. (2022), examining warehouse settings specifically rather than logistics service providers more broadly, reinforce this finding but extend it: process standardization is not merely a condition whose absence creates a barrier, but a foundational precondition that organizations must actively develop for digitalization to progress. Cichosz et al. (2020) arrive at a convergent conclusion from a different empirical context, identifying insufficient process standardization and data integration as the central conditions producing complexity barriers across logistics organizations. Building on these two bodies of work, standardization can be understood to encompass multiple interacting dimensions: product data and system interfaces (Münsberg et al., 2022), operational processes and physical layouts (Faber et al., 2013; De Koster et al., 2007), each of which must be sufficiently developed before digital tools can be integrated into everyday workflows. Together these sources suggest that **integration readiness** is both a barrier when absent and an enabling condition when actively pursued. Faiz et al. (2024) and Moeuf et al. (2018) identify phased, incremental implementation as the primary organizational response to this in resource-constrained settings, arguing that organizations investing incrementally in data structures and workflows progressively shift the

conditions constraining digitalization even outside formal implementation projects. This incremental path is particularly relevant in environments where full standardization is structurally difficult, as Münsberg et al. (2022) find to be the case when operational variability and product assortment diversity are high.

The technological environments into which warehouse digital tools must be introduced compound this challenge further. SMEs typically operate across combinations of legacy ERP systems, WMS solutions, manual recording processes, and informal workarounds developed incrementally over time (Faiz et al., 2024). These fragmented environments were not designed for integration with newer tools, and introducing new systems often requires restructuring of workflows and data flows that can exceed the capabilities of organizations without dedicated IT expertise (Moeuf et al., 2018). It is worth noting that Faiz et al. (2024) draw their findings from innovative SMEs broadly, while Moeuf et al. (2018) focus specifically on industrial SMEs in the context of Industry 4.0 adoption. Despite their different populations, both identify **system compatibility** as a central technological condition, suggesting the finding is robust across SME types rather than context specific. Compatibility is not limited to whether a new tool can technically interface with existing infrastructure but concerns the degree to which it fits with existing data flows, operational routines, and system logic. Where modular system architectures allow new tools to interface with existing infrastructure without requiring full replacement, compatibility constraints become more tractable, reducing both the technical and organizational disruption associated with implementation (Faiz et al., 2024).

The financial dimension adds a further layer of difficulty. Faiz et al. (2024) identify **adoption costs**, including initial investment, ongoing maintenance, training, and integration expenditure, as primary constraints on digitalization in SMEs. These costs become particularly consequential when the benefits of embedding are difficult to quantify in advance, while the risks of operational disruption in a live warehouse environment are immediate and concrete (Moeuf et al., 2018). Furthermore, the literature identifies phased and incremental implementation as the primary organizational response to this constraint, arguing that breaking implementation into smaller steps reduces the financial and operational exposure that makes initial investment decisions difficult in resource-constrained settings (Faiz et al., 2024; Moeuf et al., 2018). In addition, where organizations can identify discrete, bounded use cases for new tools rather than pursuing organization-wide implementation simultaneously, the cost-benefit calculation becomes more legible and the decision to proceed less organizationally disruptive. Together these findings suggest that while **adoption costs** are a genuine and structural barrier in warehousing within SME contexts, they are not fixed. The way implementation is scoped and sequenced shapes the degree to which cost exposure constrains the digitalization process.

2.5.2 Organizational Conditions

The organizational conditions shaping digitalization in warehouse settings are both extensively studied and highly consequential for understanding whether embedding progresses. The literature consistently indicates that digitalization is not determined by the technical characteristics of digital tools alone, but by the organizational conditions surrounding their introduction (Faiz et al., 2024; Moeuf et al., 2018).

In warehousing specifically, the **tacit knowledge** structures on which operations depend present a persistent and domain-specific barrier. Warehouse work often relies on personal, experience-based knowledge concerning product placement, picking sequences, spatial navigation, and local routines. When digital tools formalize decisions that workers have previously made through accumulated experience, the challenge becomes organizational rather than purely technical, meaning that system logic must align with work practices that are deeply embedded but rarely documented (Münsberg et al., 2022). Cichosz et al. (2020), identify resistance to this realignment as operating at two levels: at the institutional level, organizations may default to practices that have historically proven effective, and at the individual level, workers may resist changes to routines they have developed over time. Zaman et al. (2023), examining WMS adoption in supply chain networks, reinforce this pattern from a different research context, finding that tool adoption does not automatically translate into improved operational performance. The convergence of these findings across different empirical settings strengthens the case that tool presence and operational integration are distinct phenomena in warehouse contexts. According to Münsberg et al. (2022), this can be addressed by making **informal practices** visible before system alignment can occur. Documentation and formalization of **tacit knowledge** is identified as a necessary precondition: where organizations invest in capturing how work is actually performed, the gap between system logic and operational reality becomes legible and, over time, addressable.

These warehouse-specific challenges are closely connected to digital culture, which Faiz et al. (2024) defines as the degree to which an organization shares assumptions and norms oriented toward digital ways of working. Faiz et al. (2024) identify **digital culture** as one of the strongest predictors of adoption intention in SMEs, ahead of both technological and environmental factors, suggesting that cultural conditions shape whether digitalization progresses independently of what tools are available or what external pressures exist. Where **digital culture** is weak, resistance may persist regardless of management directives or technological capability. Organizations are not, however, passive in relation to this condition. Deliberate communication of the rationale behind digitalization initiatives, visible demonstration of digital practices by management, and the gradual accumulation of positive operational experience with digital tools have all been identified as mechanisms through which culture can shift incrementally (Faiz et al., 2024; Müller et al., 2024). Faiz et al. (2024) further note that SMEs tend to benefit from more agile decision-making processes, a characteristic that reflects their typically flatter hierarchies and closer communication channels between management and operational levels. This can reduce the organizational distance between management intent and practice, making cultural shift more direct once initiatives are underway than in larger and more hierarchical organizations.

Top management support represents another central organizational condition, determining whether digitalization initiatives receive the sustained prioritization, resourcing, and follow-up that embedding requires (Faiz et al., 2024). Its absence leaves other organizational conditions unaddressed, since digital tools require more than formal approval to become integrated into daily work. Faiz et al. (2024) and Müller et al. (2024) both identify this condition as critical, though from different angles. Faiz et al. (2024) examine its role in shaping adoption

intention among innovative SMEs broadly, while Müller et al. (2024) examine it as an enabler across SME digitalization contexts more generally. Despite these different emphases, both converge on the same finding that visible and sustained leadership commitment is the most consistently identified organizational enabler, and where management actively removes structural barriers and allocates dedicated resources, other organizational conditions become more tractable. In SMEs, sustaining such commitment is structurally difficult because managerial bandwidth is concentrated and strategic attention is frequently absorbed by operational demands (Moeuf et al., 2018; Müller et al., 2024), making the organizational design of how leadership attention is protected and directed a relevant practical concern.

Human resource capability further shapes the organizational conditions for embedding, referring to employees' ability to understand, operate, and adapt to digital tools within operational contexts (Cichosz et al., 2020). In SMEs, this capability is often constrained by limited specialist expertise and the absence of dedicated functions that larger organizations rely on (Moeuf et al., 2018). In warehouse settings specifically, this challenge is compounded because workers must adapt to both the technical use of a system and the operational changes that come with it. Digital tools may alter routines, decision-making practices, and the way daily work is coordinated. This creates a dual demand for adaptation that generic capability development approaches may not fully address (Cichosz et al., 2020). Cichosz et al. (2020) identify targeted training and gradual system introduction as conditions enabling capability development without overwhelming operational staff. Together these findings suggest that capability development in warehousing within SME settings is less about formal training volume and more about the sequencing and contextual grounding of how new practices are introduced.

2.5.3 Environmental Conditions

The external environment within which warehousing SMEs operate exerts a further layer of influence on digitalization decisions, though the literature identifies this influence as operating selectively rather than uniformly. Two environmental conditions carry particular analytical weight in supply chain-embedded warehouse settings: the expectations of trading partners, and the dependencies that arise from operating within inter-organizational networks. A third condition, **competitive dynamics**, is retained as an empirically open question whose relevance the literature leaves uncertain in this specific context.

In warehouse settings embedded within supply chain networks, trading partner expectations represent a direct and often unavoidable source of external pressure. Customers and suppliers increasingly expect digital systems to facilitate transactions, coordinate orders, and provide operational visibility, expectations that apply regardless of whether the organization receiving them has the internal conditions to meet them (Faiz et al., 2024). For warehouses operating at a critical coordination node between suppliers and customers, this pressure cannot easily be deferred, as failure to meet partner expectations carries immediate operational and relational consequences. Both Awa et al. (2016), examining ERP adoption specifically, and Faiz et al. (2024) identify **trading partner pressure** as among the environmental conditions most consistently associated with digitalization. The convergence of

these findings across different technology types and SME populations strengthens the case that partner-driven pressure is not merely context-specific, but a recurring environmental influence on digitalization.

At the same time, Faiz et al. (2024) emphasize that **trading partner pressure** should not be understood solely as a constraint. Although external requirements exceeding internal readiness may intensify the challenges associated with digitalization, such pressure can also elevate digitalization on the organizational agenda. This is particularly relevant in SMEs, where managerial attention is often absorbed by immediate operational demands. In this sense, **trading partner pressure** can function as a legitimizing force that helps sustain commitment to digitalization initiatives that internal conditions alone may not be sufficient to drive. Faiz et al. (2024) therefore implies that **trading partner pressure** can both constrain digitalization and create internal momentum for change, depending on how it interacts with the organization's existing capabilities and priorities.

Inter-organizational dependencies represent a conceptually distinct condition, though one that operates alongside **trading partner pressure** (Awa et al., 2016; Faiz et al., 2024). While **trading partner pressure** concerns the expectations partners impose**, inter-organizational dependencies** concern the degree to which the organization relies on external actors for technical expertise, system compatibility, or digital alignment that it cannot develop independently (Awa et al., 2016). Awa et al. (2016) highlights that SMEs frequently depend on external partners for the implementation support and technical knowledge that digitalization requires, making their trajectories partly contingent on partner readiness and capability. This dependency becomes constraining when the organization is expected to meet partner requirements without receiving corresponding support, resources, or technical alignment. However, it can also function as a resource when partners provide active support, technical expertise, or compatible system infrastructure. The role of inter-organizational dependency therefore depends on whether external actors have both the capability and the incentive to support the organization's digitalization process.

Competitive dynamics, understood as the degree to which industry-level digitalization creates pressure to adopt digital tools, is retained as a third environmental construct. Its relevance is treated as context-dependent rather than uniformly established. At a broader level, digitalization has increasingly become associated with organizational competitiveness, as technological change and evolving customer expectations reshape how firms create and deliver value (Vial, 2019). In this sense, **competitive dynamics** form part of the wider environmental context in which digitalization takes place.

However, the literature suggests that competitive pressure does not operate uniformly across organizational contexts. In studies of large, internationally active logistics service providers, Cichosz et al. (2020) identify competitive pressure as one of the prevailing forces driving digital transformation. By contrast, Faiz et al. (2024), find competitive pressure statistically insignificant as a driver of digitalization, suggesting that for smaller firms operating within defined supply chain relationships, partner-specific obligations are more immediately consequential than generalized market-level pressure. **Competitive dynamics** are included as

an environmental construct but not treated as an assumed driver of digitalization. Rather, the construct captures whether and how industry-level digitalization pressure becomes relevant in a specific organizational context. This recognizes that competitive pressure may function as a general background condition while having limited direct influence on the everyday decisions and constraints that shape digitalization within smaller firms (Vial, 2019).

2.5.4 Working Conceptual Model

The ten constructs derived across the three dimensions are brought together in the working conceptual model below (see Table 1). Together they represent the analytical dimensions through which the conditions shaping digitalization in warehousing within SMEs will be examined empirically. Each construct captures both the conditions that constrain digitalization and the conditions the literature identifies as enabling organizational responses to those constraints. The constructs are not exhaustive categories but interacting conditions.

Table 1: Working Conceptual Model

Context	Construct	Description	References
Technological	Integration readiness	The extent to which data structures, workflows, and system linkages are sufficiently developed to enable effective digital coordination across warehouse operations.	Cichosz et al. (2020); Münsberg et al. (2022)
	System compatibility	The degree to which new digital tools fit with existing systems, data flows, and operational routines, particularly in the fragmented technological environments typical of SMEs.	Faiz et al. (2024); Moeuf et al. (2018)
	Adoption costs	The financial and operational investment required to implement and sustain digital tools, including the risk of operational disruption that shapes feasibility in resource-constrained settings.	Faiz et al. (2024); Moeuf et al. (2018)
Organizational	Tacit knowledge and informal routines	The extent to which warehouse work relies on experience-based knowledge and undocumented practices that resist formalization in digital systems, producing structural misalignment between system logic and operational reality.	Münsberg et al. (2022); Cichosz et al. (2020); Zaman et al. (2023)
	Digital culture	The shared norms, values, and attitudes toward digital ways of working that shape whether tools are accepted and integrated into practice across the organization.	Faiz et al. (2024); Müller et al. (2024)
	Top management support	The degree to which senior leadership visibly and sustainably prioritizes resources, and drives digitalization initiatives over time.	Faiz et al. (2024); Müller et al. (2024); Moeuf et al. (2018)
	Human resource capability	Employees' ability to understand, operate, and adapt to digital tools within operational contexts, particularly where specialist expertise is limited, and adaptation demands are both technical and operational.	Moeuf et al. (2018); Faiz et al. (2024); Cichosz et al. (2020)
Environmental	Trading partner pressure	Expectations from customers or suppliers to adopt and use digital systems for coordination and transactions, operating as an external constraint or a legitimizing force depending on internal readiness.	Faiz et al. (2024); Awa et al. (2016)
	Inter-organizational dependencies	The degree to which the organization relies on external actors for technical expertise, system compatibility, or digital alignment, shaping both constraints and opportunities depending on partner capability and incentive.	Awa et al. (2016); Faiz et al. (2024)
	Competitive dynamics	The degree to which industry-level digitalization pressure shapes adoption decisions, treated as a background environmental condition whose direct influence on firm-level decisions is context-dependent and empirically open.	Faiz et al. (2024); Cichosz et al. (2020); Vial (2019)

Note. Constructs are not exhaustive categories but interacting conditions, each capturing both constraining and enabling dimensions.

The 10 constructs derived across the three dimensions represent the primary analytical conditions available from existing literature at this intersection. They are not, however, assumed to be exhaustive. As previously established, warehousing is a physically intensive domain. As such, the empirical context may surface conditions that the established working conceptual model does not fully capture.

3 Methodology

This chapter describes the methodological considerations underpinning the study, including research design, data collection, data analysis, and research quality. Ethical considerations are also addressed.

3.1 Connection Between Research Questions and Methodology

The following chapter describes the tools for data collection and data analysis used to address the research questions. Figure 3 illustrates the connection between the research questions and methods used.

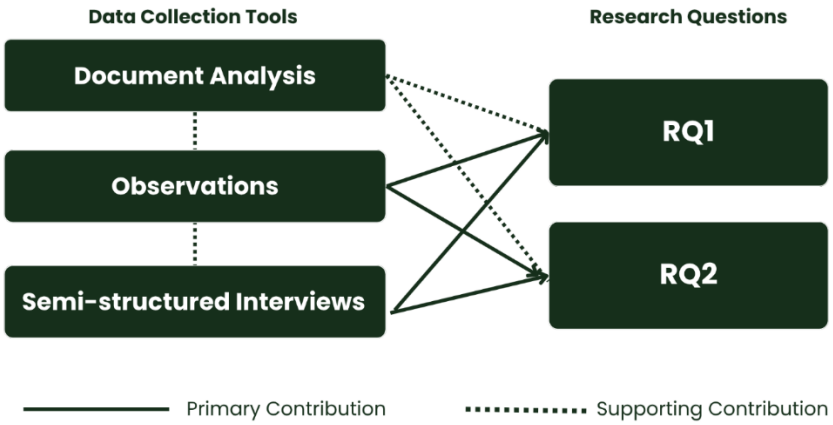

Figure 3: Connection Between Data Collection Methods and Research Questions

The two research questions in this thesis require different but complementary forms of empirical insights, and the methodological choices are therefore directly aligned with their aims.

RQ1 focuses on examining the barriers to digitalization in warehousing. To capture how these barriers manifest in practice, document analysis, observations, and semi-structured interviews were used in combination. Document analysis shaped the contextual and foundational understanding of the case company and the warehousing practices required for subsequent examination. Observations provided further insight into warehousing, system use, and day-to-day practices, while interviews captured the experiences, perceptions, and interpretations of both operational and managerial staff.

