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Optimizing Logistics and Supply Chain Management through Integrated Information Systems and Data Management

School of technology and Innovations
Master’s thesis in Industrial Management

Vaasa 2025

UNIVERSITY OF VAASA
School of Technology and Innovations
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Title of the Thesis: Optimizing Logistics and Supply Chain Management through Integrated Information Systems and Data Management
Degree: Master of Economics and Business Administration
Programme: Industrial Management
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Year: 2025 **Pages:** 89

ABSTRACT:

This study examines how integrated information systems and data management contribute to the efficiency and cost-effectiveness of logistics operations within a project-based trading unit. While prior literature highlights the benefits of digital integration, limited research has explored how fragmented systems, partial outsourcing, and organizational practices affect logistics in non-manufacturing project businesses. To address this gap, the study focuses on logistics operations within a single trading unit of a multinational company. The research is guided by three questions: (1) What challenges affect the implementation and utilization of integrated information systems? (2) How do these systems contribute to operational efficiency and cost control? (3) How do third-party logistics providers leverage digital tools to support case companies' logistics?

A mixed-methods case study approach was applied, combining qualitative data from survey sent to stakeholders, internal documents, and observations with quantitative project cost data. The case company operates in international project deliveries and relies entirely on external service providers, as its in-house logistics capacity is administrative. This context provides a relevant setting for examining system integration challenges.

The results show that fragmented tools, manual workflows, and sparse documentation hinder cost tracking, visibility, and coordination – confirming challenges identified in the literature. In response to research questions, organizational barriers such as unclear roles and reliance on informal knowledge were found to limit system adoption. Analysis of project cost data revealed significant deviations between planned and actual logistics costs, illustrating the risks of weak integration and underutilized digital tools. The study also found that while outsourcing provided flexibility, poor interoperability with 3PL systems restricted the benefits of external digital platforms.

Practical recommendations include investing in integration solutions, clarifying responsibilities through standardized processes, implementing dashboards for real-time visibility, and reassessing outsourcing partnerships based on their digital capabilities. Limitations include the case-specific scope, incomplete cost data, and the absence of direct evaluations of service provider platforms. Future research should examine longitudinal impacts of digital adoption and explore 3PL platform capabilities in greater detail.

KEYWORDS: Supply Chain Management, logistics operations, system integration, data management, outsourcing, digitalization

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Vuosi: 2025 **Sivumäärä:** 89

Tämä tutkielma tarkastelee, miten integroidut tietojärjestelmät ja datanhallinta vaikuttavat logistiikkaoperaatioiden tehokkuuteen ja kustannustehokkuuteen projektiliiketoimintaa harjoittavassa yksikössä. Aiempi kirjallisuus korostaa digitaalisen integraation hyötyjä, mutta vain rajallinen määrä tutkimusta on tarkastellut, miten pirstaleiset järjestelmät, osittainen ulkoistaminen ja organisatoriset käytännöt vaikuttavat logistiikkaan ei-teollisissa projektiorganisaatioissa. Tätä tutkimusaukkoa paikkaamaan tutkielma keskittyy yhden monikansallisen yrityksen kauppayksikön logistiikkaan. Tutkimusta ohjaavat kolme tutkimuskysymystä: (1) Mitkä tekijät rajoittavat integroitujen tietojärjestelmien käyttöönottoa ja hyödyntämistä? (2) Miten nämä järjestelmät vaikuttavat operatiiviseen tehokkuuteen ja kustannusten hallintaan? (3) Miten kolmannen osapuolen logistiikkatoimittajat hyödyntävät digitaalisia työkaluja tukeakseen tapausyrityksen logistiikkaa?

Tutkimus toteutettiin monimenetelmällisenä tapaustutkimuksena yhdistäen laadullista aineistoa sidosryhmille lähetetystä kyselystä, sisäisistä dokumenteista ja havainnoista määrällisiin projektikustannustietoihin. Tapausyritys toimii kansainvälisissä projektitoimituksissa ja nojaa lähes kokonaan ulkoisiin palveluntarjoajiin, sillä sen oma logistiikkatoiminto on hallinnollinen. Tämä tekee siitä relevantin kontekstin järjestelmäintegraation haasteiden tarkasteluun.

Tulokset osoittavat, että pirstaleiset työkalut, manuaaliset työnkulut ja puutteellinen dokumentointi haittaavat kustannusten seurantaa, näkyvyyttä ja koordinointia – vahvistaen kirjallisuudessa tunnistettuja haasteita. Tutkimuskysymyksiin vastaten havaittiin, että organisatoriset esteet, kuten epäselvät roolit ja riippuvuus hiljaisesta tiedosta, rajoittavat järjestelmien käyttöönottoa. Projektikustannusten analyysi paljasti huomattavia poikkeamia suunniteltujen ja toteutuneiden logistiikkakustannusten välillä, mikä havainnollistaa heikon integraation ja vajaakäytössä olevien digitaalisten työkalujen riskejä. Lisäksi tutkimus osoitti, että vaikka ulkoistaminen toi joustavuutta, heikko yhteen toimivuus 3PL-järjestelmien kanssa rajoitti ulkoisten digitaalisten alustojen hyötyjä.

Käytännön suosituksiin kuuluvat panostukset integraatioratkaisuihin, vastuiden selkeyttäminen standardoiduilla prosesseilla, reaaliaikaista näkyvyyttä tukevien dashboardien käyttöönotto sekä ulkoistuskumppanuuksien uudelleenarviointi niiden digitaalisia kyvykkyyksiä vasten. Rajoitteita ovat tapauskohtainen konteksti, puutteellinen kustannusdata sekä palveluntarjoajien alustojen suoran arvioinnin puuttuminen. Jatkossa tutkimuksen tulisi tarkastella digitalisaation pitkittäisvaikutuksia sekä analysoida 3PL-alustojen kyvykkyyksiä syvällisemmin.

KEYWORDS: Toimitusketjun hallinta, logistiikkaoperaatiot, järjestelmäintegraatio, datanhallinta, ulkoistaminen, digitalisaatio

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Abbreviations

ABC – Activity-Based Costing
AI – Artificial Intelligence
API – Application Programming Interface
BDA – Big Data Analytics
BSC – Balanced Scorecard
CPFR – Collaborative, Planning, Forecasting, and Replenishment
CPS – Cyber-Physical System
CSCMP – Council of Supply Chain Management Professionals
DAP – Deliver at Place (Incoterm)
ERP – Enterprise Resource Planning
HVAC – Heating, Ventilation, and Air Conditioning (contextual)
IoT – Internet of Things
JIT – Just-in-Time
KM – Knowledge Management
KPI – Key Performance Indicator
LMS – Logistics Management System
ML – Machine Learning
RACI – Responsible, Accountable, Consulted, Informed
SAAS – Software as a Service
SCM – Supply Chain Management
SCOR – Supply Chain Operations Model
TCO – Total Cost of Ownership
TMS – Transportation Management System
WMS – Warehouse Management System

Acknowledgement:
This thesis used AI tools (ChatGPT by OpenAI) with structural suggestions.

1 Introduction

1.1 Research background

Supply chain management (SCM) and logistics operations are essential functions for organizations seeking to ensure reliable material flow, cost efficiency, and customer satisfaction. SCM is generally understood as the coordinated management of sourcing, production, and distribution activities across organizational boundaries (Mentzer et al., 2006). Effective logistics execution supports competitiveness by ensuring that goods are delivered in the right quantity, to the right place, and at the right time (Chopra, 2020). As global supply chains become increasingly complex and project-driven, the ability to coordinate flows of materials and information has become a strategic priority.

In this evolving context, digitalization has emerged as a critical enabler of supply chain performance. Modern supply chains increasingly rely on information sharing, visibility, and data-driven decision-making to reduce uncertainty and manage risks (Winkelhaus & Grosse, 2020). Integrated information systems (IIS) can be understood as enterprise-level platforms, such as ERP, TMS, or WMS, that link different supply chain functions and allow information to flow seamlessly across organizational boundaries (Bitkowska et al., 2024). Alongside effective data management, these systems play a vital role in optimizing logistics processes. However, when such systems are not well integrated – or when data is fragmented or unreliable – inefficiencies, delays, and increased costs can occur (Birkel & Hartmann, 2020; Durst & Evangelista, 2018). This challenge is particularly pronounced in project-based environments, where logistics often involves multiple suppliers, distributed deliveries, and strict timelines.

At the same time, organizations seek support from third-party logistics (3PL) providers to enhance logistics performance through outsourcing. While this offers specialized capabilities, it also introduces new challenges related to system integration, visibility, and coordination between internal tools and external platforms (Alkhatib et al., 2015).

This study explores how logistics operations in a project-based trading organization can be optimized by improving coordination between integrated information systems and data management. The company was chosen because it conducts international project deliveries, relies on outsourcing for some logistics tasks, and struggles with fragmented system integration and documentation. These features make it a relevant setting for analyzing how information systems and data practices influence logistics efficiency and cost-effectiveness in project-based environments.