RQ2 focuses on how organizations respond to these barriers. The question was primarily addressed through semi-structured interviews, as responses to barriers involve organizational decision-making, experience, and adaptation, which are best explored through dialogue with participants. Interviews allowed respondents to articulate the organizational reasoning, adaptations, and responses that are not directly observable but are essential for understanding how digitalization challenges are managed. Observations contributed to a complementary perspective, making it possible to identify responses as they manifested in practice.

Document analysis supported both research questions by providing contextual background and enabling triangulation across data sources. Together, these tools provide a coherent basis for answering the research questions by capturing both the manifestation of barriers in practice and the ways of responding to them.

3.2 Research Process

The study was carried out in three sequential phases designed to ensure a coherent and well-founded research process. The following subsections outline the three phases.

Phase 1: Preparatory Work

The first phase consisted of preparatory work focused on establishing the foundation of the study. This involved defining the problem area, refining the research purpose, and formulating the research questions. During this phase, an initial review of relevant literature was conducted to establish the theoretical foundation and refine the focus of the research. Insights from this review informed the selection of Technology-Organization-Environment (TOE) framework as the analytical lens and guided the development of the observation protocol and semi-structured interview guides. Internal materials provided by the case company were examined through document analysis to gain contextual background.

Phase 2: Empirical Data Collection

The second phase consisted of the empirical data collection across three warehouse sites: Sävsjö, Borås, and Sala, during weeks 13 to 15 of 2026. Data collection involved two complementary methods, observations of operational work activities, and semi-structured interviews with managers and warehouse employees. Document analysis of internal materials continued in parallel to support contextual understanding and triangulate empirical findings.

Phase 3: Data Analysis and Synthesis

The final phase involved systematically analyzing the collected material through a structured inductive process moving from informant-centric initial codes through interpretive clustering to analytically developed themes. The analysis followed an abductive logic, in which the TOE framework served as a sensitizing lens at the synthesis stage rather than as a set of pre-determined categories imposed on the data from the outset. This phase involved coding, comparing insights across sites, synthesizing patterns, and drawing key insights in relation to the research questions.

The sequence of these phases ensured that each step of the study built logically on the previous one, from conceptual preparation to empirical inquiry and analytical synthesis and interpretation. Figure 4 illustrates the sequential phases of the study, from preparatory conceptualization through empirical data collection to analysis and synthesis

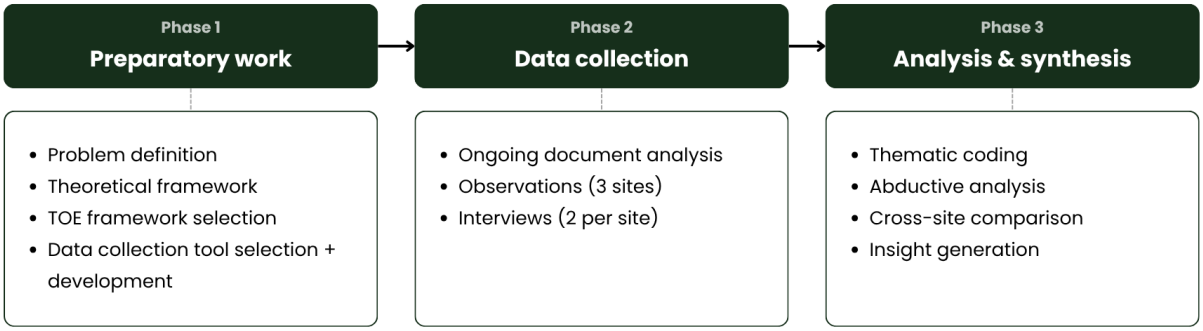

Figure 4: Research Process Overview

3.3 Research Design

To address the research questions, a qualitative approach was adopted, enabling an in-depth and context-sensitive exploration of digitalization within warehousing in SME contexts.

3.3.1 Research Strategy Approach

The study adopts a qualitative research approach, with the purpose of enabling in-depth examination of how digitalization is experienced and responded to within warehousing in SMEs. According to Säfsten and Gustavsson (2020), qualitative methods are particularly well-suited for inquiries that seek to explore phenomena as they unfold in their natural settings, rather than to measure predefined variables or test causal relationships. Such approaches are especially useful for addressing complex questions concerning how and why certain conditions and processes unfold in a specific organizational context, and for identifying factors that may not be visible through predefined quantitative measures (Harwell, 2011; Busetto et al., 2020). This aligns with the exploratory purpose of the present study, which seeks both to develop an in-depth understanding of how digitalization unfolds in warehousing in SME contexts by examining the barriers that shape the process, and subsequently how they are responded to in practice.

Within this qualitative orientation, the study follows abductive analytical logic. Abductive analysis involves an iterative movement between empirical observations and theoretical frameworks, allowing emerging patterns from the data to inform and refine theoretical interpretations, and vice versa (Timmermans & Tavory, 2012). Rather than examining data solely against predefined categories or generating theory entirely without theoretical grounding. Abductive analysis allows the TOE framework to serve as an initial sensitizing structure while keeping the analytical process open to patterns that emerge from the empirical material and were not anticipated by the framework. This approach is particularly appropriate given the complexity of digitalization in warehousing within SME context, where existing theories provide guidance but do not fully account for context-specific dynamics.

3.3.2 Research Design Selection

A case study design was selected, because case studies are well suited to investigations of contemporary phenomena situated within real-life organizational contexts, particularly when

the boundaries between the phenomenon and its context are not clearly distinguishable (Yin, 2018). As previously established, digitalization in warehousing is a multifaceted phenomenon, making a case study design suitable for capturing its contextual complexity, as it enables a holistic and contextualized examination of digitalization as it unfolds in practice (Harwell, 2011). Case studies also support the use of multiple sources of empirical material, assisting an in-depth and interpretive understanding (Seuring 2008; Säfsten & Gustavsson, 2020).

A limitation of the case study design is that findings are context-dependent and cannot be statistically generalized to a wider population of organizations (Yin, 2018). The depth of insight gained within the single case necessarily comes at the expense of breadth. This trade-off is accepted as appropriate given the exploratory and descriptive purpose of the study, where contextual richness and analytical depth are prioritized over generalizability.

The study follows a single-case design. A single case is appropriate when the objective is to develop a rich and contextually grounded understanding of a phenomenon rather than to compare across a large number or organizations (Yin, 2018; Seuring, 2008). Single-case designs are particularly suitable when the case represents a relevant example of a broader phenomenon, or when it provides an opportunity to examine processes that are otherwise difficult to access (Seuring, 2008; Yin, 2018).

3.3.3 Case Selection

Holm Trävaror AB was selected as the empirical case guided by the relevance to the research focus on digitalization in warehousing within SME context (Säfsten & Gustavsson, 2020). The company is a Swedish SME specializing in the import and distribution of wood and wood-based materials, with operations distributed across multiple warehouse sites. The organization employs approximately 75 people and generates an annual turnover of around SEK 409 million, placing it within the European Commission's definition of a medium-sized enterprise (European Commission, 2008). Its operations are characterized by a combination of physical handling processes, logistic coordination, and customer-oriented service. The breadth of its product range, together with the need for timely and reliable deliveries, places significant demands on warehouse operations and information management. This makes it a relevant context for studying how digital technologies are introduced, used, and integrated into operational practice.

The organization is currently in a phase of organizational change through broader company-wide efforts toward modernization, of which digitalization forms a central part (Magnus Andersson, personal communication, March 02, 2026, authors' translation). The case reflects several of the conditions highlighted in the background and literature, including limited operational resources, operational variability, and ongoing digitalization efforts, making it suitable for examining barriers to digitalization and how they are responded to in practice.

Within the single-case design, the study employs an embedded structure. An embedded case study involves examining multiple units of analysis within one overarching case, enabling within-case comparison while maintaining contextual depth (Säfsten & Gustavsson, 2020). In this study, the organization constitutes the overall case, while individual warehouse sites were selected as embedded units of analysis. These sites were chosen through purposive sampling

on the basis that they represent different levels of operational scale, workflow structure, and digital maturity within the same organizational context (Säfsten & Gustavsson, 2020). The presence of this variation enhances the richness of the empirical material and strengthens the suitability of the case company, enabling the study to examine how digitalization unfolds and is experienced across different operational conditions within a shared organizational context. Such an approach strengthens analytical insight without sacrificing the interpretive depth associated with single-case research (Busetto et al., 2020).

3.3.4 Unit and Level of Analysis

Given the embedded single-case design, clarification of both the unit and level of analysis is necessary. The unit of analysis is warehouse operations at the site level; it is at this level that digitalization conditions are examined and conclusions are drawn. The level of analysis is organizational and operational. While data were collected through individual interviews and observations of warehouse operations, the individuals themselves are not the subjects of analysis. They are the sources through which site-level and organizational conditions become visible. Findings therefore describe conditions shaping digitalization in warehouse operations, situated within the broader organizational context of the case company. This distinction between data source and unit of analysis is consistent with an embedded single-case logic (Yin, 2018; Säfsten & Gustavsson, 2020).

3.4 Data Collection

The following section outlines the data collection method and explains how document analysis, observations, and interviews were used to generate the empirical material.

Combining multiple data collection techniques enables the researchers to capture different dimensions of the phenomenon under study and to strengthen the overall quality of the empirical material. This approach constitutes methodological triangulation, where insights from one method can be compared with and supported by others (Säfsten & Gustavsson, 2020). Case study research in particular benefits from combining multiple sources of empirical material to enhance contextual understanding and analytical depth (Seuring, 2008).

The three methods used in this study generated different types of data and addressed the research questions from complementary perspectives. Document analysis offered contextual background and supporting information about formal organizational structures and processes. Observations provided insights into operational practices as they unfolded in real time. Interviews captured participants' experiences, interpretations, and reasoning behind what was observed. Together, these methods contributed to a more comprehensive examination of the conditions shaping digitalization in warehousing in SME contexts.

3.4.1 Document Analysis

Document analysis refers to the systematic review of written materials such as internal reports, guidelines, and other organizational documents (Busetto et al., 2020). In this study, document analysis served two distinct purposes. First, it provided the contextual and foundational

understanding of the case company and its warehouse operations required for subsequent data collection. The initial document analysis informed the purposive sampling of the warehouse sites chosen as units of analysis and guided the development of the observation protocol and the semi-structured interview guides. Second, document analysis was used as a supplementary method throughout data collections to provide contextual background and support triangulation of findings. Figure 5 illustrates how document analysis laid the foundation for the observations and semi-structured interviews.

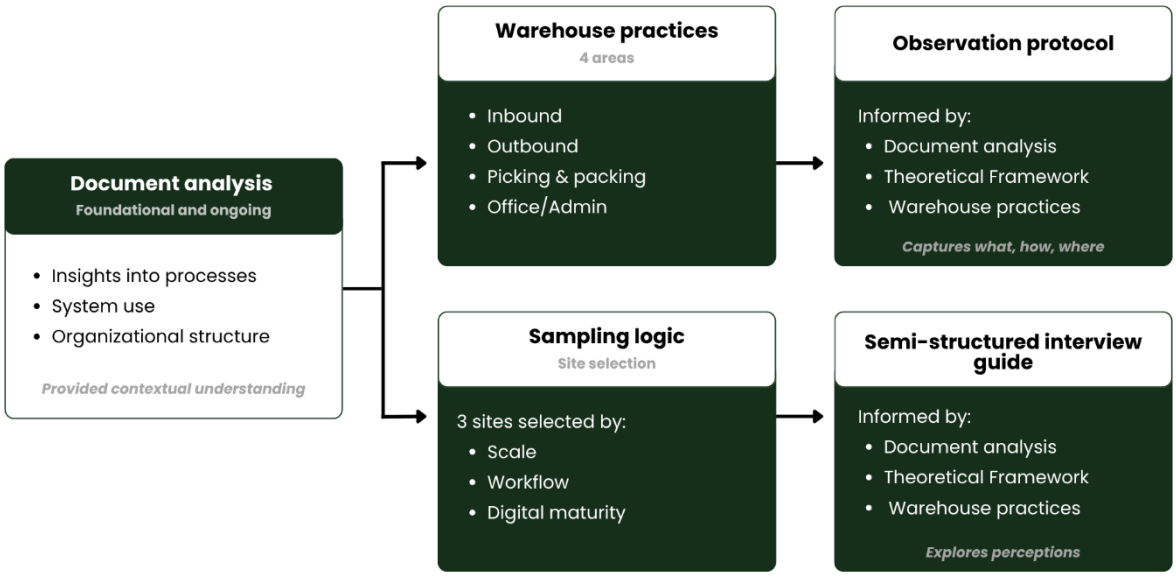

Figure 5: Document Analysis as Foundation for Data Collection Tools

Documents reviewed in this study included internal materials provided by Holm Trävaror AB, including internal reports and process descriptions. These documents were treated as secondary data, as they were originally produced for organizational rather than research purposes. Secondary data must therefore be interpreted with consideration of the perspective and context in which they were created, as they primarily reflect formal structures and organizational intent rather than capturing reality (Säfsten & Gustavsson, 2020). Due to a non-disclosure agreement with Holm Trävaror AB, the internal materials reviewed are confidential and are therefore not listed in the reference list or included as appendices.

The document analysis contributed to triangulation by enabling comparison between formal descriptions of processes, observed practices, and participants' experiences. This cross-source comparison strengthens the contextual understanding of the case and contributes to the overall robustness of the empirical material (Seuring, 2008).

3.4.2 Observations

Observations were used to gain insight into how digitalization conditions manifest in warehousing. This approach is particularly suitable when studying real-world behavior and operational settings, as observations allow researchers to examine what participants do rather

than relying solely on reported practices or perceptions (Busetto et al., 2020). In the context of warehousing, this enabled the study to capture physical flows, interactions with systems and tools, and the relationship between available digital infrastructure and actual work practices.

To capture variation within the organizational context, observations were conducted at three warehouse sites: Sävsjö, Borås, and Sala, during the weeks 13-15 of 2026. The sites were selected through purposive sampling, meaning that they were intentionally chosen based on their expected ability to provide meaningful insight into the phenomenon under study (Yin, 2018). Selecting sites with differing characteristics enabled the study to explore how conditions shaping digitalization manifest under varying operational conditions while remaining within a single organizational setting. More specifically, the chosen sites differ in warehouse operational scale, workflow structure, and level of digital maturity.

The observations were structured in accordance with four warehousing operation areas informed by the document analysis. Using these areas supported consistency and ensured all four were covered at each site. Table 2 details the specifics of all conducted observation sessions

Table 2: Overview of Observation Sessions

Site	Date	Duration	Observers	Inbound	Outbound	Picking & Packing	Office/Admin
Sävsjö	23 March 2026	~3–4 h	Both authors	✓	✓	✓	✓
Borås	30 March 2026	~2–3 h	Both authors	◦	◦	✓	✓
Sala	8 April 2026	~2–3 h	Both authors	◦	◦	✓	✓

✓ Full observation ◦ Limited observation

The observations were conducted as non-participant observations, where the researchers were present in the setting without actively engaging in operational tasks (Säfsten & Gustavsson, 2020). This approach was chosen over participant observations, with the intent of limiting disruption to ongoing workflows and to maintain an observational focus across the full range of activities. Non-participant observations allow activities to be examined as they occur in practice, minimizing influence on the observed environment (Busetto et al., 2020). Nonetheless, the presence of observers may still create a reactivity risk, where participants adjust their behavior when aware of being observed (Säfsten & Gustavsson, 2020). Furthermore, observations are limited to capturing only what is visible and cannot access participants' reasoning, interpretations, or the experiences behind what is being observed. Therefore, semi-structured interviews were a necessary complement (Busetto et al., 2020).

Both researchers were present during all observation sessions. During the observations, field notes were taken, documenting tasks, system use, and emerging themes relevant to the purpose. When multiple observers are involved, independently recorded notes can be consolidated to strengthen reliability of the interpretations (Busetto et al., 2020). Accordingly, immediately following each observation session, the researchers compared and discussed their individual notes, reflections, and preliminary interpretations. These debriefing discussions were recorded to ensure that impressions were captured while still fresh and to reduce the risk of overlooking

important details. The recordings were subsequently transcribed and reviewed using Otter AI, after which key observations were summarized. This process enabled consolidation of the observation material and supported a more structured and reliable interpretation of the empirical data.