1.2 Research problem and questions

Modern supply chains rely on digital systems and real-time data to coordinate logistics activities. However, in some organizations – especially those operating in complex, project-based environments – logistics operations are often disrupted by fragmented information systems, manual processes, and unclear lines of responsibility. These challenges can lead to delays, duplication of effort, data errors, and higher costs.

The company's unit in this study operates as a trading organization, managing electrification and industrial projects without its own manufacturing. Logistics in this context involves managing high volumes of diverse goods, coordinating multiple shipments under a single project, and ensuring that documentation, visibility, and planning are managed accurately. The current system environment includes ERP and custom-built tools that are not fully integrated or optimized for modern logistics requirements.

This thesis aims to explore how logistics operations can be improved through better coordination between internal systems, smarter data handling, and enhanced collaboration with third-party logistics providers. The goal is to identify inefficiencies and suggest improvements to support future system development and decision-making.

The study is guided by the following research questions:

1. What factors and challenges affect the effective use of integrated systems and data management in logistics operations?
2. How do integrated information systems and data management within the case company contribute to efficiency and cost-effectiveness in logistics operations?
3. How can third-party logistics providers' systems and data management practices be integrated with the case company to enhance efficiency and cost-effectiveness?

1.3 Scope and limitations of the study

This study focuses on logistics operations within a single trading business unit of a case company operating in project-based environments. The research primarily examines internal processes, system usage, and data handling practices related to logistics coordination. Both qualitative and quantitative data were collected from system records, process documents, and internal observations.

The scope is limited to the current tools, practices, and logistics-related challenges experienced within the specific unit. The study does not aim to evaluate the entire company's global logistics performance or to conduct a financial feasibility study on new system investments. While third-party logistics providers are discussed, the evaluation is based on secondary data and platform reviews, not on contractual analysis or live system demonstrations.

Furthermore, the study does not offer technical system design but instead provides analysis and improvement suggestions based on existing operations, data flows, and process observations.

The structure of this study is organized as follows. Chapter 2 presents the theoretical framework, introducing supply chain management, logistics operations, integrated information systems, and data management, with attention to outsourcing practices and digital transformation. Chapter 3 explains the research methodology, including the case study approach, data collection, and analysis methods. Chapter 4 presents empirical findings, covering the current state of logistics, stakeholder insights, cost-effectiveness, and integration challenges. Chapter 5 discusses the results in relation to the research questions and existing literature, highlighting theoretical contributions, practical implications, and limitations. Finally, chapter 6 concludes the study by summarizing the key findings, reflecting on their relevance, and suggesting directions for future research.

1.4 Case company description

The company operates in the industrial and electrical machinery sectors and is a part of a large multinational group with a strong global presence. The group's annual turnover is around thirty billion USD, and it employs more than 100,000 staff worldwide, reflecting its established role in international markets. The company serves a broad customer base across energy, automation, and heavy industry sectors, and is recognized as a reliable partner in delivering advanced technical solutions.

The business unit examined in this study specializes in projects that typically involve complex, multi-stakeholder supply chains, and strict contractual timelines. Unlike manufacturing-oriented logistics, the unit's operations are characterized by irregular shipment volumes, varying project sizes, and geographically dispersed delivery locations. This creates unique challenges for logistics coordination, visibility, and data management.

While the company primarily uses an enterprise resource planning (ERP) system to manage core processes, the unit has also developed a separate internal application to manage project-specific requirements. However, this legacy tool lacks modern integration capabilities and does not adequately support dynamic logistics demands or end-to-end documentation tracking. Consequently, the unit has faced growing difficulties in managing logistics operations effectively. Reliance on fragmented systems, limited integration with external serviced providers, and sparse internal documentation have led to reactive coordination practices, where manual processes and informal communication dominate daily operations. This has increased the risk of cost overruns and delivery delays, highlighting the need to improve logistics visibility, data management, and system integration. These challenges form the basis for examining how integrated information systems can enhance performance and cost transparency within the unit's logistics operations.

2 Literature Review

2.1 Supply Chain Management & Logistics

Modern supply chain management (SCM) and logistics are fundamental components of business operations, ensuring the efficient movement of goods, services, and information. SCM encompasses the strategic coordination of activities to enhance value creation, customer satisfaction, and competitive advantage (Mentzer et al., 2006). This section outlines the conceptual foundations of SCM and logistics, tracing their evolution and strategic role in today's environment, which increasingly depends on digital integration and data-driven coordination. The vital role of Integrated Information Systems (IIS) in enabling connectivity will be detailed in Section 2.2.

2.1.1 Evolution and Modern Trends in SCM

SCM has evolved from traditional linear supply chains to highly integrated and technology-driven networks. The digitalization of supply chains, globalization, and sustainability concerns have led to innovations in logistics and SCM (Pournader et al., 2020). Digital transformation, including big data analytics, artificial intelligence (AI), and blockchain, has improved visibility, forecasting, and decision-making across supply chains (Song et al., 2022).

In recent years, supply chain management has evolved from a function driven by manual workflows and siloed operations to one characterized by digital integration, real-time data, and predictive intelligence. Traditional supply chains often relied on experience-based planning, limited visibility, and disconnected information systems. In contrast, modern supply chains are increasingly structured as dynamic, technology-driven networks, offering greater transparency, responsiveness, and coordination (Maheshwari et al., 2021; Saberi et al., 2019; Winkelhaus & Grosse, 2020).

According to Chopra (2020), information serves as the foundation for decision-making and execution across supply chains, acting as a key enabler of integration and collaboration. The rise of technologies such as IoT, cloud computing, and AI has expanded access to real-time data, facilitating more agile operations and reducing risk. Digital platforms and SaaS-based solutions now allow globally dispersed actors to synchronize logistics efforts through shared dashboards and integrated workflows.

At the same time, researchers like Morana (2018) and Zu et al. (2021) note that logistics has grown from a purely operational concern into a strategic function. This transformation is supported by data-driven forecasting, smart transport solutions, and comprehensive traceability mechanisms – many of which rely on ERP systems, mobile tools, and automated analytics. Modern SCM frameworks increasingly focus on performance, sustainability, and customer-centricity, especially in complex project environments.

Table 1 below summarizes the key differences between traditional and modern supply chain approaches, highlighting the shift toward digitalization, automation, and integrated systems.

Table 1 Comparison Between Traditional and Modern Supply Chain Management Approaches.

Feature	**Traditional**	**Modern**	**References**
Visibility	Limited visibility, information silos, and delays in data sharing.	Real-time tracking, visibility across the entire supply chain through IoT, blockchain, and cloud-based supply chain management systems.	Winkelhaus & Grosse (2020); Saberi et al. (2019)
Process Efficiency	manual workflows, high lead times.	Automated processes, Robot	Maheshwari et al. (2021)

		Process automation, streamlined workflows.	
Data Management	manual processes, duplicates, many places for data	digitalized, automated, IoT, AI-driven	Durst & Evangelista (2018); Bitkowska et al. (2024)
Decision-Making	Based on incomplete or outdated information	Data-driven decisions with real-time insights	Shcherbakov & Silkina (2021)
Automation	Reliant on manual work, prone to errors	Automated processes for increased efficiency and accuracy	Tang (2020)
Risk Management	Higher risk of errors and delays	Reduced risks with real-time monitoring and data analysis	Birkel & Hartmann (2020)
Forecasting and planning	Experience-based, reactive, and partly manual. Forecasting relies on historical trends and expert intuition.	Data-driven, proactive, and automated. Uses AI, machine learning, and 3D modeling for accurate predictions.	Rao Tummala et al. (2006); Franke (2024)
Sustainability	Traditional fuels, high carbon footprint	Green technologies, CBAM, calculations, optimization, goals to be carbon neutral, etc.	Pournader et al (2020)

Customer experience	Relationship-driven, reliant on personal trust and interpersonal chemistry between buyer and seller	Fast, proactive and well customized solutions	Nicoletti & Appolloni (2024)

As illustrated, the shift toward digitalization and data-centric systems is not only technical but also strategic, affecting every layer of supply chain operations. These moderns' trends are the basis for further exploration of logistics as a core function of SCM.

2.1.2 Logistics as a Core Function of SCM

Logistics plays a vital role in SCM by ensuring timely and cost-effective transportation, inventory management, and warehousing (Mentzer et al., 2006). It enables companies to balance cost efficiency and service quality, directly impacting customer satisfaction (Herold et al., 2021). According to Larson and Rogers (1998), logistics is fundamental to SCM because it links internal functions with external partners, enabling organizations to serve customers effectively while minimizing total costs. The authors emphasize the intraorganizational focus of logistics as a contrast to the broader behavioral dimensions of SCM, such as inter-firm relationships and strategic alignment. Efficient logistics coordination contributes directly to improved service quality and enhanced customer experience.