The observations were semi-structured in character and guided by a pre-developed observation protocol. As previously described, the observation protocol was derived from the document analysis and theoretical framework. This protocol ensured consistency across sites while allowing flexibility to capture unexpected or emergent phenomena. Such flexibility is characteristic of qualitative data collection, where observations can reveal aspects of the research setting that were not initially anticipated (Busetto et al., 2020). The observation protocol is provided in Appendix 1.

3.4.3 Semi-structured Interviews

Following the observations, semi-structured interviews were conducted to capture participants' experiences, interpretations, and perceptions of digitalization within the warehousing. Interviews are commonly used in qualitative research to gain insight into experiences, perceptions, and processes that cannot be directly observed (Rowley, 2012). While observations provided insights into warehousing tasks, interviews allowed researchers to further explore how participants interpret these tasks and how they experience and respond to the conditions shaping digitalization.

Semi-structured interviews were chosen because they combine a consistent thematic structure with flexibility to explore emerging topics and adapt questions to each participant. This format typically relies on an interview guide containing predefined themes while allowing variation in question order and follow-up probing depending on participant responses (Rowley, 2012). The semi-structured format also supports deeper reflection and clarification, enabling participants to elaborate on issues that they perceive as important (Yin, 2018). At the same time, the predefined themes ensure that interviews remain focused and comparable across participants, which Timmermans and Tavory (2012) highlights as particularly valuable in case study research.

It is nonetheless acknowledged that semi-structured interviews carry methodological limitations. Participants may present practices, decisions, or attitudes more favorably than reality, a risk known as social desirability bias. This may mean that some accounts do not fully reflect everyday experience (Busetto et al., 2020). Additionally, some responses drew on participants' retrospective recollections of past events and decisions, which introduces the possibility of memory-related inaccuracies (Rowley, 2012). These limitations were partially mitigated through triangulation with observations and document analysis, which provided independent reference points against which interview accounts could be compared (Seuring, 2008).

Two semi-structured interviews were conducted at each of the three warehouse sites, resulting in a total of six interviews. Participants were selected using purposive sampling to capture perspectives from both operational and managerial roles at each warehouse site. This with the

aim to capture how conditions shaping digitalization may manifest differently across organizational levels of warehousing. As data collection progressed, core patterns became consistent, suggesting that the dataset reached a point of analytical sufficiency in relation to the research questions (Thomas, 2006).

The interview guide was structured around the theoretical framework and further informed by insights from document analysis and observations. In qualitative research, interview guides are often refined during the data collection process as the researcher gains familiarity with the field and emerging themes (Busetto et al., 2020). Accordingly, the interview guide was slightly adapted across the different sites to account for contextual differences and insights identified during the observation phase. This iterative approach allowed the interviews to remain focused while still accommodating unexpected and site-specific insights. The interview guide is provided in Appendix 2.

The interviews were conducted in person, with both researchers present, at the respective warehouse sites. For all interviews, one researcher led the interview while the other took notes and managed recordings. Interviews were recorded with informed consent and subsequently transcribed using Turboscribe, with all transcriptions reviewed manually to verify accuracy (Busetto et al., 2020). Interview details are summarized in Table 3.

Table 3: Overview of Semi-Structured Interviews

Name	Site	Role	Interview Date	Interview Time (minutes)
Fredrik	Borås	Warehouse Operator	31 March 2026	41:46
Jonas		Warehouse Manager	31 March 2026	41:03
Ronny	Sala	Warehouse Operator	08 April 2026	51:02
Sofie		Warehouse Manager	08 April 2026	47:26
Marcus	Sävsjö	Warehouse Operator	16 April 2026	58:33
Richard		Warehouse Manager	16 April 2026	52:47

To support the credibility of the empirical material, respondent validation was conducted following transcription. For each site, interview transcriptions were summarized into brief accounts, alongside a summary of the key observations conducted at that site. These site-level packages were shared with the respective participants, who were given the opportunity to review, correct, and confirm the accuracy of the summaries before the material was used in the analysis. This process ensured that the empirical material reflected participants' intended meanings and reduced the risk of misinterpretation (Lincoln & Guba, 1985).

3.5 Data Analysis

The following section outlines the analytical approach and procedure applied to examine the empirical material generated through semi-structured interviews and observations. Both datasets were analyzed in parallel using a consistent analytical process, ensuring coherence and comparability across data sources.

The empirical material was analyzed through thematic analysis, as this approach is well suited for systematically identifying, analyzing, and interpreting patterns across a qualitative dataset (Nowell et al., 2017; Braun & Clarke, 2023). It was chosen for its flexibility and its capacity to accommodate both theory-informed and data-driven reasoning, which suited the abductive analytical logic of this study as described in section 3.3.1. The analysis followed a deliberate sequence in which early coding stayed close to informant language and observed behavior, rather than being derived from theoretical categories. This reflects a coding philosophy drawn from Gioia et al.'s (2013) approach, in which first-order codes are grounded in participants' own terms before the researcher introduces interpretive abstraction.

The progression from initial codes to clusters, site-level themes, and cross-site synthesis also aligns with Miles and Huberman's (1994) view of systematic data reduction, where raw empirical material is gradually condensed into analytically manageable forms. Their emphasis on structured, matrix-based analysis further supports the spreadsheet-based approach described later in this section. Only at the final synthesis stage was the TOE framework introduced as a sensitizing lens, consistent with Thomas's (2006) general inductive approach, where research objectives guide but do not predetermine analytical categories. A consequence of this sequencing is that the final themes carry empirically derived labels rather than the construct labels of the working conceptual model. This was a deliberate choice that preserves the integrity of both the empirical findings and the theoretical framework, whose relationship is examined in the discussion.

The analysis process followed four main stages, reflecting the progressive condensation and synthesis of empirical material described by Miles and Huberman (1994).

Stage 1: The first stage involved close and repeated reading of all transcripts and observation notes to develop familiarity with the material before any coding began. Initial codes were generated directly from the empirical material, prioritizing informant language and observed behavior over theoretical categories (Gioia et al., 2013).

Stage 2: Initial codes were grouped into clusters based on shared meaning. Each cluster was accompanied by a narrative explaining the analytical reasoning behind the grouping, including explicit justification for codes that appeared across multiple clusters. This stage represents the first movement of data reduction (Miles & Huberman, 1994).

Stage 3: Clusters were synthesized into site-level themes at the individual interview and individual observation session level, capturing the most analytically significant patterns within each source before cross-site comparison was introduced. Steps 1-3 generated 322 initial codes from interview transcripts across six participants and 26 observation-derived patterns across the three sites.

Stage 4: Site-level themes were synthesized across all six interviews and three observation sessions. The TOE framework was introduced here as a sensitizing lens, reflecting the abductive turn in which emergent patterns were brought into dialogue with the theoretical framework (Timmermans & Tavory, 2012). Themes were organized across the three dimensions, rather

than being mapped onto the specific constructs of the working conceptual model, whose role is taken up in the discussion of results.

The synthesis also revealed that themes could be distinguished not only by TOE dimension but by their empirical character: some describing current conditions constraining digitalization, others capturing organizational responses, and others reflecting anticipatory accounts of forthcoming change. This emergent distinction informed how findings are presented in Chapter 4, where themes are organized to reflect these three empirical characters alongside TOE dimension. Figure 6 provides an illustrative process of the stages, showing how empirical material progressed from initial codes to final themes.

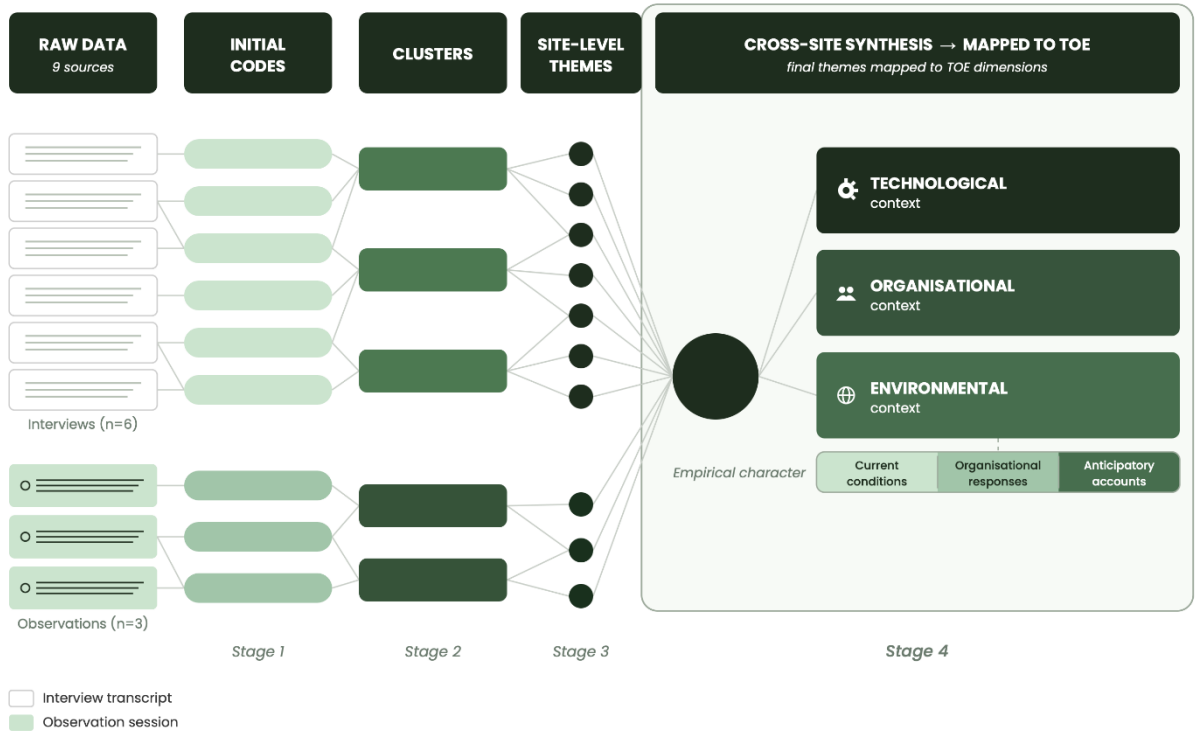

Figure 6: Analytical Stages: From Raw Data to Final Themes

The analysis was conducted using structured spreadsheets rather than dedicated software such as NVivo. This choice was deliberate and suited to the collaborative nature of the analytical process. Both researchers worked simultaneously across shared files, and all coding decisions and theme development steps were discussed and agreed upon throughout, reducing the risk of individual interpretation dominating the analysis (Nowell et al., 2017).

It is acknowledged that prior engagement with the TOE framework introduces a risk of confirmation bias (Nowell et al., 2017). This was addressed by reserving the framework for Stage 4 only, ensuring that earlier coding stages remained inductively grounded. To further support transparency, the final themes from the cross-site synthesis are presented in Chapter 4 as a comprehensive list, including their distribution across the TOE dimensions. This follows Braun and Clarke's (2023) emphasis on making analytical decisions visible to the reader.

3.6 Research Quality

The quality of qualitative research is commonly assessed using the concept of trustworthiness, which encompasses credibility, transferability, dependability, and confirmability (Lincoln & Guba, 1985; Nowell et al., 2017). These criteria provide a framework for evaluating whether the research process is transparent, systematic, and grounded in empirical material. In this study, trustworthiness was addressed through a range of methodological choices throughout data collection and analysis. Table 4 summarizes the measures implemented for each criterion, which are subsequently described below.

3.6.1 Credibility

Credibility concerns the extent to which the findings accurately represent participants' experiences and the studied phenomenon (Nowell et al., 2017). One commonly used strategy for enhancing credibility is triangulation, where multiple data sources or methods are used to examine the same phenomenon (Lincoln & Guba, 1985). In this study, credibility was strengthened through methodological triangulation, combining document analysis, observations, and semi-structured interviews. This enabled comparison between observed practices, participants' interpretations, and formal organizational descriptions, reducing reliance on a single data source (Seuring, 2008; Busetto et al., 2020).

Credibility was further supported through respondent validation, which reduced the risk of misinterpretation and ensured that the empirical material reflected participants' intended meanings (Lincoln & Guba, 1985). In addition, credibility was strengthened through iterative engagement with the empirical material, involving repeated readings of transcripts and observation notes alongside iterative coding and theme development. This prolonged and cyclical interaction with the data enabled patterns to be more robustly identified and interpretations to be continuously refined over time.

The analysis was conducted collaboratively by both authors, with coding decisions and theme development discussed throughout, reducing the risk of individual interpretation dominating the analysis (Busetto et al., 2020; Nowell et al., 2017). The use of the TOE framework provided a structured basis for interpretation, while the abductive sequencing mitigated the risk of confirmation bias by ensuring that the framework did not constrain what could emerge from the data in earlier stages, as described in section 3.5.

3.6.2 Transferability

Transferability refers to the extent to which findings may be applicable to other contexts (Lincoln & Guba, 1985). In qualitative research, transferability is not achieved through statistical generalization but through analytical generalization, demonstrating that findings are grounded in sufficient contextual and empirical depth to be relevant beyond the immediate case (Yin, 2018; Nowell et al., 2017).

In this study, transferability was supported through a thick description of the case context, including the organizational setting, warehouse operation practices, and data collection

procedures. By describing the characteristics of Holm Trävaror AB and the operational environments studied, the reader is provided with sufficient information to evaluate the applicability of findings to similar contexts. The case organization represents an SME operating within a traditional industry sector, suggesting that findings may be particularly relevant for similar organizations facing comparable digitalization conditions.

3.6.3 Dependability

Dependability concerns the consistency and transparency of the research process (Nowell et al., 2017). To enhance dependability, the methodology of this study was clearly documented, including data collection procedures, sampling strategy, and analytical approach. Thorough documentation created an audit trail that allows the research process to be reviewed and assessed by others.

Consistency in data collection was supported using observation protocols and interview guides, providing a common structure across sites while allowing flexibility to capture context-specific insights (Busetto et al., 2020). During analysis, the four-stage coding procedure was followed consistently across all interview and observation datasets, with coding decisions discussed between the authors and documented throughout the process (Nowell et al., 2017).

3.6.4 Confirmability

Confirmability refers to the extent to which findings are grounded in the empirical material rather than shaped by researcher bias (Lincoln & Guba, 1985). This was addressed through several measures. The use of multiple data sources allowed interpretations to be compared across documents, observations, and interviews. The abductive analytical approach ensured that findings were both systematically connected to theory and grounded in the empirical material, with initial coding conducted inductively and the TOE framework introduced only at the synthesis stage (Timmermans & Tavory, 2012). Collaborative analysis further supported confirmability, as coding decisions and interpretations were discussed between both authors throughout the process, reducing the risk of individual bias influencing the results (Nowell et al., 2017).

Additionally, reflexivity was maintained throughout the analysis, with the authors acknowledging their positionality as students conducting research within the host organization. Recognizing this relationship supported critical reflection on how researcher perspectives may influence interpretation (Lincoln & Guba, 1985).

Table 4: Trustworthiness Criteria and Implemented Quality-Enhancing Measures

Criteria	Quality-enhancing measures implemented	References
Credibility	Methodological triangulation through document analysis, observations, and semi-structured interviews. Respondent validation through site-level summary packages confirmed by participants. Collaborative coding and theme development. Abductive sequencing mitigating confirmation bias risk from TOE framework.	Lincoln & Guba (1985); Nowell et al. (2017); Busetto et al. (2020); Seuring (2008)
Transferability	Thick description of case context, organizational setting, and data collection procedure. Detailed presentation of empirical context enabling reader assessment of applicability	Lincoln & Guba (1985); Nowell et al. (2017); Yin (2018)
Dependability	Clearly documented methodology creating an audit trail. Observation protocols and semi-structured interview guides ensuring consistency across sites. Four-stage coding procedure applied consistently across all datasets with documented analytical decisions.	Nowell et al. (2017); Busetto et al. (2020); Säfsten & Gustavsson (2020)
Confirmability	Abductive analytical approach combining inductive initial coding with theory-informed synthesis. Collaborative analysis reducing individual bias. Reflexivity regarding researcher positionality within the host organization. Multiple data sources supporting cross-source interpretation.	Lincoln & Guba (1985); Nowell et al. (2017); Timmermans & Tavory (2012)

3.7 Use of AI

The Use of AI tools in this thesis complies with the academic integrity policies of Jönköping University. The final content and analysis are of the authors' own creation.

Artificial intelligence tools were used in supporting capacity during the development and writing of this thesis. Specifically, Claude (Anthropic, 2026) and ChatGPT (OpenAI, 2026), were used to assist with language editing, improving sentence structure, clarity, and academic tone and flow. These tools were also used to support structuring sections of the methodology and identifying and evaluating potentially relevant literature.