This view is supported by Tadic et al. (2020), who highlight the interdependence between logistics subsystems – such as warehousing, transportation, and inventory – and the consequences of inefficiencies in any of these sections. Disruptions or mismatches in logistics processes can lead to increased costs and a decline in delivery performance. Therefore, high-quality logistics execution is essential not only for operational performance but also for maintaining financial health and customer trust.

Digitalization has expanded the strategic importance of logistics. Technologies such as the Internet of Things (IoT), RFID, artificial intelligence (AI), and cloud computing have transformed logistics into a real-time, data-driven operation. Smart logistics, enabled by these technologies, enhances visibility, responsiveness, and adaptability in complex environments (Ding et al., 2021). Tools such as Warehouse Management (WMS), Transport Management Systems (TMS), and Logistics Management Systems (LMS) provide integrated digital platforms for planning, tracking, and optimizing logistics processes (Ding et al., 2021).

Logistics now serves as a strategic interface between the company and its stakeholders, rather than merely handling deliveries (Morana, 2018). Through digital platforms and automation, logistics activities increasingly influence customer experience, sustainability performance, and competitive differentiation (Morana, 2018).

In summary, logistics has evolved from a support function to a central pillar of supply chain strategy, a core function of SCM. Its effectiveness is vital not only for reducing operational costs but also for enabling agile, customer-focused, and technology-driven supply chains.

2.1.3 Challenges and Future Directions

While technology adoption has improved logistics performance, challenges such as supply chain disruptions, regulatory complexities, and cybersecurity risks persist (Saberi et al., 2019). The shift toward real-time digital ecosystems has also introduced new vulnerabilities and the need for continuous system updates and data protection protocols.

Digital platforms designed to optimize logistics performance often face barriers to adoption. For instance, the discontinuation of *Tradelens* – a blockchain-based logistics initiative by IBM and Maersk – demonstrated that even high-potential solutions may fail without sufficient cross-industry collaboration, scalable integration and cost justification

(Jovanovic et al., 2022; O'Leary, 2023). This case highlights the structural and organizational vulnerabilities that can slow down digital transformation in logistics.

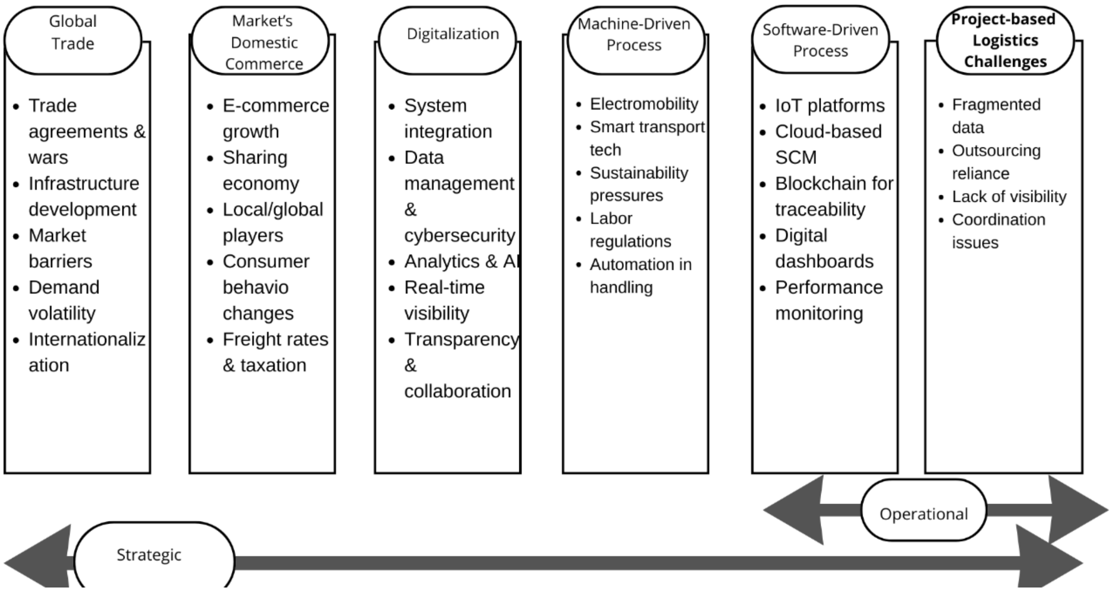

Figure 1 Transport and logistics trends (adapted from Bueno-Pascual et al., 2022 extended with project-based logistics challenges identified from literature).

Figure 1 illustrates how logistics processes are shaped by strategic global forces and operational technologies. This reinforces the growing role of logistics as a strategic enabler in supply chain management. As shown in the framework – which spans global trade dynamics, decarbonization pressures, and digital transformation – effective logistics management today relies on combination of policy awareness, infrastructure resilience, and real-time digital tools. These overlapping domains highlight that logistics are no longer purely operational but embedded in long-term business strategy and sustainability transitions.

To extend this framework, a separate column has been added to capture project-based logistics challenges. Prior research emphasizes that fragmented data, reliance on outsourcing, limited visibility, and coordination gaps are recurring issues in project-driven supply chains (Durst & Evangelista, 2018; Nicoletti & Appolloni, 2024; Solakivi et al., 2013; Winkelhaus & Grosse, 2020). These challenges differ from those in large-scale manufacturing contexts, where processes are often more standardized. Including them in the framework highlights that digital integration and outsourcing efficiency must be considered together when analyzing logistics in project environments. To address many of these challenges, integrated information systems (IIS) have emerged as a central solution for improving data visibility, coordination, and resilience in logistics. The following section (2.2) discusses the role of IIS in more detail.

2.2 Integrated Information Systems

Integrated Information Systems (IIS) enables seamless data exchange, coordination, and decision-making among various stakeholders. These systems integrate functions such as procurement, production, distribution, and logistics to enhance efficiency and supply chain resilience (Song et al., 2022).

The adoption of Enterprise Resource Planning (ERP), Warehouse Management Systems (WMS), Logistics Management Systems (LMS), Transportation Management Systems (TMS), and Blockchain with IoT has significantly improved supply chain visibility and operational performance (Rao Tummala et al., 2006).

Cloud-based ERP platforms represent a modern evolution of integrated information systems, offering seamless integration of logistics, procurement, and financial processes. These platforms allow globally distributed teams to work within unified systems, improving decision-making and responsiveness. These systems have emerged as practical solutions for agile and cost-effective digital integration, offering improved scalability, flexibility, and reduced implementation costs compared to traditional on-premise systems (Bitkowska et al., 2024).

While the benefits of IIS are significant, companies may still face implementation challenges, including legacy system compatibility, data standardization, and user adaptation. Nevertheless, advancements in AI, API standardization, and real-time data platforms continue to support more effective and scalable supply chain integration.

2.2.1 The Role of IIS in Supply Chain Management

Integrated Information Systems (IIS) play a vital role in synchronizing activities across the supply chain. These systems enable firms to reduce lead times, improve coordination, and enhance supply chain visibility. By facilitating real-time data exchange, IIS supports more accurate forecasting, faster decision-making, and improved responsiveness to operational disruptions (Chan & Choi, 2024; Durst & Evangelista, 2018).

The use of IIS available connects procurement and logistics into one unified platform. Complementary systems like Logistics Management Systems (LMS) and Transportation Management Systems (TMS) further extend this functionality by automating freight bookings, creating digital packing lists, and ensuring communication with third-party logistics (3PL) providers. As a result, companies can gain end-to-end transparency and control over complex logistics networks.

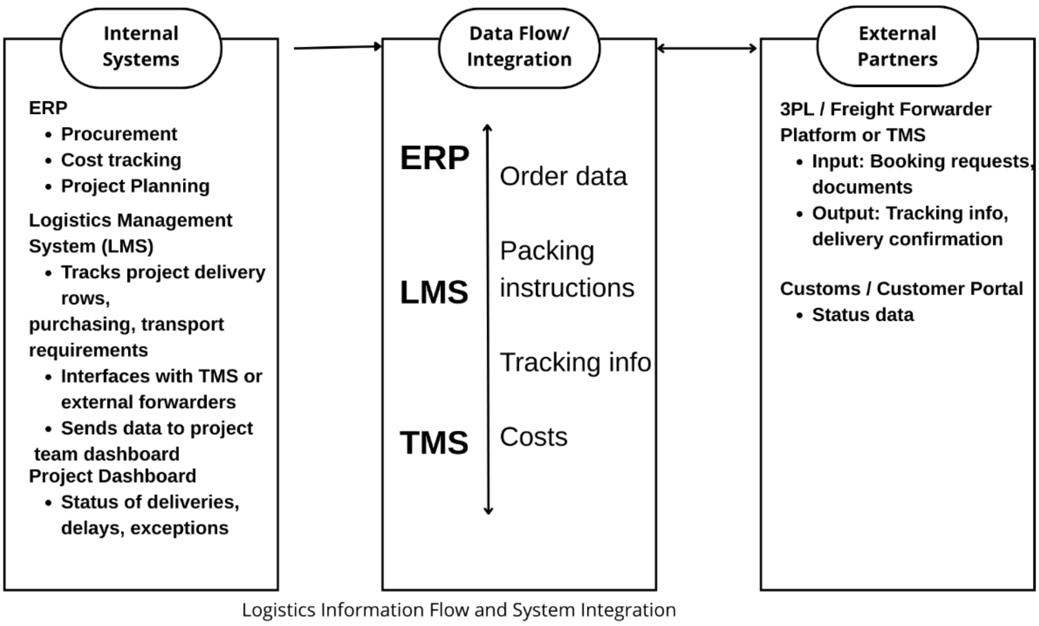

Figure 2 Logistics Information Flow and System Integration. Source: Created by the author (2025).

Figure 2 illustrates how logistics information flows between internal systems and external logistics partners. Internally, ERP manages core functions such as procurement and cost tracking, while logistics management system (LMS) supports delivery tracking, transport coordination, and data preparation for freight booking. TMS or external platforms then manage transport execution and cost-related data. The diagram emphasizes the importance of system integration in ensuring smooth data exchange – particularly in project logistics, where delays or incorrect information can result in costly disruptions.

Well-integrated systems also support real-time visibility for both internal users and external partners, such as 3PL providers and custom authorities. Dashboards function as an essential tool for summarizing logistics performance (e.g., delivery status, delays, and exceptions) for decision-makers, without requiring deep system expertise. The figure reinforces the idea that a modular yet connected system landscape is essential for agile and cost-effective logistics in complex supply chains.

2.2.2 Key Technologies in Integrated Information Systems

Enterprise Resource Planning (ERP) systems are the backbone of integrated supply chain management, combining data from procurement, production, finance, and logistics. They enable better demand planning, improved data visibility, and faster coordination across departments (Herold et al., 2021). Companies leveraging ERP have reported improved demand planning, cost reduction, and operational agility.

Logistics Management Systems (LMS) play an essential role in integrating supply chain operations with external logistics providers. These systems enable firms to coordinate with third-party logistics (3PL) providers, track shipments in real time, and automate freight management (Nicoletti & Appolloni, 2024). However, the successful integration of LMS with existing ERP and SCM tools remains a challenge, as firms must ensure seamless data exchange while maintaining system interoperability (Shcherbakov & Silkina, 2021).

Transportation Management Systems (TMS) streamline carrier selection, route planning, and freight billing. TMS can help to eliminate logistical inefficiencies such as congestion at transshipments points, delas in dispatching, and coordination issues by facilitating real-time transport planning and improving the vehicle scheduling process (Tadić et al., 2020).

Warehouse Management Systems (WMS) are designed to improve warehouse operations by enhancing inventory accuracy, streamlining order fulfillment, and optimizing space utilization. These systems help manage inbound and outbound logistics flows, while also improving the precision of storage and retrieval processes. Companies increasingly implement WMS to reduce errors, accelerate warehouse throughput, and support the broader goals of integrated logistics (Tadić et al., 2020).

Table 2 Overview of Key Supply Chain Information Systems.

System	**Primary Function**	**Role in SCM**	**References**
ERP	Enterprise-wide integration	Materials planning, procurement, order tracking	Herold et al. (2021), Rao Tummala et al. (2006)
WMS	Warehouse operations	Inventory accuracy, order fulfillment	Tadic et al. (2020)
TMS	Transportation execution	Route planning, carrier management, freight billing	Tadic et al. (2020)
LMS	Logistics coordination	Multi-shipment tracking, packing lists, document flow	Nicoletti & Appolloni (2024), Shcerbakov & Silkina (2021)

While Table 2. categories the systems separately, modern logistics platforms increasingly blur the lines between Transportation Management Systems (TMS) and Logistics Management Systems (LMS). Many advanced TMS platforms now incorporate features commonly associated with LMS – such as shipment tracking, packing list creation and documentation flow – creating a more unified solution. As logistics networks become more intelligent and connected, some systems also integrate warehouse-related functionalities or offer compatibility with warehouse networks. This convergence reduces the need for multiple standalone systems and supports a more seamless, end-to-end logistics management experience.

2.2.3 Challenges and Future Directions

Despite the recognized benefits of integrated information systems (IIS), several challenges continue to limit their effective adoption in supply chain and logistics management. Literature highlights that companies often struggle with legacy system compatibility and interoperability issues, which hinder seamless data exchange between internal and external platforms (Winkelhaus & Grosse, 2020). High implementation and maintenance costs also restrict widespread adoption, particularly for project-driven organizations that depend on flexible and scalable solutions (Gupta & Kumar, 2023). In addition, cybersecurity risks remain a critical concern, as increasing digitalization exposes logistics operations to data breaches and system disruptions (Saberi et al., 2019). Organizational resistance to change, insufficient training, and lack of user readiness further complicate implementation (Bitkowska et al., 2024).

At the same time, future developments point toward more advanced and resilient solutions. Emerging technologies such as AI, IoT, and blockchain are expected to improve interoperability, enable predictive analytics, and strengthen security across logistics networks (Pournader et al., 2020). Open-source platforms and cloud-based ERP solutions may also provide more cost-effective and scalable integration opportunities, while cross-organizational governance and standardization frameworks are needed to align technical and operational practices (Nitsche & Straube, 2023).

Table 3 summarizes the key challenges identified in literature and highlights potential directions for overcoming them.

Table 3 Challenges and Future Directions in Integrated Information Systems (IIS).

Theme	**Key Challenges**	**Future Directions / Solutions**	**References**
Interoperability	legacy system compatibility, fragmented platforms	Cloud-based integration, open APIs, standardization	Winkelhaus & Grosse (2020,) Nitsche & Straube (2023)
Cybersecurity	Data breaches, lack of safeguards	Blockchain security, AI-based monitoring	Saberi et al. (2019), Pournader et al. (2020)
Implementation costs	High initial investment, complexity	Scalable cloud ERP, modular tools	Bitkowska et al. (2024), Gupta & Kumar (2023)
Organizational Factors	Resistance to change, lack of training	Change management, capacity building	Bitkowska et al. (2024)

2.3 The role of Data and Data management in SCM

Data management is a critical component of modern supply chain management (SCM), facilitating real-time decision-making, process optimization, and risk mitigation. As supply chains become increasingly complex, companies must leverage advanced data analytics, integrated information systems, and digital technologies to enhance efficiency and transparency (Rao Tummala et al., 2006). Effective data management enables firms to track inventory, forecast demand, and improve supply chain resilience in response to disruptions (Song et al., 2022).

2.3.1 The Role of Data in Supply Chain Decision-Making

SCM relies on multiple types of data: transactional data (e.g., orders, invoices), master data (e.g., product codes, supplier info), and operational data (e.g., real-time inventory, location updates). Managing this information effectively ensures synchronization across supply chain nodes and enables advanced analytics to function accurately (Bitkowska et al., 2024; Chopra, 2020).

Accurate and timely data allows organizations to optimize procurement, inventory control, and logistics planning. Real-time and accurate data exchange is fundamental to enhancing supply chain visibility, improving coordination among stakeholders, and supporting sustainable and efficient operations (Lopes De Sousa Jabbour et al., 2019). The integration of digital tools such as cloud computing and IoT has significantly improved the accuracy of supply chain predictions and operational adjustments (Durst & Evangelista, 2018). Companies that effectively utilize big data analytics (BDA) can reduce costs, minimize delays, and enhance overall supply chain agility (Chan & Choi, 2024).

2.3.2 Digital Technologies and Data-Driven SCM

The adoption of digital technologies, including blockchain, IoT, and artificial intelligence, has revolutionized data management in supply chains. Blockchain technology provides an immutable ledger of transactions, improving traceability and reducing fraud risks (Pournader et al., 2020). IoT-enabled sensors enhance inventory tracking and monitoring, ensuring precise stock levels and minimizing disruptions (Herold et al., 2021). Artificial intelligence and machine learning further refine demand forecasting, enabling firms to predict supply chain fluctuations with greater accuracy (Nitsche & Straube, 2023). The Integration of Cloud ERP systems has emerged as a powerful enabler of data-driven supply chain management. By providing real-time access to logistics and operational data, Cloud ERP supports informed decision-making and enhances the responsiveness of supply chains. According to Bitkowska, Dziembek, and Gzik (2025), these systems contribute to improved data quality, consistency, and availability, all of which are essential for optimizing logistics workflows and facilitating digital transformation across the supply chain.