AI tools were additionally used during parts of the thematic analysis process. Specifically, AI was used to review the consistency of code labels and provide feedback on the clarity of theme definitions. All decisions regarding which codes to include, how clusters were formed, which themes to develop, and how findings were interpreted were made by the authors. AI-generated suggestions were critically evaluated before any incorporation, and the authors retain full responsibility for all analytical decisions and interpretations.

No sensitive, confidential, or proprietary data from Holm Trävaror AB were entered into any AI system. All theoretical framing, data collection, analysis, and conclusions were produced by the authors, who remain fully responsible for the content and academic integrity of this thesis.

3.8 Ethical Considerations

The study was conducted in accordance with the academic integrity policies of Jönköping University and the ethical principles governing qualitative research, including informed

consent, voluntary participation, right to privacy, and honest handling of data (Lincoln & Guba, 1985).

Prior to data collection, all employees at Holm Trävaror AB were informed about the study through a company-wide distributed email, clearly stating the academic purpose of the research, how data would be used, and who would have access to it. Participants selected for interviews received an additional brief containing a simplified version of the interview guide in advance to ensure that they were fully informed about the objectives and scope of the research before agreeing to take part. Before each interview, explicit consent was obtained for recording, and all participants consented to being identified by first name and role within the thesis. Observation sessions were conducted with the knowledge and agreement of site management and operational staff present at each site. The research process caused no harm to any participant.

The researchers conducted this study within a host organization, which is acknowledged as a potential source of conflict of interest. To mitigate this, participation was kept voluntary (Busetto et al., 2020), no data was collected without explicit consent, and the relationship is disclosed transparently here (Lincoln & Guba, 1985). All data were used solely for academic purposes and handled with integrity throughout, including honest treatment of unexpected or contradictory findings without selective omission or fabrication. Due to a non-disclosure agreement with Holm Trävaror AB, internal documents are treated as confidential and excluded from the reference list, as noted in section 3.4.1. No proprietary data was entered into any external system or AI tool.

4 Results

This chapter presents the empirical findings of the study. It begins with the empirical context, providing an account of the case company, its site structure, and the digital systems in use at the time of the study. Following this, the chapter presents the findings generated through interview and observation data collected across three sites: Sävsjö, Borås, and Sala.

4.1 Empirical Context

Holm Trävaror AB is a Swedish SME specializing in the import and distribution of wood and wood-based materials. Founded in 1927 and headquartered in Sävsjö, the company has grown into a national distributor serving customers across manufacturing industries, construction businesses, and the education sector. Operations are distributed across five warehouse sites, Sävsjö, Sala, Borås, Stockholm, and Skellefteå, together comprising approximately 30,000 to 35,000 square meters of storage space and a product range of over 70 wood species alongside processed and finished materials.

The company's ERP at the time of the study is Visma Business, a cloud-based platform originally oriented toward accounting and financial management (Visma, n.d.), which has been incrementally adapted over time to support operational functions beyond its original scope. Approximately two years prior to this study, Qpick, a barcode-based mobile warehouse management application integrating directly with Visma Business (Qsys, n.d.), was introduced at Sävsjö as a pilot and subsequently extended to Sala. At the time of the study, the company was in an active transition from Visma Business to Monitor ERP (Monitor ERP, n.d.), with full implementation planned for September 2026. This transition is company-wide in scope, spanning sales, purchasing, supply management, and warehouse operations, and represents the broader organizational change.

The five sites differ in customer segment, product assortment, operational scale, and level of digital maturity, as summarized in Table 5.

Table 5: Overview of warehouse sites by customer segment, product focus, and digital maturity

Site	Customer segment	Product focus	Digital maturity
Sävsjö	Industrial, mixed	Massive wood, mouldings, adhesives, some construction materials	Hybrid
Sala	Construction and education	Building materials, school-related wood products	Full digital
Borås	Marine and industrial	Massive wood, marine materials	Manual
Stockholm	Industrial	Massive wood	Manual
Skellefteå	Industrial	Massive wood	Manual

Note. Fully digital: all picking processes supported by digital tools without paper documentation on the warehouse floor. Hybrid: digital picking tools in use alongside paper-based processes. Manual: picking and handling conducted through paper-based processes without digital tool support on the warehouse floor.

The three sites included in this study represent each of the three maturity tiers. Across all three, inbound deliveries arrive without advance notice from suppliers, and inbound quality control is conducted on paper forms subsequently scanned and forwarded to the purchasing function.

Sala is the most digitally developed of the three studied sites. Picking is conducted entirely through Qpick on handheld devices, and stock balances update automatically when an order is confirmed. Warehouse operators carry out picking operations under the coordination of a warehouse manager who also oversees inbound processes and system configuration.

Sävsjö is the company's main operational site and handles the broadest product assortment of the three. Qpick is in use, but paper-based processes continue to operate in parallel across all operational areas. The warehouse manager's role extends well beyond floor coordination to include system administration, freight documentation, cross-site supply coordination, and order preparation.

Borås is the smallest of the three studied sites, with a total site workforce of four. No digital picking tools are in use on the warehouse floor. Picking is conducted from printed paper order sheets, product placement is based on informal agreement between the two warehouse operators, and all system entry is handled by a single administrative colleague.

4.2 Empirical Results

The findings presented in this section draw on interview and observation data collected across Sävsjö, Borås, and Sala. The thematic analysis resulted in 24 themes. These are organized into three parts.

Part 1 presents the conditions identified as constraining or complicating digitalization in warehousing. These are structured and presented across three TOE dimensions. Part 1 directly addresses RQ1. Parts 2 and 3, address RQ2. Part 2 presents the workarounds, adaptations, and organizational decisions made in response to the conditions described in Part 1. Part 3 presents participants' reflective and anticipatory accounts of the forthcoming Monitor transition and past system implementations. This material is empirically distinct from Parts 1 and 2, concerning not current practice but how participants interpret their situation and its trajectory. All themes for Part 2 and 3 concern organizational conditions; this pattern is reported as a finding. The dynamic between the three parts is shown in Figure 7.

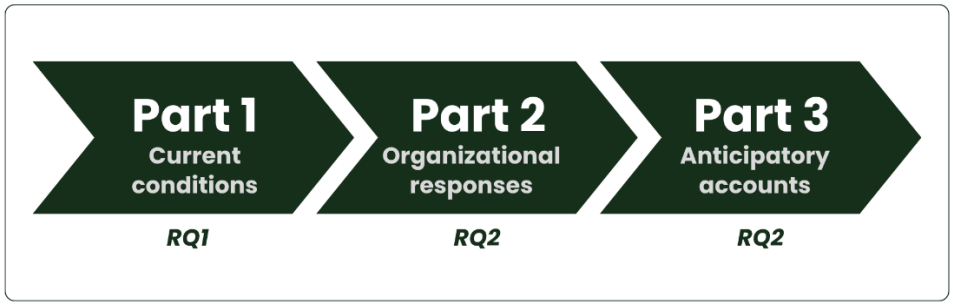

Figure 7: Three-part presentation of Empirical Results

4.2.1 Part 1: Current Conditions

The conditions described in this section are presented as the operational reality within which digitalization is currently unfolding.

4.2.1.1 Technological Dimension

The technological conditions concern the fit between digital tools and the operational reality they were introduced to support, the reliability of the data those tools hold, and the gap between what current systems can in principle deliver and what they actually provide.

System misfit

A structural mismatch between the design logic of the systems in use and the operational demand of the warehouse is present across all three sites. This operates through two related problems. Information required during picking is fragmented across system modules that do not communicate with each other consistently. Furthermore, the systems' underlying logic does not accommodate the variability that characterizes wood products operations: variable product dimensions, multi-group order completion, and dynamic storage patterns. When workers need information held across those modules during picking, they must leave the warehouse floor to retrieve it through other channels.

These discrepancies between systems are identified and resolved by individuals rather than being surfaced automatically. Sofie describes her experience of responding to these inconsistencies directly:

"It's a bit of a hit and a miss, especially when the systems don't always line up with Q-Pick. One thing might show in Visma, something else in Q-Pick. And the system isn't always easy to understand when something has gone wrong." — Sofie

Beyond inter-system discrepancy, the system's location logic assumes fixed, stable product placement. In practice, everyday adjustments (batch substitutions, article changes, partial picks) cannot be handled within the picking workflow and require manual intervention outside it. Sofie summarizes the overall assessment:

"Having a system like this is good. But I don't think the system we have now is suited for the operations we run." — Sofie

Data trust erosion

A related but distinct condition concerns not what information is missing from the system, but the reliability of information that is present. Accumulated entry errors, and master data that has drifted from operational reality (parameter drift), over time, have reached a point where workers do not treat system data as a sufficient basis for operational decisions, even when that data technically exists. Manual verification persists not as habit but as a rational response to the risk of acting on figures that may be wrong. At Sävsjö, weight data is available in the system, but physical verification is maintained regardless. Richard describes the reasoning:

"Yes, we do weigh them. It's simply something we have continued doing, because we haven't fully trusted the system. The system may indicate that a truck is carrying 38 tons, and that is probably roughly correct, but we may still choose not to rely on it completely. In the end, we are still legally responsible through the freight documents." — Richard

A related expression of the same condition is visible in how unsellable stock is managed. A dedicated warehouse routine has been established to hold damaged or unsellable goods, with physical and system records kept in parallel. This is because the system carries no logic that prevents such items from appearing as available to the sales department unless a specific location is manually checked.

Unrealized system potential

A distinct condition concerns not what the systems do poorly, but what they are capable of delivering and have not been configured to provide. Across the sites, known improvements exist, for example features that could be activated and configurations that could be changed, that have not been implemented. This gap takes different forms: functionality the system cannot support in the required way, features active at one site but not another, and development that stalled before a planned phase was delivered. At Sävsjö, further Qpick development was deliberately frozen in anticipation of the Monitor transition, leaving identified gaps unaddressed. Richard describes one such gap:

"Rolling inventory is not supported. We wanted to be able to do inventory continuously, but the system could not support it in the way we needed. We could not block product groups in the right way, and at first, it was not possible to set a date for when an item had been counted." — Richard

Order prioritization illustrates a different expression of the same gap: the feature exists and is active within Qpick at Sala, but has not been configured at Sävsjö, where the printed order paper rather than the digital queue remains the operative picking trigger. At Sala, Ronny describes the broader pattern of stalled development:

"They came here and looked at how we worked, and it sounded like the system would become something much bigger. Eventually, we were supposed to be able to handle booking through it as well. But it died out pretty quickly, the development of the system as a whole, they never put in phase two, basically." — Ronny

Digital tools absent from the warehouse floor

At Borås, the deployment gap takes its most complete form: no digital tools have reached the point of work. All warehouse transactions are recorded on paper and entered into the system afterward by a single administrative colleague. The digital record therefore reflects completed work rather than current activity, creating a structural lag between physical reality and system state. System competence, as a result, is informally concentrated in one role, while floor workers engage with the system infrequently enough that their fluency does not develop. Fredrik describes this:

"It goes much faster when she [Anna-Lena] does it, maybe a minute, or even ten seconds, whereas if Jonas or I sit there trying to sort it out, it can take a long time. She works in the system all the time, while I do not use the computer as much, so I forget things between times." — Fredrik

Partial digitalization creating new failure modes

Where digital tools have been extended beyond the scope of their original implementation, new operational problems have emerged that were not present under paper-based processes. These take two forms: interface limitations that appear only when order complexity exceeds what the system was configured to handle, and information routing failures that emerge when the system is used across functions with different entry practices. At Sala, high-complexity orders expose an interface limitation that simpler order types do not:

"The school department [specific assortment group] has a big problem with the handheld devices, because you cannot see the whole order at once. If an order has twenty lines, you have to scroll through two or three pages, so you lose the overview. It would be better if items in the same category appeared after each other, because they are physically located next to each other." — Ronny

The second new failure mode concerns information field routing. Notes entered by sales department in the main order field in Visma do not appear on the handheld device; only information placed in the correct Qpick-specific field reaches the picker. This distinction is not documented anywhere, meaning the failure is discovered only when it produces an error at the point of work. Sofie describes it:

"You have to be careful to put it [essential order or article information] in the right place so it comes up for the people picking. And these are small manual things that just have to be known. It's not written down anywhere." — Sofie

This was observed directly during the site visit at Sala, where a picking error occurred because a required plank length had been entered in a field that did not appear on the handheld device and was not discovered until the freight document stage.

Material and physical ceilings

Some aspects of warehouse work are determined by the physical properties of the product and the physical space, independent of which digital tools are in use or how they are configured. Two such ceilings are visible across the sites: the variability of solid wood dimensions, which makes volume only knowable at the moment of physical measurement, and the geometry of the warehouse space. Jonas describes why the first ceiling limits what digital picking logic can achieve:

"With massive wood [specific assortment group], I can pick three boards, and the volume can differ depending on whether they are 125 or 140 millimeters wide. So, I have to measure them, write it down on paper, calculate the volume, subtract it from the original bundle, and create a new bundle label." — Jonas

At Sävsjö, the building geometry and dimensions of the primary product range create unavoidable congestion. Marcus describes a specific instance:

"The wood products take up a lot of space. Sometimes, to access one package, you have to move incoming goods, outgoing goods, and several other packages first. Yesterday, I spent about thirty minutes moving things just to get access to ten planks, and then another thirty minutes putting everything back. That is an hour spent on unnecessary work." — Marcus

Missing planning functionality

The systems in use record decisions once made. No alerts exist for incoming orders, no labor estimates are available per order line, and no capacity ceiling is visible to upstream departments placing demand on the warehouse. Planning decisions therefore depend entirely on individuals reviewing order information manually. Richard identifies a specific gap that creates recurring double-handling as a direct result:

"One thing that takes a lot of time is that we cannot get a proper list of today's orders showing how many of each article we need to pick. If several customers need the same item, we could bring that material forward once and then split it between the orders. As it is now, we may bring material out for one order, put it back, and then have to bring it out again for the next customer." — Richard

4.2.1.2 Organizational Dimension

The organizational themes concern the conditions within the organization that shape how digitalization unfolds: how work is structured, how knowledge and responsibility are distributed, and how information moves through and between departments.

The coherent manual system

At Borås and Sävsjö, paper-based practices have not been displaced by digital tools, which were introduced alongside existing manual workflows rather than in place of them. Consequently, the manual system has continued to deliver adequate operational outcomes by its own logic. Jonas describes the properties of physical documentation that sustain this logic at Borås:

"I still maintain that a binder and paper works best. If the system goes down, you can't get anywhere. But if you have a binder with papers in it you can always find what you need. And if there's a complaint, you can always go back and look at the physical incoming inspection sheet." — Jonas

At Sävsjö, despite Qpick being in active use, the printed order paper remains the operative trigger for picking and the coordination mechanism for multi-group orders. The digital system is visible but not acted upon unless the paper signal is present. Marcus identifies the organizational logic sustaining this:

"Before it's been: how can we make the system fit how we work. Instead of seeing how the system wants us to work." — Marcus

Workarounds becoming permanent

Across the sites, adaptations developed in response to immediate system gaps have become normalized practice, treated as part of how work is done rather than as temporary fixes to be revisited. Because these adaptations allow work to continue, there is no operational pressure to address the underlying problem they compensate for, and the gap the workaround covers remains in place. Marcus describes the pattern directly:

"What tends to happen is that when we find a problem, we fix it for right now, not for how things should work going forward. And then we just keep working the way we put out that fire. These small quick fixes become our routine. And in my view, that is just time-wasting." — Marcus

A concrete expression of this at Sävsjö: Marcus has reorganized his section of the warehouse using color coding and physical separation, creating a location system of his own. It is locally effective and routinely used but exists nowhere outside his own knowledge and cannot be maintained or replicated if he is absent.

Structural overload blocking improvement

Recognized improvements consistently fail to materialize not because no one sees the need, but because the organizational structure provides no capacity for non-urgent work. This operates through two related conditions: a concentration of responsibility in a single management role that has already absorbed all available slack, and an arrangement in which decisions that generate work for the warehouse are made by upstream functions that do not carry the operational cost.