2.3.3 Case Examples on Data-Driven Supply Chains

There are companies that have successfully adopted data-driven strategies to enhance supply chain performance. These examples demonstrate how digitalization and real-time data utilization can improve visibility, efficiency, and responsiveness across logistics operations.

Companies like Amazon and Walmart are often cited as pioneers in leveraging big data and digital infrastructure to create a competitive advantage. These firms have embraced a digitalization logic, building operations on scalable technology platforms that support real-time data flow and advanced analytics (Herold et al., 2021). While they operate on a different scale than the case company, their supply chain strategies rely on integrating digital tools to streamline inventory control, fulfillment speed, and customer service.

Similarly, FedEx is often referenced for its early emphasis on information as a competitive asset in logistics. FedEx recognized early on that shipment data is as critical as the physical movement of goods (Baldwin, 2013, as cited in Herold et al., 2021).

Across industries, data-driven supply chains increasingly utilize cloud-based platforms, real-time tracking, and predictive analytics to optimize decision-making. The use of cloud ERP systems, for example enables firms to maintain consistent, high-quality data across functions, which supports agile logistics and efficient resource planning (Bitkowska et al., 2024). Furthermore, AI and machine learning enhance forecasting capabilities and support more accurate, automated decisions under uncertainty (Nitsche & Straube, 2023).

These examples illustrate how data-driven supply chains outperform traditional models by enabling greater control, responsiveness, and strategic agility across the value chain.

2.3.4 Challenges in Data Management for SCM

Despite the clear benefits of data management in SCM, there are challenges. Key issues include data security risks, system interoperability problems, and high implementation costs (Gupta & Kumar, 2023). As supply chains become increasingly digitized, ensuring robust cybersecurity is essential to protect sensitive logistics and transactional data from potential violations (Saberi et al., 2019). Furthermore, seamless integration between various systems and partners remains difficult due to a lack of standardized data formats and fragmented infrastructures (Winkelhaus & Grosse, 2020).

2.4 Operations optimization in logistics

Optimizing logistics operations is crucial for maintaining a competitive edge by reducing costs, improving lead times, and enhancing customer satisfaction (Rao Tummala et al., 2006). This involves refining supply chain processes, leveraging data-driven decision-making, and adopting efficiency-enhancing strategies (Durst & Evangelista, 2018).

2.4.1 Lean and Agile Logistics Approaches

Logistics optimization relies on lean and agile methodologies to enhance operational efficiency. Lean logistics focuses on waste reduction, just-in-time (JIT) inventory management, and streamlined workflows, minimizing excess stock and reducing costs (Belantová et al., 2019). Meanwhile, agile logistics enables firms to rapidly respond to market changes, demand fluctuations, and supply chain disruptions (Tadić et al., 2020). In practice, companies aim to combine both to build responsive and cost-effective solutions.

The integration of predictive analytics and real-time tracking supports both lean and agile logistics, enabling better demand forecasting and minimizing lead times (Surajit & Telukdarie, 2018). For example, advanced forecasting tools help firms optimize replenishment cycles, reducing stockouts and overstock scenarios (Pasupuleti et al., 2024).

2.4.2 Sustainability and Future Trends in Logistics Optimization

Sustainability has become a key driver of logistics optimization, influencing how companies design and manage their operations. Green logistics practices – such as optimizing delivery routes to reduce carbon emissions, minimizing deadheading, and adopting energy-efficient warehousing technologies – directly contribute to both environmental goals and operational resilience (Pasupuleti et al., 2024; Raslan et al., 2023). These measures not only reduce environmental impact but also enhance cost efficiency and customer satisfaction.

Emerging technologies are shaping the future of sustainable logistics. Machine learning (ML) algorithms are being used to forecast and manage logistics flows more accurately, significantly reducing inefficiencies such as empty runs in transportation networks (Pasupuleti et al., 2024). Blockchain technologies, while still under development, are also being explored as enablers of sustainability by improving traceability, transparency, and accountability in supply chains (Saberi et al., 2019).

Moreover, sustainability is increasingly becoming a strategic imperative for supply chain design, not just an operational concern. As Nitsche and Straube (2023) state, logistics networks must adapt to growing global demands and regulatory pressures by embedding sustainability into their long-term strategies. These shifts are also intertwined with the rise of digitalization, challenging firms to rethink how they align technology and sustainability goals within globally distributed operations.

In conclusion, as supply chains evolve, the integration of sustainability into digital logistics frameworks will become a core competency. Companies must balance environmental objectives with performance outcomes, leveraging innovations like AI, blockchain, and autonomous transport systems to meet future demands.

2.5 Change Management in Digital Logistics Transformation

Change Management is central to the success of digital transformation in supply chain management (SCM). While integrated information systems (IIS) and data-driven tools provide technical opportunities, their effective use depends on leadership, employee readiness, and organizational alignment (Bitkowska et al., 2024; Durst & Evangelista, 2018). Without structured change management, new systems risk underutilization or even rejection.

2.5.1. Leadership and Employee Adaptation

Leadership plays a key role in driving digital adoption by communicating a clear vision, ensuring training resources, and motivating employees to embrace change (Chan & Choi, 2024). Resistance is common when staff perceive digital tools such as ERP or TMS as disruptive to established practices (Winkelhaus & Grosse, 2020). Employee engagement through participatory implementation, skills training, and trust-building reduces reliance on informal workarounds and ensures that IIS and data management tools are used effectively.

2.5.2 Organizational Alignment and Overcoming Resistance

Digitalization in logistics often requires reconfiguring workflows, roles, and partner collaboration. Legacy practices and fragmented systems create structural resistance, slowing adoption (Saberi et al., 2019). Addressing these challenges demands clear role definitions, process standardization, and governance mechanisms that support cross-organizational coordination (Nilsson, 2006). Kotter's (1996) principles of urgency creation, coalition building, and embedding new practices remain relevant as guiding frameworks, but they must be adapted to logistics realities such as outsourcing and platform interoperability (Appelbaum et al., 2012).

2.6 Process handling and development in SCM

Effective process handling and continuous development in supply chain management (SCM) are essential for improving efficiency, ensuring flexibility, and integrating technological advancements. Organizations must focus on process integration, continuous improvement methodologies, and digital transformation to enhance operational performance and remain competitive in an evolving market (Von Stietencron et al., 2022).

2.6.1 Process Integration and Automation

Process integration is key to achieving operational efficiency in SCM. Digital platforms and automation tools facilitate the seamless coordination of various supply chain activities, reducing delays and improving accuracy (Shcherbakov & Silkina, 2021). Automated order processing minimizes manual intervention, enhancing speed and accuracy in the order-to-delivery cycle. IoT-enabled tracking systems provide real-time visibility into shipments, allowing proactive decision-making (Ding et al., 2021). Cyber-Physical Systems (CPS) integrate physical operations with digital analytics, improving logistics responsiveness and adaptability (Douaioui et al., 2018).

2.6.2 Continuous Process Improvement in SCM

Continuous improvement methodologies, such as Lean Six Sigma, enable companies to identify inefficiencies, minimize waste, and enhance performance (Shcherbakov & Silkina, 2021). Digital tools support these initiatives by providing real-time data analytics and performance monitoring (Maheshwari et al., 2021). Real-time data analytics facilitates demand forecasting and predictive maintenance, ensuring proactive supply chain management (Maheshwari et al., 2021). Process automation reduces errors and enhances efficiency in logistics operations (Ding et al., 2021). Additionally, IoT-enabled risk management enhances transparency in supplier selection and sourcing strategies, reducing uncertainties (Birkel & Hartmann, 2020).

2.6.3 Smart Logistics and Process Handling

Smart logistics models leverage IoT, cloud computing, and machine learning to enhance process efficiency and reduce operational costs (Tang, 2023). IoT-enabled sensors improve supply chain visibility, enabling organizations to monitor inventory, shipments, and warehouse conditions in real time (Feng & Ye, 2021). Cloud-based platforms centralize data management, optimizing supply chain processes and decision-making (Tang, 2023). Predictive analytics enhances operational efficiency by identifying process inefficiencies before they escalate (Maheshwari et al., 2021). AI-driven automation supports self-regulating logistics operations, reducing the reliance on manual interventions and improving overall supply chain responsiveness (Ce et al., 2023).

2.6.4 Standardization and Process Frameworks

Standardizing logistics processes improves reliability and performance across supply chain operations. Frameworks such as The Supply Chain Operations Reference (SCOR) model (Figure 3) provides a structured approach to planning, sourcing, making, delivering, and returning goods, ensuring consistency and efficiency in process management (Nicoletti & Appolloni, 2024). Other frameworks supporting process standardization include Collaborative Planning, Forecasting, and Replenishment (CPFR), which enhances supply chain coordination and reduces operational costs (Cichosz et al., 2020). The Balanced Scorecard (BSC) Framework provides performance measurement for continuous process evaluation, ensuring alignment with strategic goals (Lizhong Tong et al., 2015). In addition, emerging logistics park platforms improve resource integration and operational performance, enabling greater efficiency across supply chain networks (Lyu et al., 2019). Altogether, these frameworks illustrate diverse approaches to achieving standardized and optimized logistics processes.

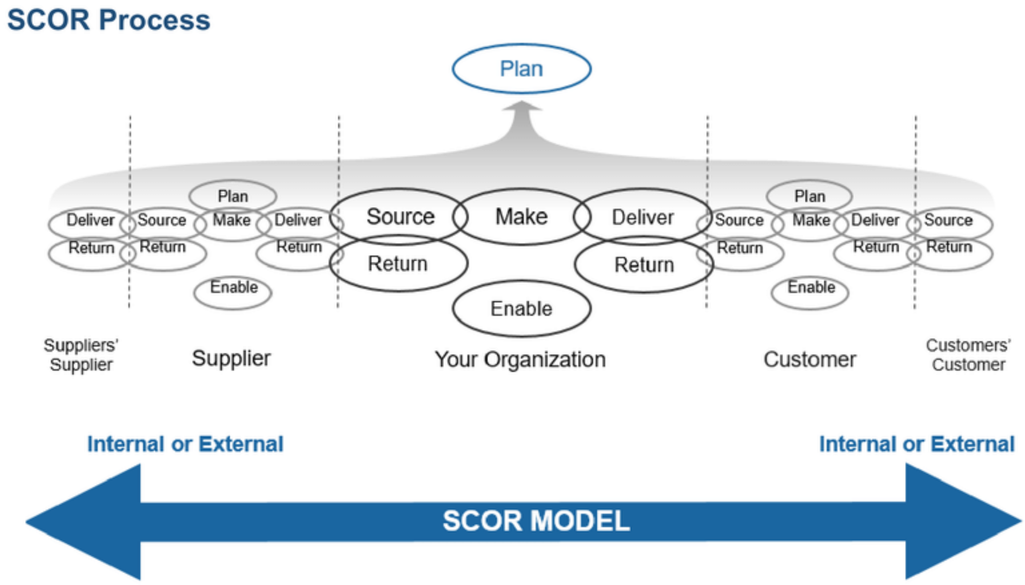

Figure 3 The SCOR Model Source: APICS 2017.

2.6.5 Future Developments in Process Handling

Digitalization significantly enhances the SCM process handling by integrating automation, AI, and real-time monitoring. The Value Stream 4.0 model emphasizes the role of digital tools in mapping and optimizing both physical and digital processes (Franke, 2024). Predictive maintenance reduces downtime and increases equipment lifespan, ensuring uninterrupted logistics operations (Tang, 2023). Blockchain enhances supply chain security and transparency by providing immutable transaction records, reducing fraud risks and improving traceability (Pournader et al., 2020). Benchmarking and Activity-Based Costing (ABC) support performance evaluation and cost reduction by identifying key operational inefficiencies and optimizing resource allocation (Larson & Rogers, 1998).

As supply chains evolve through automation and digital process integration, organizations increasingly reassess which functions should be managed internally, and which are better managed by specialized partners.

2.7 Logistics Outsourcing

Logistics outsourcing is a strategic approach that enables companies to focus on their core competencies while leveraging specialized logistics service providers (LSPs) to manage supply chain operations. Outsourcing logistics functions, also known as third-party logistics (3PL) or contract logistics, offers potential benefits such as cost savings, efficiency improvements, and enhanced supply chain flexibility (Larson & Rogers, 1998). However, effective outsourcing requires careful coordination, digital integration, and strong partnerships to mitigate risks and ensure optimal performance (Song et al., 2022).

2.7.1 Benefits and Challenges of Logistics Outsourcing

Outsourcing logistics can provide operational flexibility, allowing companies to scale logistics operations according to demand fluctuations (Song et al., 2022). Digitalization has further transformed logistics outsourcing by improving coordination, efficiency, and real-time visibility in supply chain management (Herold et al., 2021). Companies utilizing 3PLs benefit from access to specialized expertise, lower capital investment, and increased service efficiency (Maheshwari et al., 2021). Logistics platforms also enhance operational performance by integrating outsourced logistics functions into a company's supply chain network (Lyu et al., 2019).

However, outsourcing logistics introduces challenges, including loss of control, data security concerns, and dependency on external providers (Shi et al., 2024). Companies must balance cost savings with risks such as service disruptions, reduced responsiveness, and limited visibility into outsourced operations (Solakivi et al., 2013). Establishing strong contractual agreements and continuous performance evaluation can help mitigate these risks (Lizhong Tong et al., 2015).

2.7.2 Impact of Digitalization on Outsourced Logistics

The integration of Industry 4.0 technologies, including IoT, AI, and cloud computing, has significantly improved logistics outsourcing by enhancing supply chain visibility and operational efficiency (Abdirad & Krishnan, 2023). Digital platforms enable real-time shipment tracking, automated inventory management, and AI-driven decision support systems, reducing inefficiencies in outsourced logistics operations (Winkelhaus & Grosse, 2020). Additionally, predictive analytics allows companies to anticipate disruptions and optimize route planning, leading to improved supply chain resilience (Feng & Ye, 2021).

Cloud-based ERP systems play a crucial role in enabling digital transformation in outsourced logistics operations. They provide real-time data access, flexible scalability, and cost-effective integration with other systems (Bitkowska et al., 2024). Unlike traditional on-premises ERP systems, cloud ERP platforms can be accessed by third-party providers through secure portals or APIs, reducing technical barriers to collaboration. This ease of access facilitates seamless coordination with external logistics partners, supporting integrated planning and execution across organizational boundaries and enhancing agility and responsiveness.

Despite these advancements, digital transformation in logistics outsourcing also presents cybersecurity risks, interoperability challenges, and resistance to technology adoption, requiring firms to implement robust data security protocols and ensure seamless system integration with logistics providers (Cichosz et al., 2020).

2.7.3 Strategic Considerations: Insourcing vs Outsourcing

While logistics outsourcing is widely adopted, some companies prefer insourcing to retain greater control and integration over their supply chain (Tadić et al., 2020). Insourcing allows companies to maintain a higher degree of vertical integration, data security, and supply chain customization (Sharakhin et al., 2021). However, it also requires significant capital investment in logistics infrastructure and expertise (Solakivi et al., 2013).

The decision between insourcing and outsourcing depends on factors such as cost-effectiveness, strategic priorities, and the complexity of logistics operations (Han & Hui, 2010). Market leaders often develop proprietary IT systems for supply chain management to maintain a competitive edge and enhance data security (Sharakhin et al., 2021). A part of companies tends to outsource some parts of logistics operations and maintain some parts.

2.7.4 Advanced Models: 4PL and 5PL

As logistics outsourcing has matured, companies increasingly seek providers capable of managing not only physical flows but also information, coordination, and strategy. Advanced outsourcing models such as fourth-party logistics (4PL) and fifth-party logistics (5PL) reflect this evolution toward data-driven and system-integrated supply chains (Nicoletti & Appolloni, 2024).

4PL providers act as integrators that manage logistics resources, technologies, and service providers on behalf of the client, emphasizing visibility, strategic alignment, and digital coordination across the network (Ji, 2009; Zhang et al., 2006). This model can reduce administrative workload for the buyer and support end-to-end optimization. However, adoption remains challenging due to collaboration difficulties, system integration barriers, and unclear role boundaries between 3PL and 4PL actors (Fattam et al., 2023).

5PL providers extend the concept further by employing big data analytics, AI, and cloud-based ecosystems to orchestrate global logistics networks (Nicoletti & Appolloni, 2024). These models emphasize predictive planning, multimodal optimization, and end-to-end visibility, often relying on digital platforms and automation tools to enhance responsiveness (Gruchmann et al., 2020).

The evolution from 3PL toward 4PL and 5PL thus reflects a broader shift from transactional outsourcing to integrated, data-driven collaboration, illustrating how digital transformation reshapes the strategic role of logistics service providers within supply chain management.