At Sävsjö, both conditions are visible in Richard's role. Beyond formal warehouse management, it extends to system mediation, cross-site coordination, and upstream error correction. A logistics coordinator role created to relieve this was abandoned as unsustainable. Richard identifies its absence as an active problem:

"In general, I think a lot of things could have been caught at an earlier stage. I genuinely believe that would have helped a great deal." — Richard

The consequence for improvement work is that capacity simply does not exist for anything non-urgent. Marcus describes improvement ideas raised from the warehouse floor that are received but not acted on:

"He has too much responsibility as warehouse manager to make things run well and smoothly for the team. He's really capable at that. But he has too much to do to put energy into the things that would benefit us going forward." — Marcus

At Sala, the same structural outcome developed through a different mechanism. Reduction of the workforce, without a corresponding reduction in operational scope led to freight booking being redistributed across all floor workers. Ronny describes this as interrupting the picking flow and lowering the daily tempo, a normalized inefficiency that has never been redesigned.

Operations held together by individuals

Across sites, critical knowledge and task responsibility are concentrated in specific individuals. The operational consequence is the same at all sites: the workflow depends not only on digital tools being present, but on particular people being present to interpret, correct, and coordinate in ways the system does not handle autonomously. At Borås, the entire bridge between floor activity and the digital record runs through a single administrative colleague. Fredrik describes both the dependency and its structural consequence for the forthcoming system transition:

"With Visma, Anna-Lena is the expert, it's good that she's in the building, because you can just go to her and ask how to do something and she either shows you or sorts it herself. But when the new system comes, she won't know it any better than I do. Who do you call then?" — Fredrik

At Sävsjö, administrative coordination decisions all pass through Richard's role. At Sala, the digital picking workflow requires Sofie to assign priority codes before workers receive orders on their handheld devices, a step that cannot be completed by anyone else in her absence.

Knowledge that never travels

Knowledge available within the organization, across sites, and on the warehouse floor, does not reach the levels of or people positioned to act on it. Two channels through which this gap operates are visible: knowledge held by floor workers that does not reach the decisions shaping how their practices are configured, and knowledge that exists at one site but not others. For example, Jonas at Borås is aware that Sävsjö uses handheld scanners, but his contact with Sävsjö is limited to logistics coordination. Marcus at Sävsjö holds operational benchmarks drawn from prior experience at a large logistics organization, but this knowledge has not been drawn on in either the Qpick or Monitor implementation processes.

Where improvement ideas do reach the site manager, the chain from warehouse floor to upstream departments (where picking efficiency is directly affected by how sales department structures orders) is described as broken. Ronny describes what happens to feedback sent in that direction:

"I think if I'm going to be completely honest, I don't think it's been raised at all. I think you may as well talk to a stone lying outside." — Ronny

Broken information chains

The reliability of the digital record at warehouse level depends on data entered correctly by upstream departments who do not experience the downstream consequences of entering it incorrectly. When data is missing, incomplete, or placed in the wrong system field, the warehouse absorbs the correction work, manually. At Sala, the most consistently recurring failure concerns incomplete purchase order data. Purchasing department is responsible for entering orders before delivery arrives, but gaps in that entry prevent warehouse staff from processing inbound goods in the system. Sofie describes what is required when this has not been done:

"They get a delivery note before the goods arrive to us. That's when they should prepare the purchase order so that we can simply go into Q-pick or the computer and release it. And therefore it needs to be entered before we receive the goods." — Sofie

When preparation is incomplete, Sofie must manually retrieve article numbers, enter them into Qpick, assign package numbers, and specify quantities before labelling can begin. A second failure mode concerns how data entered in the main order field in Visma does not reach the picker's handheld device, a distinction that is not documented anywhere. Across both failure modes, the people entering the data are not the people who experience the consequences of entering it incorrectly.

Implementation designed without the warehouse

Workers across sites describe having had no involvement in implementation decisions. The pattern is not described as deliberate exclusion but as a structural one: implementation decisions are made by those with authority over the process, and the warehouse is positioned as a recipient rather than a contributor.

At Sävsjö, Marcus describes the people currently deciding how Monitor will be configured as those most familiar with “old” practices and argues that this determines what gets carried into the new system rather than what gets changed by it. At Sala, Sofie notes that the one person from the site included in the Monitor project has since resigned, and no one has been asked to step in.

4.2.1.3 Environmental Dimension

The environmental conditions concern factors originating outside the warehouse and outside the organization’s direct control.

Commercial model limiting planning

The commercial model operates on same-day order acceptance for same-day delivery, meaning orders are committed to before the warehouse has visibility. This compresses the planning horizon as the warehouse must remain permanently open to demand it cannot yet see. Orders continue to arrive until 10:00 and are still expected to ship that afternoon. Richard describes the situation:

"Ideally, when we start at 06:30, we would already know exactly what we have to work with that day. That would make planning much easier. But sales wants to be able to promise late ordering, because that is what competitors offer." — Richard

Logistics partner obligations

A second environmental barrier concerns requirements imposed by third-party logistics carriers that current systems cannot satisfy through digital means. Unlike the barriers described elsewhere in this section, these manual steps persist not because of internal configuration choices or resource constraints but because external carrier requirements make them unavoidable within current arrangements. At Sävsjö, besides risk management (as previously

presented), physical weight verification is maintained as a result of the freight agreement in place. Richard describes the arrangement:

> *"Our agreement with X is based on weight, not loading meters. Because our goods are stackable, they can place other freight on top, which reduces our costs. That means X wants the weight to be as precise as possible." — Richard*

At all sites, workers manually measure package dimensions and enter these into carrier booking portals, a step required by the carrier system itself. At Sala, this constitutes the last remaining paper-mediated step in an otherwise fully digital order cycle.

Table 6: Summary of Current Conditions

Part / Dim.		Theme	Key empirical points
Current Conditions	Technological	**System misfit**	• Systems not built for wood product variability. • Information fragmented across modules, not accessible from the handheld device. • Discrepancies resolved by individuals rather than surfaced automatically.
		Data trust erosion	• Accumulated errors mean data is not treated as a trusted basis for operational decisions. • Manual verification maintained as rational risk management, not habit.
		Unrealized system potential	• Known improvements not configured, partly due to anticipated ERP transition. • Active features differ across sites. • Gap between what systems can deliver in principle and what they actually provide.
		Digital tools absent from the floor	• System competence concentrated in one role. • Digital record reflects completed work, not current activity, structural lag between physical reality and system state.
		Partial digitalization creating new failures	• Extending digital tools beyond original scope introduces new failures. • High-complexity orders expose system limitations (no overview on handheld device). • Information in the wrong field is invisible at the point of work; discovered only when an error occurs.
		Material and physical ceilings	• Variable solid wood dimensions limits picking logic. • Warehouse geometry creates unavoidable handling constraints.
		Missing planning functionality	• Systems record decisions once made. • No order summary, labor estimates, or capacity ceiling visible to upstream departments placing demand on the warehouse. • Planning is entirely person-dependent and intangible.
	Organizational	**The coherent manual system**	• Digital tools layered on top of existing workflows rather than replacing them. • Paper-based practices persist as they continue to deliver adequate operational outcomes.
		Workarounds becoming permanent	• Immediate fixes to system gaps become normalized routine rather than temporary fixes. • No operational pressure to revisit workarounds once work can continue.
		Structural overload blocking improvement	• Recognised improvements consistently fail to materialise. • Warehouse bares operational costs of decisions made by upstream departments. • Reduction in workforce prompting task redistribution.
		Operations held together by individuals	• Critical knowledge and task responsibility concentrated in specific individuals. • Digital workflows contingent on individual availability and judgment rather than autonomous system function.
		Knowledge that never travels	• Visible differences in digital maturity. • Floor-level improvement ideas raised but do not reach decision-makers.
		Broken information chains	• Digital record reliability depends on data entered correctly by upstream departments. • Information in the wrong system field is invisible at the point of work.
		Implementation designed without the warehouse	• Warehouse operators excluded from implementation decisions. • Implementation defaults to replicating current practice, encoding existing misfit into incoming systems.
	Environmental	**Commercial model limiting planning**	• Same-day order acceptance compresses the planning horizon. • Inbound deliveries arrive without advance notice across all three sites.
		Logistics partner obligations	• Manual steps persist as direct obligations imposed by third-party carriers. • Physical weight verification and package dimension entry required by carrier systems.

4.2.2 Part 2: Organizational Responses

The responses described in this section concern the specific practices, decisions, and organizational arrangements through which participants responded to the conditions described in Part 1.

Governance as the determining condition for embedding

At Sala, the introduction of Qpick was managed differently from how digital tools were introduced at the other two sites. Ronny describes his initial response and what followed:

"It was not very positive everywhere. I was not positive about it myself. [...] We started from the first day without paper. That was what we were told: we have brought in this system so that you should not need paper anymore. And we were nervous about it too, because it felt safe to have that sheet to look at. But it went fine. It only took a day or so before you could manage it. Because what we do in the system is not that complicated." — Ronny

At Borås and Sävsjö, paper remained available throughout implementation, and workers continued to use it. Marcus describes how this played out at Sävsjö and how he expects similar decision structure to be repeated:

"Right now it is very much the case that the people involved in implementing the new system, and deciding how we should work with it, are people who have been here a very long time. What they know is how we currently work. I think those people need to set that aside entirely, stop looking at how we work now, and instead ask: what would actually work well here?" — Marcus

Fredrik identifies a different dimension of governance, not pre-implementation involvement, but what is needed at the point of go-live:

"Whoever is running this, they need to actually come here once the system is implemented. Not just show up, say this is how it works, and go home, but really make sure that everyone who needs to understand it actually does." — Fredrik

Worker knowledge of operational requirements

Workers hold specific knowledge of their operational conditions and of what the digital tools in use do and do not handle well. How this knowledge connects to practice differs between sites. At Sala, it has reached the decisions shaping how operations are organized. At Borås and Sävsjö, no comparable mechanism is described. At Sävsjö, Marcus holds operational benchmarks drawn from prior experience at a large logistics organization:

"At my previous company you just pressed next order on the handheld. An order would come up and it told you: pick this many from that location, this many from this one. It was completely straightforward." — Marcus

He also describes what single-click article history and automated freight booking triggered by order release looked like in practice. Marcus reports that this knowledge was not drawn on for either the Qpick or Monitor implementation processes.

At Sala, Sofie describes a different relationship between worker knowledge and operational decisions. Sofie identifies changes to picking priority sequencing, inbound labelling, and the distribution of freight booking responsibility across the team as responses to worker input. Ronny's acknowledgement of improvement under Sofie is direct:

"It has become so much better now that we have Sofie as manager, there is no comparison." — Ronny

Resilience through distributed responsibility

Where task responsibility is concentrated in a single person, that person's absence creates an operational gap that no one else is equipped to fill. A deliberate response to this pattern is visible at Sala: specific digital task responsibilities have been redistributed across the team with the explicit aim of reducing single-person dependency. Sofie describes the reasoning behind the redistribution of freight booking:

"Part of it is that they book the freight themselves now. That was introduced because before there was only one person who knew how, and if that person was away, it was very vulnerable. For us, it has worked really well that they all do it themselves, partly because they become more involved, and partly because everyone can manage it. You are not stuck when someone is away." — Sofie

Ronny describes freight booking as an interruption to picking flow that reduces the daily tempo, an acknowledged trade-off against the resilience the distribution provides. At Borås and Sävsjö, no comparable redistribution has occurred. Marcus describes the same principle applied to improvement capacity, a time-bounded role with limited capacity for non-urgent work:

"I think we would need someone else on the warehouse floor so that there is actually time to improve things. If we could bring one person in for two years, dedicated to compressing and improving how things work, that person might not even be needed after that, because by then things would run much more smoothly." — Marcus

Table 7: Summary of Organizational Responses

Part / Dim.	Theme	Key empirical points
Organizational Responses	**Governance as the determining condition for embedding**	• Where paper remained available at go-live, digital tools did not advance beyond initial deployment. • Implementation governance determined the outcome.
	Worker knowledge as an operational resource	• Workers hold specific, experience-grounded knowledge of what effective digital tools would require. • At Sala, floor-level input has produced structural operational responses under current management. • At Borås and Sävsjö, comparable knowledge exists but has not reached the decisions shaping practice.
	Resilience through distributed responsibility	• At Sala, freight booking is redistributed to reduce single-person dependency. • Redistribution trades picking-flow efficiency for operational continuity. • No comparable redistribution at Borås or Sävsjö; single-person dependencies remain in place.

4.2.3 Part 3: Anticipatory Accounts

This section presents participant accounts of the forthcoming Monitor transition and system implementations. Participants describe what they expect, what they anticipate repeating, and what they would want to be different. All six participants addressed the forthcoming Monitor transition directly.

Caution drawn from operational experience

Workers express concern regarding not the technology itself, but the transition window: the period during which person-dependent operational knowledge is disrupted before new system competence forms. Richard approaches the Monitor transition with caution grounded in direct experience of previous system changes.

"A challenge. Part of it is simply getting a system that works as well as what we have today, just reaching that level of competence with the new one. We have switched ERP systems several times. I know how much time and effort it takes for everyone." — Richard

The current concentration of operational knowledge in individuals is pointed out as what makes this window particularly demanding. Richard also has specific expectations of improvement (rolling inventory management and freight booking) alongside recognition of the effort the transition will require.

Skepticism about implementation governance repeating

Further concerns regard how the implementation will be managed. Marcus was present for the Qpick implementation at Sävsjö:

"That makes me worried that they will do the same thing again with the new system, adapting it to old way of working instead of actually improving how they work." — Marcus

Marcus describes the Qpick implementation as one in which the system was configured around existing working practices. He acknowledges that Qpick brought some improvement (location-guided picking is now in use where it was not before) but frames this as partial. He identifies two things that would need to be different: involvement of people outside the current implementation team, and a willingness to let the system's logic shape working practice rather than the reverse. He also describes a concern about operational complexity: if Monitor proves as difficult to navigate as the current multi-step process in Visma, he sees no point in the change.

Conditional openness to change

Overall, workers express a pragmatic approach towards the coming Monitor transition. Jonas, who arrived at Borås during a period of ongoing organizational change, describes that the system needs to demonstrably do what the current manual process does before he is comfortable committing to it.

"These are the kinds of questions where, if you want an honest answer, you have to give it a chance and work with it for a while. There have been plenty of times when you've been a bit resistant and then looked back and realized you don't want to go back. You have to be humble

and at least give things a chance. As long as someone shows us how — I think you just have to try." — Jonas

Participants report having received only general information about Monitor: that a new system will be introduced, but are uncertain about what the final solution will look like in practice.

Concern about the loss of informal system knowledge

Participants express further concern about the Monitor transition, not about learning the new system itself, but rather regarding the informal knowledge structure that currently makes Visma functional, and that will not transfer when the system changes. Fredrik explains:

"With Visma, Anna-Lena is the expert, it's good that she's in the building, because you can just go to her and ask how to do something and she either shows you or sorts it herself. But when the new system comes, she won't know it any better than I do. Who do you call then?" — Fredrik

Fredrik's concern is specifically about the period after Monitor replaces Visma, before anyone at Borås has built comparable system familiarity. He does not express doubt about his own ability to learn the new system.

Nervousness about exclusion and the absence of site representation

Sofie's concern about the Monitor transition is about what it will mean for Sala specifically, and whether Sala's operational conditions will be adequately accounted for in how the system is configured.

"People are somewhat nervous about what the new system will mean for them if they are not allowed to participate." — Sofie

Sofie describes concern that Monitor may be configured around Sävsjö's conditions without sufficient account of Sala's assortment. She describes both herself and the warehouse staff as open to the change, but clear about what they need: demonstration in their actual operational context. Ronny describes his orientation through the lens of the Qpick transition (full commitment from day one as the model for how change should work) and applies it cautiously to Monitor:

"I generally tend to worry about things like this. But even though the current system felt difficult in the beginning, it turned out to be an improvement once I learned it. I therefore hope the new system will be an additional step forward." — Ronny

Table 8: Summary of Anticipatory Accounts

Part / Dim.	Theme	Key empirical points
Anticipatory Accounts	**Caution drawn from operational experience**	• Concern regarding transition window. • Current concentration of operational knowledge in individuals makes this window particularly demanding. • Specific improvement expectations held alongside recognition of transition effort.
	Skepticism about implementation governance repeating	• Monitor implementation decided by those most familiar with current practice, risk of encoding existing misfit. • Qpick framed as partial improvement: system adapted to existing work, not work reshaped by the system. • Floor worker involvement and logic-led configuration identified as what needs to be different.
	Conditional ope nness to change	• Pragmatic orientation: new system must demonstrably do what current process does before commitment. • Only general information received about Monitor; final solution in practice remains unclear. • Willingness to engage is conditional on adequate demonstration and on-site support at go-live.
	Concern about the loss of informal system knowledge	• Concern is not about learning the new system, it is about the informal knowledge structure that makes the current system functional. • No clear answer to who fills that role in the transition period before comparable familiarity builds.
	Nervousness about exclusion and absent site representation	• Concern that Monitor will be configured around Sävsjö's conditions without accounting for other sites' assortments. • Staff open to change, but clear that demonstration in their actual operational context is required.