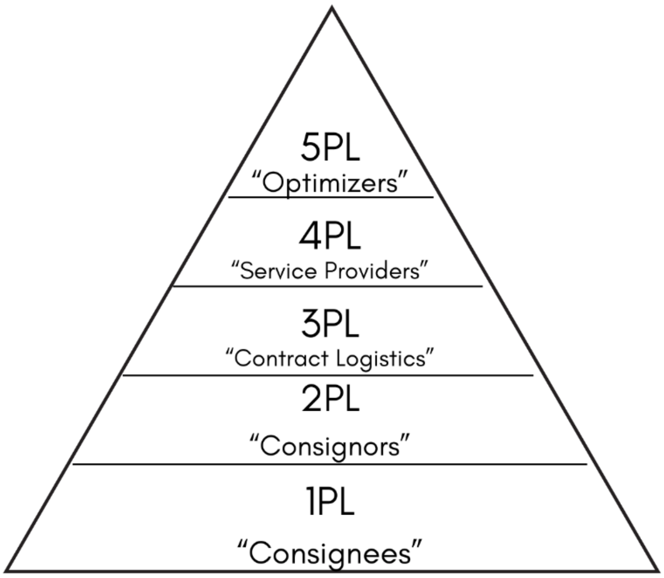

Figure 4 Hierarchical overview of logistics service provider levels. Source Author 2025

2.7.5 Future Trends and Managerial Implications

The future of logistics outsourcing will be shaped by technological advancements, sustainability requirements, and evolving supply chain strategies (Han & Hui, 2010). Companies must integrate digital supply chain solutions, AI-driven decision support systems, and green logistics practices to remain competitive (Arif & Jawab, 2018).

Key managerial considerations include selecting the right LSPs, ensuring data security in outsourced operations, and aligning logistics outsourcing strategies with corporate objectives (Alkhatib et al., 2015). As global supply chains become more interconnected, companies must adopt agile outsourcing models that balance efficiency, risk mitigation, and supply chain resilience (Shi et al., 2024).

2.8 Cost-Effectiveness in Logistics Operations

Cost-effectiveness in logistics operations is a key driver of supply chain performance, enabling organizations to reduce operational costs while maintaining high service levels. Companies achieve cost optimization by improving inventory management, streamlining transportation, and leveraging digital technologies to enhance efficiency (Rao Tummala et al., 2006). Collaboration with suppliers and distributors is also critical, as it enhances coordination and reduces inefficiencies across the supply chain (Durst & Evangelista, 2018).

2.8.1 Strategies for Cost Optimization

Cost-effectiveness in logistics requires a balance between minimizing expenses and maintaining service quality. Effective knowledge management (KM) contributes to cost reduction by improving decision-making and optimizing resource utilization (Lee & Song, 2018). Implementing Lean Six Sigma techniques and Industry 4.0 tools further enhances efficiency by eliminating waste, automating processes, and improving logistics coordination (Tadić et al., 2020).

2.8.2 The Role of Digitalization in Cost Reduction

Digital transformation in logistics has fundamentally reshaped cost structures by reducing manual interventions and increasing process automation. Herold et al. (2021) assert that digital technologies, including AI, the IoT, and blockchain, are transforming supply chain processes. By adopting IoT-based tracking systems, companies can enhance visibility, reduce shipment losses, and optimize fleet utilization, leading to significant cost savings (Feng & Ye, 2021). Smart contracts and blockchain technology further improve financial flows by reducing intermediaries, preventing fraud, and ensuring timely payments (Saberi et al., 2019).

2.8.3 Economic Benefits of Cost-Effective Logistics Operations

Achieving cost-effectiveness in logistics operations provides tangible economic benefits, including lower transportation costs and improved financial performance (Cichosz et al., 2020). The Balanced Scorecard (BSC) framework, which aligns logistics performance with strategic goals, enables companies to monitor cost-related KPIs and identify savings opportunities (Lizhong Tong et al., 2015).

2.8.4 Case Studies on Cost-Effective Logistics Practices

Real-world applications of cost-effective logistics strategies illustrate their impact on supply chain performance. For example, DHL implemented an IoT-enabled climate control system that reduced energy costs by 40% by adjusting facility temperatures based on weather forecasts (Gupta & Kumar, 2023). Additionally, the use of low-power sensors to monitor the location of logistics equipment has helped DHL reduce shrinkage and improve asset utilization.

Companies that utilize big data analytics (BDA) in inventory management have also reported reduced stock levels while maintaining high service quality (Maheshwari et al., 2021). These systems analyze customer behavior, demand fluctuations, and supply chain patterns to improve decision-making and forecasting accuracy.
Finally, broader Logistics 4.0 initiatives – such as real-time tracking, digital document flows, and route optimization – have enabled companies to lower fuel consumption, improve fleet utilization, and minimize delays (Winkelhaus & Grosse, 2020).

2.9 Summary of the Literature Review and Identified Research Gaps

The literature review demonstrates that digital transformation, integrated information systems (IIS), and data-driven management are key enablers of logistics efficiency, visibility, and cost-effectiveness (Herold et al., 2021; Winkelhaus & Grosse, 2020). Technological solutions such as ERP and TMS improve coordination and transparency, while outsourcing models such as 3PL and 4PL provide flexibility and specialized expertise (Nicoletti & Appolloni, 2024). However, their success depends not only on technology but also on organizational alignment, process standardization, and information sharing across internal and external partners (Bitkowska et al., 2024; Durst & Evangelista, 2018).

Despite these advancements, several research gaps exist. First, existing studies mainly focus on large manufacturing or retail contexts, while project-based trading organizations – where logistics processes are unique and coordination is more complex – remain underrepresented in the literature (Solakivi et al., 2013). Second, prior research emphasizes technological integration but pays less attention to how organizational culture, communication, and data management practices influence digital adoptions and efficiency (Chan & Choi, 2024; Nilsson, 2006). Third, although outsourcing and 3PL/4PL frameworks are widely discussed, there is limited understanding of how digital connectivity and information sharing between client and provider affect logistics visibility and cost control in practice (Gruchmann et al., 2020).

This study aims to address these gaps by analyzing logistics operations in a project-based trading unit that relies on external logistics providers. It explores how integrated systems and data management support operational efficiency and cost-effectiveness, and how digital collaboration with logistics providers can enhance transparency and decision-making.

3 Research Methods

3.1 Methodology Selection

This study adopts a mixed-methods case study approach, combining qualitative and quantitative research techniques to investigate logistics coordination and information system integration in an organizational setting. A case study design was selected because it enables an in-depth, contextual analysis of complex supply chain and logistics phenomena within their real-life environment, rather than in a controlled or experimental context (Farquhar et al., 2020). This approach is particularly suitable for examining how integrated information systems and data management practices function within a single business unit.

The mixed-methods design allows for a comprehensive understanding of the research problem by integrating qualitative and quantitative perspectives. Combining these two approaches enhances both the depth and validity of the findings (Farquhar et al., 2020). In this study, qualitative data – including stakeholder insights, internal documents, and observations – were analyzed thematically to identify recurring patterns in system usage and organizational practices. Quantitative data, such as project cost records and freight performance statistics, complemented these findings by providing measurable evidence on logistics efficiency and cost control.

To improve the robustness and credibility of the findings, triangulation was applied in line with the recommendations of Farquhar et al. (2020). The triangulation in this study included three elements:

1. Data triangulation – combining multiple types of data, such as survey answers, documents, and cost records.
2. Methodological triangulation – integrating thematic analysis with quantitative analysis of logistics performance data.
3. Source triangulation – incorporating insights from stakeholders across separate roles within the case company.

Together, these approaches ensured that the research findings were well-grounded, consistent across data types, and reflective of the case company's real operational environment.

3.2 Data Collection Procedure

The data in this study was collected through multiple sources using a mixed-methods approach, combining both qualitative and quantitative material.

The quantitative data consists primarily of systems-based information retrieved from the company's internal tools, including cost breakdowns from earlier logistics projects and freight booking records available through systems. In addition, financial data related to ERP and subsystem development budgets were gathered to support the analysis of operational and digital investments' efficiency.

The qualitative data was collected through several complementary internal sources. First, an internal survey conducted as part of a logistics improvement initiative provided open-ended responses reflecting employee perceptions of current practices, bottlenecks, and improvement needs. The survey was distributed to 14 sales personnel and 10 project managers, of whom 6 and 7 responded, respectively. In addition, two logistics employees completed the same survey targeted at project managers (Appendix 2). This resulted in a total of 15 responses, corresponding to an overall response rate of approximately 60%, which provided a balanced perspective across key operational roles.

Second, a role clarification (RACI) workshop was organized with three key participants, representing project management and logistics, to map responsibilities and identifying overlapping or unclear areas between logistics and related functions. Third, internal reports and documentation, including "lessons learned," reports were analyzed to capture recurring issues and improvement proposals. These materials provided additional triangulation by confirming several patterns observed.

In addition, observations of internal logistics workflows have been gathered throughout the time of creating the study. These observations provided a contextual understanding of how daily operations, communication flows, and information systems interacted in practice. Informal clarifying discussions occasionally took place to deepen understanding of survey responses or observed processes; however, these were not treated as formal interviews and were used only to support interpretation.

The internal process survey status targeted two key respondent groups: sales personnel and project managers. The response rate among sales respondents was slightly below 50%, while approximately 80% of project managers participated. This high response level among project managers strengthened the reliability of qualitative insights.

A summary of all qualitative data sources used in the study, including the survey, RACI, and internal documentation, is presented in Appendix 1 (Table 9). The survey forms and questions are provided in Appendix 2, with key findings.