5 Discussion

This chapter discusses the findings presented in Chapter 4 by interpreting them through the Working Conceptual Model presented in Chapter 2, addressing the study's purpose and the two research questions. The chapter begins by presenting discussion of findings, addressing the study's purpose, RQ1, and RQ2 in turn. Next, it discusses research- and practical implications and reflects on the methodological choices of the study.

5.1 Discussion of Findings

The discussion of findings is structured to address the study's purpose and both research questions individually. Following a brief statement of how the purpose was fulfilled, findings are interpreted through the three dimensions of the TOE framework: first to identify the conditions shaping whether digitalization becomes embedded in warehousing (RQ1), and then to examine how organizations respond to those conditions (RQ2).

5.1.1 Purpose

The purpose of this study was to examine the conditions shaping digitalization in warehousing within SME contexts. To fulfil this purpose, a qualitative, embedded single-case study was conducted at Holm Trävaror AB, a Swedish SME distributing wood and wood-based materials across five warehouse sites. Empirical material was generated through document analysis, non-participant observations at three sites representing different levels of digital maturity, and six semi-structured interviews with warehouse operators and managers at those sites. The thematic analysis produced 24 themes distributed across the technological, organizational, and environmental dimensions of the TOE framework, organized into three parts: current conditions, organizational responses, and anticipatory accounts. Together, these provided an empirically grounded account of how digitalization currently unfolds within warehousing in an SME context and of the conditions that shape the progression or stalling of digitalization.

5.1.2 RQ1: What barriers to digitalization exist in warehousing within SMEs?

The findings presented in Part 1 of Chapter 4 are here interpreted through the ten constructs of the working conceptual model, connecting the empirical patterns to the theoretical framework and providing an explicit answer to RQ1. The following three subsections work through each dimension in turn.

Technological conditions

The most structurally significant technological barrier concerns the construct **integration readiness**, as Cichosz et al. (2020) define it: the extent to which data structures, workflows, and system linkages are sufficiently developed to enable effective coordination across the operation. The *system misfit* finding demonstrates this barrier across multiple dimensions simultaneously. Information required during picking is fragmented across system modules that do not communicate consistently; the location logic assumes fixed product placement in an

environment defined by continuous physical adjustment; and discrepancies between systems are resolved by individuals rather than surfaced automatically. This is not simply a software design problem. It reflects what Cichosz et al. (2020) identify as the primary technological barrier in digitalization, the complexity of underlying processes that exceed available standardization and integration infrastructure. In warehousing specifically, Münsberg et al. (2022) argue that process standardization is not merely a technical task but a foundational precondition for embedding. The mismatch found confirms this: without sufficient standardization of data structures and workflows, digital tools can be formally adopted without becoming operationally integrated.

The *data trust erosion* finding extends the **integration readiness** picture in a distinct direction. Rather than concerning the absence of data, it concerns data that exists but cannot be relied upon. Accumulated entry errors and parameter drift have reached the point where workers maintain physical verification as rational risk management. This is an **integration readiness** construct of a specific kind. Even where digitization has occurred, the data quality required for embedding has not been established or maintained. Zaman et al. (2023) find that WMS adoption does not automatically translate into improved supply chain performance; the present findings reveal one concrete mechanism through which that gap emerges. Where system data cannot be trusted as a sufficient basis for operational decisions, the expected efficiency gains of digital tools remain structurally unrealized even when the tools themselves are in place.

The *unrealized system potential* finding introduces a further layer, implicating both **system compatibility** and **adoption costs** constructs as defined by Faiz et al. (2024). Known improvements have not been implemented: features active at one site remain unconfigured at others, and further development of the current system was deliberately frozen in anticipation of the coming transition. The decision to halt investment in a system that will soon be replaced is an entirely rational adoption cost response in resource-constrained contexts. Faiz et al. (2024) identify the cost of implementation as a primary constraint in SME digitalization, and Moeuf et al. (2018) show that limited resources push SMEs toward the least disruptive and cheapest available option. What the findings add are a specific consequence of that rationality. The period of deliberate non-development coincides with the point at which operational experience has most clearly surfaced what the gaps are. This means that identified **integration readiness** constraints go unaddressed precisely when the organization is best positioned to understand them.

The findings also show a prevalent expression of **system compatibility** failure: The *digital tools absent from the warehouse floor* finding depict the fragmented technological environment described by Faiz et al. (2024) and Moeuf et al. (2018) as the most constraining for SMEs in its most complete form. The absence of compatible tools at the floor level means workers cannot develop the operational familiarity that would allow them to identify what workflow adjustments integration would require. The compatibility gap therefore reproduces itself, as the conditions that would allow it to be addressed are blocked by the gap itself.

The *partial digitalization creating new failures* finding provides a further and distinct expression of the **system compatibility** construct in practice. Where digital tools have been

extended beyond the scope of their original configuration, the interface and routing limitations that emerge produced barriers that did not exist under paper-based processes. These conditions reflect what Faiz et al. (2024) identify as the compatibility challenge in fragmented SME technological environments: the degree to which digital tools fit with existing data flows and operational routines determines not only whether embedding progresses but whether partial deployment introduces new operational risks alongside the benefits it delivers.

The *missing planning functionality* finding illustrates how the **integration readiness** and **system compatibility** constructs interact in practice. Current systems do not support the coordination and sequencing process that precedes picking, and operational decisions are only recorded after they are made. This reflects both an **integration readiness** limitation and a **system compatibility** mismatch. The data structures needed to generate order summaries, labor estimates, and demand visibility are not in place. At the same time, the systems were not originally designed to support the planning functions required in warehouse operations. As a result, planning depends on individual judgement and manual review of order lists. This contributes to the double-handling and sequencing inefficiencies described in the empirical findings.

The *material and physical ceilings* identified stands out as a finding that does not cleanly map onto the working conceptual model. The variable dimensions of solid wood products mean that volume can only be confirmed through physical measurement. Together with the geometry of the physical warehouse, this creates handling constraints that no system configuration can fully remove. These conditions therefore set a domain-specific limit on what digital tools can currently achieve in this specific operational context. These conditions are not technological barriers in the TOE sense. Instead, they are physical properties of the product and the space that define the outer boundary of what digitalization can address regardless of how far integration readiness, system compatibility, or organizational capacity develop. This finding points to a dimension of warehousing that existing constructs do not explicitly account for.

Organizational conditions

The *coherent manual system* finding is, organizationally, the most theoretically significant, because it reveals that the primary barrier to **digital culture** development is not resistance to change, but the functional adequacy of the alternative. Faiz et al. (2024) define **digital culture** and identify it as the strongest predictor of adoption intention ahead of both technological and environmental factors. What the findings reveal is a specific mechanism through which **digital culture** fails to develop: where the manual system continues to deliver adequate operational outcomes through known, trusted workflows, it removes the operational pressure that would otherwise make abandoning paper necessary. Similarly, Cichosz et al. (2020) identify organizational-level inertia, defaulting to historically effective practices, as a central barrier at the institutional level. The present findings show that this inertia is not passive but actively sustained. The analytical implication is consequential: **digital culture** cannot shift simply by introducing more capable digital tools, because the barrier is not the tools' inadequacy but the absence of a condition that makes adopting them operationally unavoidable.

The *workarounds becoming permanent* finding reinforces this and connects it directly to the **tacit knowledge and informal routines** construct. Workarounds and immediate fixes to system gaps have become normalized practice, indistinguishable from how work is supposed to be done. Münsberg et al. (2022) argue that informal practices must be made visible before system alignment can occur; the findings demonstrate the inverse dynamic. When workarounds become routine, they become invisible. The gap they compensate for disappears from organizational attention, and the digital tool's embedding is frozen at the point where the workaround was introduced. The manual system is reinforced rather than replaced, and each successive implementation cycle inherits the workarounds of the previous one. This pattern raises a broader question beyond the scope of this study: where workarounds have become deeply embedded and continue to deliver adequate operational outcomes, is digitalization always the most effective response to every operational condition?

The *structural overload blocking improvement* finding directly implicates the **top management support** construct. Faiz et al. (2024) and Müller et al. (2024) both identify visible and sustained leadership commitment as consistently critical organizational enabler of digitalization. In addition, Moeuf et al. (2018) specifically identify SMEs' concentration of managerial bandwidth as a structural condition that makes sustaining that commitment difficult. The findings show what this structural difficulty looks like in practice, for example, warehouse manager's role far exceeding formal responsibilities. The consequence is not simply that improvement work is deprioritized, it is that the organizational capacity through which sustained attention to digitalization could be directed does not currently exist. This could extend Moeuf et al.'s (2018) observation beyond a general claim about SME bandwidth to a specific structural mechanism where the discretionary capacity that digitalization requires is consumed before it can be directed.

The *operations held together by individuals* finding implicates both the **tacit knowledge and informal routines**, and **human resource capability** constructs simultaneously. Workers hold essential operational knowledge about system quirks, product-specific handling requirements, carrier obligations, and workflow sequencing. This knowledge exists nowhere in documented form and cannot be transferred if the person holding it is absent. Münsberg et al. (2022) and Cichosz et al. (2020) both identify undocumented tacit knowledge as producing a structural misalignment between digital system logic and operational reality. The present findings confirm and sharpen this. The individual dependency is not simply a training challenge; rather, as Cichosz et al. (2020) explain, operational competence is often stored in individuals rather than in systems or documented procedures. This makes the organization particularly vulnerable during transition periods, when system changes place the greatest demands on organizational knowledge and continuity. Expressed concern about what happens when the new system replaces the current informal knowledge structure is an analytically exact description of this fragility.

The *knowledge that never travels* finding adds an intra-organizational dimension to the **human resource capability** construct. The three studied sites represent different levels of digital maturity within the same organization, but no structured mechanism appears to exist for transferring what has been learned at the more mature sites. This is a resource already available

within the organization that is not mobilized. Cichosz et al. (2020) highlight contextually grounded capability development as an enabling condition; the findings show that even where operational learning has produced a more developed digital practice, the absence of any intra-organizational knowledge transfer mechanism means that learning remains isolated rather than becoming an organizational asset.

The **human resource capability** construct is further implicated by both the *broken information chains*- and *implementation designed without the warehouse* findings, but as a structural rather than individual condition. The reliability of the digital record depends on data entered correctly by upstream departments. The absence of any feedback mechanism means correction work is absorbed at the point of work without closing the gap that produces it. Cichosz et al. (2020) identify training as a condition for capability development, but the findings indicate that training the wrong actors cannot address a systemic structural barrier. In reality, what is required is a feedback mechanism that makes entry errors visible to those responsible for them. The exclusion of warehouse operators from implementation decisions compounds this. When implementation is configured by those most familiar with current practice, the structural misalignments that workers could most precisely describe are not available as inputs to configuration decisions. This is precisely the condition Cichosz et al. (2020) and Münsberg et al. (2022) identify as preventing system logic from aligning with operational reality. The result is that each transition cycle encodes existing misfit into the incoming system rather than using the transition as an opportunity to resolve it.

Environmental conditions

The two environmental findings present a picture consistent with the environmental constructs developed in Chapter 2, with one empirically significant qualification. The *commercial model limiting planning* is an environmental constraint, but it is not produced by **trading partner pressure** in the sense Faiz et al. (2024) and Awa et al. (2016) define. That is, customers demanding digital compliance that exceeds internal readiness. It is instead produced by a commercial model designed to match competitive behavior, which structurally eliminates the planning horizon that would allow warehouse coordination to be more systematically supported. In this context, the *commercial model limiting planning* barrier appears to lie beyond what internal organizational or technological responses can address, as the constraint originates in how the commercial relationship with customers is structured at a level above the warehouse. This confirms the context-dependency of **competitive dynamics** as a construct (Faiz et al., 2024; Vial, 2019); competitive pressure does not directly shape digitalization by demanding internal digital capability, but by locking in a commercial arrangement whose operational consequences digitalization cannot dissolve.

The *logistics partner obligations* finding is the clearest expression of **inter-organizational dependencies** in the data. Physical weight verification and manual dimension entry persist as requirements imposed by third-party carriers regardless of how far the internal digital environment develops. Awa et al. (2016) and Faiz et al. (2024) both identify **inter-organizational dependencies** as capable of functioning as either constraints or resources depending on whether external actors have the incentive and capability to support the

organization's digitalization trajectory. In the findings, the carrier relationship functions purely as a constraint as it imposes manual steps that cannot be eliminated through internal configuration choices, and the carrier has no incentive to alter the requirements that generate them.

A notable empirical finding is the complete absence of **competitive dynamics** as a condition shaping digitalization. No participant described industry-level pressure from competitors' digitalization trajectories as a factor influencing how or whether they pursued digital tools. This is consistent with Faiz et al.'s (2024) finding that competitive pressure is statistically insignificant as a driver for SMEs in defined supply chain relationships. The present findings extend this to a warehousing context: what matters is not industry-wide digitalization momentum but the specific inter-organizational obligations arising from particular commercial and logistics relationships. **Competitive dynamics** are present as background context, Vial (2019) identifies them as part of the broader environment in which digitalization takes place, but they do not manifest as an operative condition shaping digitalization of warehousing in the organization studied here.

5.1.3 RQ2: How do organizations respond to existing barriers to digitalization in warehousing within SMEs?

The second research question asks how the organization responds to the barriers identified in RQ1. The findings address this from two related but distinct perspectives: first, the organizational practices, decisions, and arrangements currently used to manage existing barriers; and second, the anticipated implications of the forthcoming system transition. Therefore, Part 2 focuses on the responses already visible in daily operations. Part 3 extends this by examining how the upcoming transition is expected to interact with existing barriers. Taken together, both parts address the same underlying question: which of the barriers identified in RQ1 appear possible to respond to through organizational action, and which remain unresolved within the current organizational conditions.

Part 2: Responses to current conditions

The most consequential organizational response in the data concerns how implementation conditions shape use after go-live, captured in the governance as the determining condition for embedding finding. The findings suggest that digital embedding is affected not only by the quality of the tool or the attitudes of workers, but by whether the organization preserves manual alternatives alongside the digital system. Where paper remained available as a functional option, workers could continue to rely on the established manual system, and the digital tool did not advance much beyond its initial deployment. Where paper access was removed from the start, the digital system became the necessary basis for daily work. This changed the conditions under which workers encountered the tool and created repeated opportunities to build practical familiarity with it. In this sense, the cultural shift described by Faiz et al. (2024) was not produced mainly through persuasion or training, but through an implementation decision that changed the structure of everyday use. The digital culture construct, in this

context, therefore, appears tractable, but only when governance decisions alter the conditions that sustain manual alternatives

A second response, captured in the worker knowledge as an operational resource finding, concerns how operational knowledge is allowed to influence organizational decisions, and addresses the tacit knowledge and informal routines construct. Across the data, relevant knowledge exists at the operational level: employees can identify system limitations, describe the functions that paper-based routines currently fulfil, and point to alternative ways of organizing the work. However, this knowledge only becomes an organizational response when there is a channel through which it can affect decisions. In some cases, floor-level input led to concrete changes in picking priority sequencing, inbound labelling, and the distribution of freight booking responsibility. In other cases, comparable knowledge remained local and did not shape wider operations. This supports Münsberg et al.'s (2022) argument that informal practices must be made visible for systems to be aligned with operational reality. It suggests that visibility is not only a matter of documenting informal knowledge; it also depends on whether the organization has structures that allow such knowledge to reach decision-making. The barrier is therefore not the absence of relevant knowledge, but the uneven ability of the organization to convert that knowledge into action.

A related but distinct response, captured in the resilience through distributed responsibility finding, concerns the redistribution of task responsibility and addresses the operations held together by individual's barrier. Where responsibility is deliberately spread across several employees rather than concentrated in one role, the findings suggest that person-dependency can be reduced and operational continuity improved. However, this redistribution also created a trade-off, since the task interrupted picking flow and introduced a new bottleneck around the shared booking station. The response therefore reduced one form of fragility while creating another operational cost. This reflects a broader organizational issue: structural redesign can make the operation less vulnerable to individual absence, but only if the redesign also considers workflow consequences. In line with Faiz et al. (2024), this suggests that SMEs may be able to act quickly when management is close to operations and has authority to redesign work. However, the findings also show that this does not happen automatically. Where concentrated competence is not recognized as an organizational design problem, dependency remains in place.

These responses suggest that several barriers identified in RQ1 are tractable, but not through digital tools alone. The organization can influence embedding by changing the conditions of system use, creating channels for operational knowledge to inform decisions, and redesigning the distribution of responsibility. However, these responses are unevenly applied. Some barriers are actively responded to through structural decisions, while others remain unresolved because the organization has not yet created the governance, capacity, or role structures needed to address them.

Part 3: Orientations toward change

The anticipatory accounts collected suggest a consistent organizational pattern that participants approach the forthcoming system transition with a well-grounded understanding of which

barriers are likely to persist, and why. Rather than expressing generalized anxiety about technological change, the orientations are organizationally specific, pointing to the same structural conditions identified in Part 1 as the sources of concern.

The most consistently raised concern across sites concerns the transition window, the period during which person-dependent operational knowledge is disrupted before new system competence forms. This suggests that the operations held together by individuals barrier identified in RQ1 is not only a current operational condition but an anticipated source of vulnerability during the transition itself. Where operational competence is stored in people rather than systems or documented procedures, it dissolves the informal knowledge infrastructure that makes existing tools functional, without any structural mechanism to manage that dissolution (Cichosz et al., 2020; Münsberg et al., 2022). The concern raised at Borås is particularly illustrative of this: the worry is not about personal capacity to learn the new system, but about who fills the informal support role during the period before comparable familiarity builds. This provides evidence that workers themselves have a precise understanding of the fragility that individual-concentrated competence creates, even where that understanding has not been translated into organizational preparation.

A second pattern concerns implementation governance. Across sites, participants indicate that the structural conditions for reproducing the implementation designed without the warehouse barrier are already in place for the system transition. The previous WMS implementation is described in retrospect as one in which the system was configured around existing working practices rather than using the transition as an opportunity to reshape them, and the composition of the current system implementation team is seen as likely to replicate that dynamic. This suggests that the barrier is not simply a past condition but an anticipated future one. Operational employees can identify what would need to change, but they are not in roles that allow them to influence the decisions that shape implementation. In this reading, the top management support construct manifests not as an absence of commitment to digitalization in general but as a structural exclusion from the decision structure through which implementation is determined, extending the literature as proposed by Faiz et al., 2024 and Müller et al., 2024.

A third pattern concerns the conditions under which the digital culture construct might become tractable in the next transition. Across sites, participants indicate a pragmatic rather than resistant orientation toward the new system: willingness to engage is conditional on the system being demonstrated in the actual operational context, with adequate on-site support at go-live. This is consistent with what the governance finding in Part 2 established, that the digital culture construct is tractable through demonstrated functionality under the right structural conditions. However, the orientations suggest that those conditions are not yet in place. Participants across sites report having received only general information about the new system, without clarity about what the final solution will look like in their specific operational context. This indicates that the demonstration condition for cultural shift, identified as decisive in Part 2, remains unmet as the transition approaches.

Taken together, the Part 3 orientations contribute something analytically distinct from the enacted responses described in Part 2. Where Part 2 reveals which barriers have proven tractable

through organizational responses already enacted, Part 3 reveals the boundaries of that tractability going forward: the transition window fragility, the implementation governance structure, and the site representation gap are all conditions that participants can name precisely but cannot address from their current organizational position. What the orientations cannot resolve, and what remains open at the time of this study, is whether the organization will act on this distributed organizational knowledge before the transition, or whether the new system will inherit the barriers that have constrained embedding in the systems it is intended to replace.

5.2 Research Implications

This study contributes empirically grounded insight to a research intersection that remains underexplored: digitalization in warehousing within SME contexts. Prior research applying the TOE framework has focused predominantly on manufacturing and production settings (Moeuf et al., 2018; Müller et al., 2024). Simultaneously, research on warehouse digitalization research has largely examined technological capabilities without systematic attention to firm size or organizational constraints (Winkelhaus & Grosse, 2020; Perotti et al., 2022). This study situates the framework within the specific conditions that define warehousing in SMEs. In doing so, the findings engage with the framework and several of its constructs in ways that refine and extend existing understanding across four areas.

The TOE framework. The findings suggest that all three TOE dimensions are present and active in this context, though not to the same extent. The organizational dimension carries the most analytical weight: all navigation responses in the data fall within it, and organizational conditions shape whether barriers in the other dimensions become more or less consequential in practice. This points toward a differentiation that Baker's (2012) account of TOE does not explicitly establish: that the tractability of a barrier (the degree to which it can be addressed through actions taken within the warehouse) appears to be structured by the dimension in which it originates, and is treated here as an emergent finding rather than a theoretical assumption. Organizational barriers appear responsive to actions taken within the warehouse; technological barriers tend to require investment decisions above it; and environmental barriers appear largely beyond the reach of the warehouse. The findings do not challenge the framework but suggest that when applied for warehouse operations in operationally constrained SME settings, the three dimensions may need to be understood as carrying different degrees of practical relevance rather than as equally weighted analytical categories.

Digital culture. Faiz et al. (2024) identify digital culture as the strongest predictor of adoption intention and point to management demonstration and the accumulation of positive operational experience as the mechanisms through which it can shift. Müller et al. (2024) similarly identify cultural conditions and visible management practices as enablers of digitalization in SMEs. The findings suggest a more specific condition for those mechanisms to take hold: the removal of the functional alternative. Where a manual system continues to deliver adequate operational outcomes, it appears to sustain the conditions that keep digital culture from developing. Not because workers resist change, but because the operational pressure that would otherwise make change necessary is absent. This adds to both accounts by identifying the persistence mechanism rather than only the enabling conditions for shift.

Integration readiness. Prior research, including Cichosz et al. (2020) and Münsberg et al. (2022), treats integration readiness primarily as a pre-adoption precondition, a threshold that needs to be in place before embedding can progress. The findings suggest this framing may be incomplete. Integration readiness appears to be an ongoing condition rather than a one-time investment: data quality can erode after adoption if it is not actively maintained, reaching a point where tools are formally in use but the reliability conditions for their effective use have degraded. This indicates that embedding is not secured at the point of adoption but depends on continued attention to the data structures and workflows that digital tools rely on.

Top management support. Faiz et al. (2024), Müller et al. (2024), and Moeuf et al. (2018) converge on top management support as the most consistently critical organizational enabler and note that SMEs face structural difficulty sustaining it due to concentrated managerial bandwidth. The findings suggest a more specific mechanism through which this difficulty develops: where adjacent functions generate work that flows to warehouse management without those functions bearing its operational cost, the capacity available for digitalization-related decisions is gradually consumed. This indicates that the barrier may be less about the level of management commitment and more about how responsibilities are defined and distributed across functions. This is a distinction that points toward a different kind of organizational response than simply strengthening leadership engagement.

Warehousing in SME contexts and material constraints. Beyond the individual constructs, the findings point to a boundary condition that the TOE framework does not currently account for: the physical properties of the product and the operational space. Winkelhaus and Grosse (2020) identify the physical and human dimensions of warehousing as among the least systematically studied, and Münsberg et al. (2022) include physical layouts as a dimension of standardization complexity. The present findings support and extend this perspective. Product variability and spatial constraints can define an outer limit on what digitalization can achieve, one that cannot be dissolved through technological improvement or organizational development alone. In highly physical and materially constrained warehouse environments, the established TOE dimensions may be insufficient for capturing all conditions that shape digitalization.

The findings also carry indirect relevance to sustainability research. Paper dependency, resource inefficiency from double-handling and unnecessary physical movement, and the fragility of knowledge concentrated in individuals all inherent sustainability dimensions that the current study warehousing has not systematically examined. Where digitalization remains partial or stalled, organizations continue to carry operational costs whose sustainability consequences, such as material consumption, energy use, and organizational resilience, accumulate alongside the operational ones.

5.3 Practical Implications

The first implication concerns the governance of system implementation. The findings suggest that whether paper-based alternatives remain available at go-live is a consequential decision for embedding outcomes. Where paper remained accessible, workers continued to rely on it and digital tools did not advance beyond initial deployment. This does not suggest that training,

communication, or change management are unimportant. Rather, it points to an additional consideration that tends to receive less deliberate attention: the structural conditions under which workers first encounter the new system shape whether positive experience with it can accumulate. For managers approaching system transitions, treating go-live design as a strategic decision, including explicit consideration of whether and how manual fallbacks are preserved, may be as consequential as the implementation activities that typically receive the most planning effort.

A second implication concerns how organizations in multi-site contexts use the knowledge already available within them. The findings reveal that sites within the same organization can differ significantly in digital maturity, and that practices developed at more digitally developed sites are directly relevant to the challenges faced at less developed ones. Yet no mechanism currently connects them. A related finding concerns data quality: entry errors persist not because of skill gaps but because those responsible for entering data do not experience the downstream consequences of entering it incorrectly. Taken together, these findings suggest that before investing in new tools or training, organizations may benefit from asking whether relevant knowledge and solutions already exist within the organization, and whether accountability for data quality is currently located where the consequences of poor entry are actually felt.

A third implication concerns how managers identify and categorize the barriers they are trying to address. The findings suggest that not all barriers respond to the same type of action: some can be addressed through decisions taken within the warehouse, some require decisions at a higher organizational level, and some originate in external commercial or logistics arrangements that internal responses cannot reach. In resource-constrained SME settings, the cost of misidentifying which type of barrier is being faced is direct: effort directed toward a barrier that internal action cannot address produces no return. Developing a working sense of where a barrier originates, and what type of response it therefore requires, may be a more valuable managerial capability than any specific implementation technique.

5.4 Discussion of Methods

This study employs a qualitative embedded single-case design across three warehouse sites, combining semi-structured interviews, non-participant observations, and document analysis. The triangulation of methods strengthens the credibility of the findings, and respondent validation through site-level summary packages confirmed by participants reduced the risk of misinterpretation. The presence of both researchers across all observation sessions, followed by recorded debriefing discussions, supported consistency and reduced the risk of individual interpretation dominating the material. The abductive analytical sequencing, in which the TOE framework was introduced only at the final synthesis stage rather than as a predetermined coding structure, mitigated the risk of the framework constraining what the empirical material could reveal. The embedded design enabled within-case comparison across three sites of meaningfully different digital maturity, which strengthened the analytical richness of the material without sacrificing contextual depth. As with all single-case research, however, findings are analytically rather than statistically transferable, and caution should be exercised

when applying them to organizations with substantially different structural or operational conditions. Two of the five sites within the organization, Stockholm and Skellefteå, were not included in the study, meaning the full organizational picture is not captured.

Several specific limitations warrant acknowledgment. The most analytically significant concerns observation duration: sessions of two to four hours per site constrain the depth to which tacit and informal practices could be directly observed, a relevant tension given that such practices emerged as central to the findings. The interview sample of six participants, while sufficient to reach analytical saturation within this context, remains small and concentrated at two roles per site, limiting the breadth of perspectives captured at each location. The study was conducted by researchers embedded within the host organization, which introduces a positionality risk: despite deliberate reflexivity throughout the process, the relationship between researchers and the case company may have influenced how participants formulated their accounts and how findings were interpreted. Additionally, data collection occurred during weeks 13 to 15 of 2026, at a specific organizational juncture, Qpick development had been frozen in anticipation of the Monitor ERP transition, and the organization was in an active period of change, meaning the findings reflect conditions shaped by this particular moment rather than a stable operational state. Finally, internal documents reviewed through document analysis were subject to a non-disclosure agreement and cannot be cited or listed, which limits the audit trail for that element of the triangulation, and analysis was conducted using structured spreadsheets rather than dedicated qualitative software, a deliberate choice consistent with Miles and Huberman (1994) that nonetheless reduces the automated audit trail that tools such as NVivo provide.

6 Conclusion

This chapter synthesizes the study's findings in response to the research questions, states its contributions and limitations, and identifies directions for future research.

The challenge this thesis addressed is both a practical and a research problem of considerable consequence. Despite growing availability of digital tools designed for warehouse environments, the gap between their formal adoption and their embedding into operational practice remains wide and persistent. Within SME contexts, where structural constraints are sharpest, that gap has proven most consequential and least examined. Warehouse digitalization research has developed without systematic attention to firm size or organizational constraints; SME digitalization research has focused almost exclusively on manufacturing and production settings. This study addressed the intersection where neither trajectory had arrived.

6.1 Summary of findings

Fifteen barriers to digitalization were identified across all three TOE dimensions, organized into the themes summarized in Table 9. The most important analytical finding about these barriers is not their number but their character: they do not operate as discrete or independent conditions. They interact across dimensions in ways that compound their individual effects, and the organizational dimension carries the most practical weight. Technologically, system design logic consistently fails to accommodate the operational variability that defines warehouse work, data quality erodes after adoption when it is not actively maintained, and known improvements remain unconfigured due to the anticipated cost of investment in a system soon to be replaced. A product-physical boundary condition, the dimensional variability of solid wood and the geometry of the warehouse space, defines an outer limit on what any system configuration can achieve, a condition that the established TOE constructs do not account for. Organizationally, the functional adequacy of the manual system actively prevents digital culture from developing, workarounds become invisible as permanent routine, structural overload eliminates the managerial capacity needed for improvement work, and successive implementation cycles encode existing misfit into incoming systems by excluding the people whose knowledge could most precisely identify what needs to change. Environmentally, both identified barriers originate entirely outside the firm's capacity to address through internal means: a commercial model that compresses the planning horizon beyond what warehouse coordination can systematically accommodate, and logistics carrier obligations that impose manual steps regardless of internal digital maturity. Competitive dynamics did not emerge as an operative condition at any of the three studied sites, their absence is itself a finding, consistent with the evidence that partner-specific obligations carry more direct weight than industry-level pressure for SMEs operating within defined supply chain relationships.

Table 9: Summary of Findings

Part	Dimension	Theme
Current conditions	Technological	System misfit; Data trust erosion; Unrealized system potential; Digital tools absent from the floor; Partial digitalization creating new failure modes; Material and physical ceilings; Missing planning functionality
	Organizational	The coherent manual system; Workarounds becoming permanent; Structural overload blocking improvement; Operations held together by individuals; Knowledge that never travels; Broken information chains; Implementation designed without the warehouse
	Environmental	Commercial model limiting planning; Logistics partner obligations
Organizational responses	Organizational	Governance as the determining condition for embedding; Worker knowledge as an operational resource; Resilience through distributed responsibility
Anticipatory accounts	Organizational	Caution drawn from operational experience; Skepticism about implementation governance repeating; Conditional openness to change; Concern about the loss of informal system knowledge; Nervousness about exclusion and absent site representation

All organizational responses identified fall within the organizational TOE dimension. No response to a technological or environmental barrier was observed across any of the three sites, as addressed in the discussion of RQ2. Within the organizational dimension, three responses were visible: removing paper access at go-live produced stronger embedding outcomes than training or communication alone; channeling floor-level knowledge into operational decisions produced structural improvements where a management structure existed to enable it; and the deliberate redistribution of freight booking responsibility reduced single-person dependency at an acknowledged cost to picking flow tradeoff.

6.2 Contributions and limitations

Four contributions to existing understanding follow from the findings. The tractability of a barrier, the degree to which it responds to organizational action, appears to be structured by the TOE dimension in which it originates, a differentiation that Baker's (2012) account of the framework does not explicitly establish. The mechanism through which digital culture fails to develop is the functional adequacy of the manual alternative rather than resistance to change, a distinction that Faiz et al.'s (2024) account of enabling conditions does not address. Integration readiness is better understood as an ongoing condition requiring active maintenance than as a threshold met once at adoption, extending the framing of Cichosz et al. (2020) and Münsberg et al. (2022) who treat it primarily as a precondition to adoption. The product-physical boundary condition identified here points to a dimension the established TOE constructs do not currently account for, and that may warrant development in research on physically constrained warehouse environments.

Three practical implications follow from these findings. Go-live design, specifically whether manual alternatives remain available at the point of system introduction, is a strategic decision whose consequences for embedding are at least as significant as the implementation activities that typically receive the most planning attention. Before investing in new tools or training, organizations operating across multiple sites may benefit from asking whether relevant

knowledge and solutions already exist within the organization, and whether accountability for data quality sits where the consequences of poor entry are actually felt. Not all barriers respond to the same type of action, and in resource-constrained settings, identifying where a barrier originates is a precondition for selecting a response that can produce a return.

The methodological boundaries of this study are described in detail in Section 5.4, with the most analytically significant constraint being that the single-case design provides contextual depth at the expense of breadth, and findings are analytically rather than statistically transferable. Several directions for future research emerge from the questions the findings opened. A comparative multi-case study across SMEs in different product categories or national contexts would allow the tractability differentiation identified here to be examined across settings and establish whether it constitutes a generalizable analytical finding or a condition specific to wood distribution. A longitudinal study tracking an organization through a major ERP transition would allow direct examination of whether the transition window fragility identified here unfolds as participants anticipate, and whether the embedding gap narrows or reproduces itself in the new system. The governance finding, that removing paper access at go-live produced stronger embedding outcomes than training or communication alone, is grounded in a single implementation case and runs counter to where implementation guidance typically directs attention; it warrants examination across different tool types and organizational settings. Whether the product-physical boundary condition is specific to wood distribution or a recurring feature of physically constrained warehouse environments more broadly remains an open question that research in comparable settings could begin to address.

6.3 Future research

Several directions for future research emerge from the questions this study opened. A comparative multi-case study across SMEs in different product categories or national contexts would allow the tractability differentiation identified here to be examined across settings, and establish whether it constitutes a generalizable analytical finding or a condition specific to wood distribution. A longitudinal study tracking an organization through a major ERP transition would allow direct examination of whether the transition window fragility identified in the anticipatory accounts unfolds as participants expect, and whether the embedding gap narrows or reproduces itself in the new system. The governance finding is grounded in a single implementation case and runs counter to where implementation guidance typically directs attention; it warrants examination across different tool types and organizational settings before conclusions about its broader applicability can be drawn. Whether the product-physical boundary condition is specific to wood distribution or a recurring feature of physically constrained warehouse environments more broadly remains an open question that research in comparable settings could begin to address. Finally, the sustainability dimensions of warehouse digitalization, among them paper dependency, resource inefficiency from double-handling, and the fragility of knowledge concentrated in individuals, remain systematically unexamined in this context and represent a substantive direction for future inquiry.

What this study shows, taken as a whole, is that digitalization in warehousing is not primarily a technological problem. The barriers that most persistently constrained embedding across all

three sites were not about the absence of appropriate tools or the unwillingness of workers to use them. They were about how work was structured, how knowledge moved through the organization, and how implementation was governed.

7 References

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8 Appendices

Appendix 1 – Observation protocol

OBSERVATION PROTOCOL

Session information

Site	
Date	
Observer(s)	Maria Menjura, Klara Wiberg
Session no.	
Duration	Approx. 2–4 hours
Observation type	Non-participant, continuous

Purpose and connection to research questions

This observation protocol is designed to capture conditions shaping digitalization as they manifest in operational warehouse operations, through physical flows, worker–system interactions, and the visible relationship between digital tools and how work is actually performed. Observations are not evaluative; the aim is to **understand**, not assess.

Observations serve as the primary data source for RQ1 (barriers to digitalization in warehousing) and provide a complementary perspective to RQ2 (how organizations respond to those barriers). Observed practices are triangulated against findings from document analysis and semi-structured interviews.

Observer role and conduct

The observers adopt a non-participant role throughout the session (Säfsten & Gustavsson, 2020; Busetto et al., 2020). Both observers are present and attentive but do not engage in operational tasks or direct workers. Observers introduce themselves briefly at the start of each visit and explain they are present to observe general warehouse operations for research purposes.

Questions during the observation are limited to brief, neutral, logistical queries, such as identifying an area of the warehouse, that do not signal evaluative interest. Any question touching on why something is done a certain way belongs in the interview; these are noted under 'questions raised' in the field notes.

Focus areas and guiding prompts

These prompts are sensitizing lenses, not a checklist. Not all prompts will be relevant at every site. Let the activity on the floor lead; use these to orient attention.

General walkthrough

- What does the physical layout suggest about how work is organized?
- Where is technology visibly present → screens, scanners, labels, printed lists?
- Where is technology visibly absent where you might expect it?
- What are workers doing with their hands, and are systems involved?
- Where is informal coordination happening → verbal, handwritten, habitual?
- Are there visible moments of friction, workaround, or hesitation in relation to systems?

Technological conditions

- What digital tools or systems are visibly in use → WMS, ERP, scanners, tablets, paper?
- How integrated do these tools appear with each other and with the physical flow?
- Are there signs of parallel systems → digital and manual used for the same task?
- Does the technology appear to support or interrupt the work being done?

Organizational conditions

- How do workers relate to the digital tools present → confident, hesitant, avoidant, adapted?
- Are there visible signs of informal workarounds → sticky notes, printed lists, verbal coordination?
- Is there a sense of whether digitalization has been introduced from above or grown organically?
- What does the physical environment suggest about management priorities and investment levels?

Environmental conditions

- Can you see signs that customers or suppliers are dictating how things need to be done → through specific labelling, documentation formats, or scanning requirements?
- Does it appear that external pressure (from customers, suppliers, or carriers) is shaping how digitally the site operates, regardless of internal choice?

Field note template

Complete during and immediately after the observation session. Use the four sections below for all notes. Mark all interpretations clearly as such — do not blend them with descriptive notes.

Section	Notes
Descriptive notes	

What you actually saw, heard, and noticed. Be specific: 'Worker consulted a printed sheet before scanning item' rather than 'manual process observed.'	
Interpretive notes [I] *Your initial sense of what something might mean in relation to the TOE constructs. Mark all entries [I] to distinguish from descriptive notes.*	
Questions raised *Things the observation made you want to follow up on in the interviews. Write these down immediately.*	
Surprises *Anything that contradicted your expectations or the literature. These often point toward the most analytically significant findings.*	

Post-visit procedure

Before moving to the next site, each observer independently writes a short summary (half a page, free-form) of their overall impression of the site's digitalization conditions. The two summaries are then compared. Points of agreement indicate solid observations; points of divergence identify areas worth exploring further in the interviews. Summaries are recorded and transcribed to support dependability (Lincoln & Guba, 1985).

Appendix 2 – Interview Questions

SEMI-STRUCTURED INTERVIEW GUIDE

Site	
Date	
Interviewer(s)	Maria Menjura, Klara Wiberg
Interviewee role	
Duration	45–60 minutes
Recording	Yes / No (consent obtained before start)

Preamble — read aloud at the start

Thank you for taking the time to speak with us. We are two bachelor's students at Jönköping University studying how digitalization works in warehouse operations at smaller distribution companies. We are not here to evaluate how your site performs, we want to understand how things actually work in practice. There are no right or wrong answers, and we may ask follow-up questions simply because we want to understand more.

With your permission, we would like to record the audio so that we can focus on the conversation rather than taking notes. The recording will only be used for our research and will not be shared externally. You can withdraw consent at any time.

Do you have any questions before we begin?

Questions

1. Background and role

Q1. Can you tell me about your role here — what does a typical day look like for you?

→ *how long in this role · which areas of the warehouse · has the role changed over time?*

2. Digital tools and current practice

Q2. What digital tools or systems do you use in your daily work?

→ *name the systems · which do you use most · any you rarely use, and why?*

Q3. If you think about a typical task — picking an order or receiving a delivery — what happens digitally and what still happens on paper?

→ *walk me through it · why paper for that task · has it always been that way?*

3. What makes digitalization difficult → *RQ1*

Q4. Are there things you know how to do in your work that are not written down anywhere — things you have just learned over time?

→ *example · how would a new person learn that · what happens if the person who knows it leaves?*

Q5. Are there situations where something is still done manually that you feel could or should be handled digitally?

→ *specific example · why is it still manual · does it create extra work?*

Q6. Are there things outside this warehouse — customers, suppliers, or logistics partners — that affect how digitally you can work?

→ *specific requirement · anything you must do manually because of an external obligation?*

4. How barriers are responded to

Q7. When the system does not do what you need — what do you do?

→ *figured out yourself or shown by someone · does everyone use the same workaround · does it actually work well?*

Q8. Has anything about how digital tools are used here actually improved over time? What made that happen?

→ *who drove it · what gets in the way of other improvements · is there time and capacity for that?*

Q9. How does management respond when someone on the floor suggests a change to how something is done?

→ *example of a suggestion taken up · example of one that was not · do you feel involved in system decisions?*

5. Looking forward

Q10. I understand there is a new system being introduced. What do you know about it, and how do you feel about the change?

→ *what you expect to change · what you are looking forward to · what worries you?*

[Only raise this if the interviewee is aware of the Monitor transition — do not introduce it yourself]

Q11. If you could change one thing about how digital tools are used here, what would it be?

→ *what would need to happen · who would need to be involved · do you think that is realistic?*

Closing

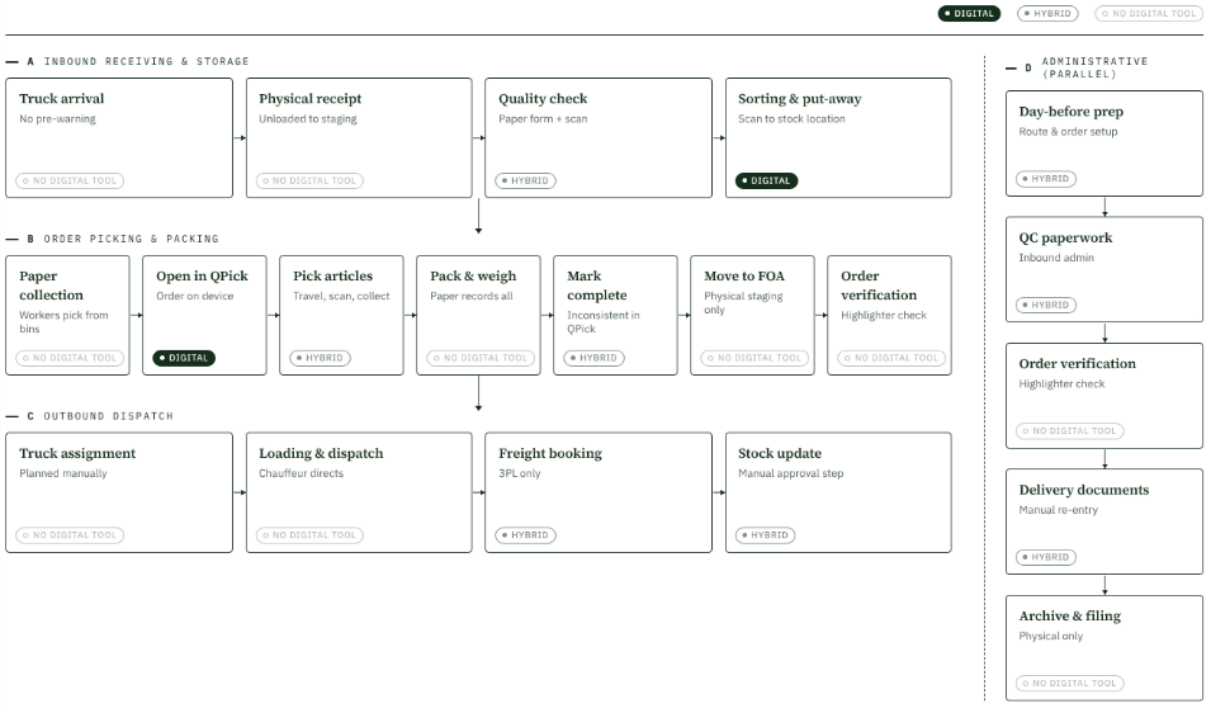
Is there anything we have not asked about that you think is important for us to understand?

Is there anything you said that you would like us not to include in the research?

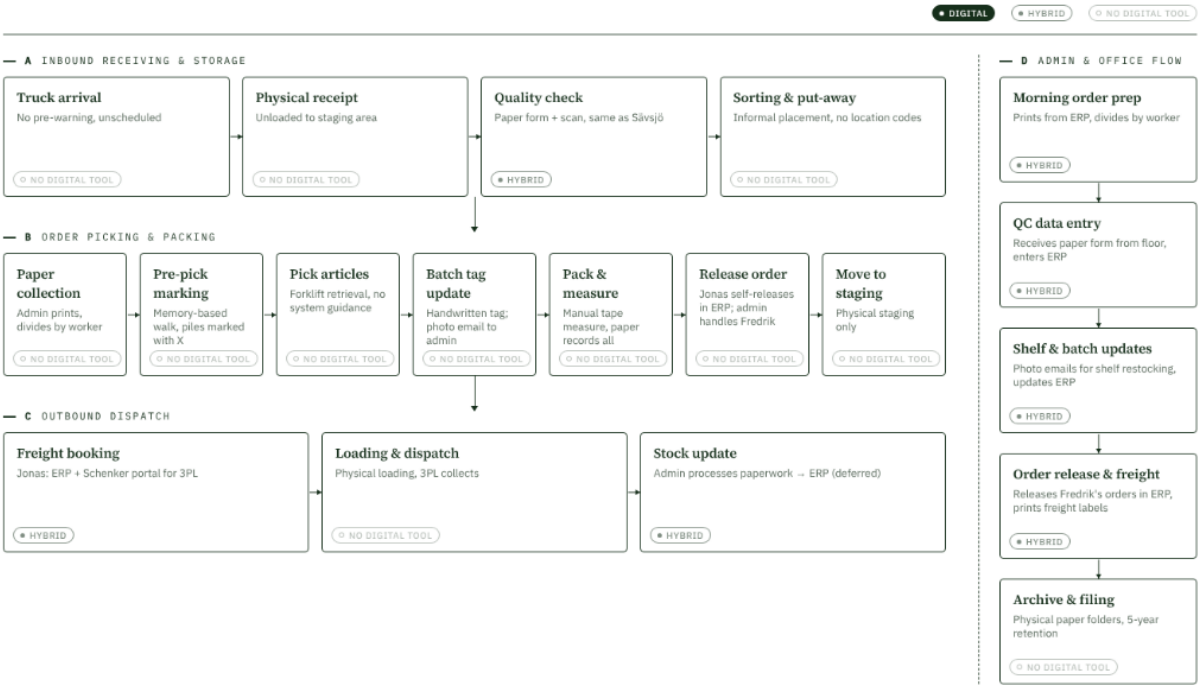
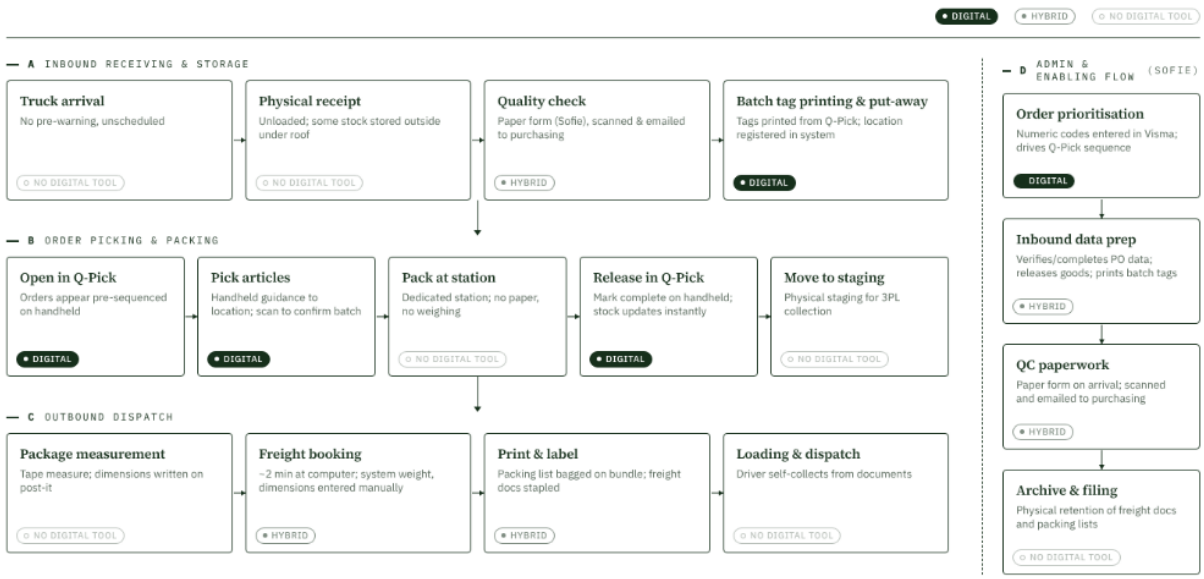
We may have a few follow-up questions after reviewing our notes, would you be willing to be contacted by email if needed?

Thank you very much for your time.

Appendix 3: Warehouse process flow at Holm Trävaror, Sävsjö



Appendix 4: Warehouse process flow at Holm Trävaror, Borås



Appendix 5: Warehouse process flow at Holm Trävaror, Sala