Finally, secondary data from a prior internal logistics evaluation project (Huhta, 2024) were utilized to strengthen triangulation. This earlier survey included qualitative comments and performance assessments that echoed several of the same challenges identified in the present study, such as limited visibility in delivery timelines and fragmented coordination between systems. The consistency of findings across time periods reinforces the credibility and validity of the present analysis.

The overall data collection process followed the guidelines of Braun and Clarke (2006), ensuring a thorough and systematic approach to gathering qualitative material. The use of multiple sources aligns with the principles of triangulation emphasized by Farquhar et., al (2020), increasing the validity and robustness of the findings.

3.3 Data Analysis Procedure

The collected data was analyzed through a combination of thematic analysis, descriptive statistical analysis, and document analysis, following a systematic approach aligned with the study's mixed-methods design. Each method was selected to correspond with the type of data collected and to enable methodological triangulation (Farquhar et al., 2020).

The qualitative data, mostly from recent years 2022-2025, was analyzed using thematic analysis, which is well-suited for identifying and interpreting recurring patterns in qualitative data (Braun & Clarke, 2006). The analysis followed Braun & Clarke's (2006) six-phase framework:

(1) Familiarization with the data
(2) Generating initial codes
(3) Searching for themes
(4) Reviewing themes
(5) Defining and naming themes, and
(6) Producing the final report.

Initial coding was conducted manually by reading and annotating notes as well as survey results. Codes were first assigned to descriptive segments such as "system usability problems, "manual work redundancy," and "lack of ownership." These were then grouped into broader themes – "fragmented system landscape" and "organizational resistance to digital tools" – reflecting recurring issues across different data sources. This thematic structure was compared against the challenges discussed in the literature (Saberi et al., 2019; Winkelhaus & Grosse, 2020) to identify both alignment and divergence between empirical observations and theoretical expectations.

In addition to thematic coding, narrative elements reflecting participants' emotional and experiential perspectives were observed and noted. These narrative insights provided a deeper contextual understanding of how system usability, process fragmentation, and organizational resistance were perceived within the logistics operation (Holley & Colyar, 2012).

The quantitative data, primarily drawn from 2022-2024 ERP reports, freight booking records, and logistics cost summaries, were analyzed using descriptive statistical methods to identify cost structures, booking timelines, and process variations. Descriptive analysis is appropriate for case studies where the objective is to summarize data characteristics and detect patterns without statistical generalization (Farquhar et al., 2020). The data was processed and visualized using Microsoft Excel to compare cost elements across projects, identify deviations in booking lead times, and support the interpretation of cost-efficiency metrics.

Document analysis complemented these findings through a structured review of internal reports, workflow descriptions, and prior logistics evaluations. Following *Bowen's (2009)* systematic approach, documents were assessed for their authenticity, credibility, representativeness, and meaning. This analysis offered a historical perspective on logistics documentation practices and validated several issues identified in the qualitative findings - particularly the limited standardization of reporting and inconsistent data maintenance.

Across all three data types, triangulation was applied to strengthen the reliability of the results (Farquhar et al., 2020). Evidence from qualitative themes, quantitative cost analysis, and document review was cross-referenced to ensure consistency and reinforce the robustness of interpretations.

This integrated analytical procedure provided a comprehensive understanding of the company's logistics operations and information system landscape, combining empirical depth with methodological rigor.

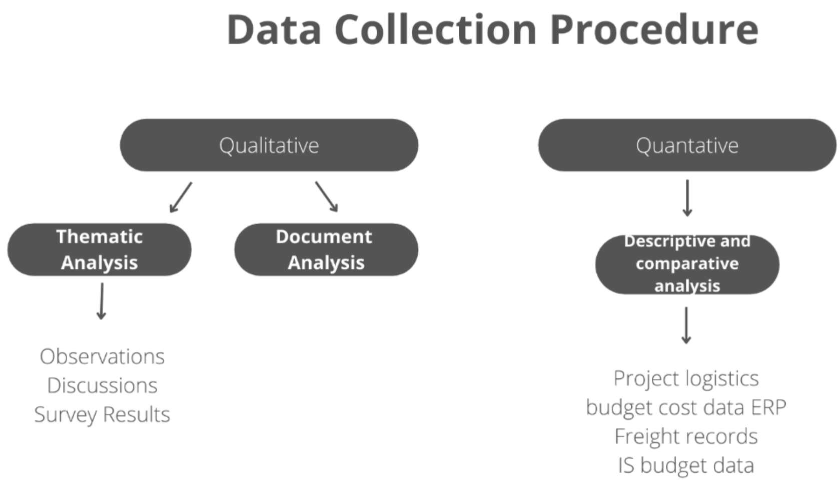

Figure 5 Data Collection and Analysis Overview. Source: Author

Figure 5 illustrates the parallel structure of qualitative and quantitative analysis, reinforcing the mixed-methods design adopted in this study.

4 Results

4.1 Current Logistics System Performance

In this chapter, the aim is to briefly describe the current logistics system performance with data and observations from the employees in the case company. The focus is on how freight costs are planned, tracked, and realized across project deliveries.

4.1.1 Freight Cost Patterns

This section presents an overview of freight cost performance across seven anonymized projects. The comparison is based on planned logistics budgets versus realized costs. The data used for Figure 6 was retrieved from the company's internal ERP system. The percentage deviation for each project was calculated using the following formula:

Percentage Deviation (%) = (Realized Cost – Planned Budget) / Planned Budget x 100

A positive value indicates that the project remained under budget (cost savings), while a negative value indicates budget overruns. To ensure comparability, only closed projects with the same currency and year were chosen. The deviations were visualized in Excel (Figure 6).

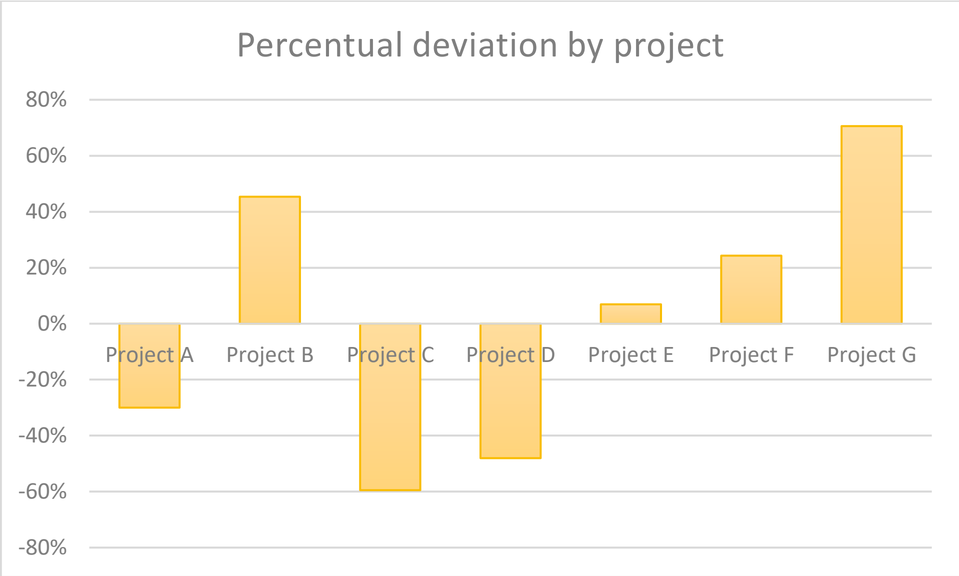

Figure 6 Percentual deviation between planned and actual freight costs by project. Source: Author

Freight cost performance varied between projects. Projects B, E, and F reported budget variances, with realized costs falling below the planned logistics budget by 7-45%. These savings were partially attributed to efficient supplier coordination, consolidated truckload bookings, and clear scope control. For example, in Project B, the use of a centralized warehouse and synchronized shipments enabled cost optimization through bulk quotations and reduced administrative overhead. Similarly, Project F, which was closely related to Project E, showed 24% savings despite a comparable budget structure, suggesting effective logistics execution and minimal delays.

In contrast, Projects A, C, and D showed budget overruns, with Project C exceeding its logistics budget by almost 60%. In this case, complex cross-border delivery chains and partial shipments led to higher handling and coordination costs. The delivery route, which included transportation between multiple countries and warehouse storage, introduced inefficiency and customs-related costs. The data suggests that fragmented logistics flows and multi-country deliveries contribute to higher cost variance across projects. Furthermore, Projects suffered from limited visibility into supplier-arranged DAP deliveries. The associated logistics costs were either absorbed by suppliers or recorded outside the main costs, which complicates budget follow-up.

Project G presented a different kind of challenge. Although low logistics costs, the discrepancy between the procurement volume and the given logistics budget suggests that a sizable part of deliveries was executed through supplier-managed arrangements, which are not fully traceable within internal systems. Additionally, some logistics related expenses were recorded during the warranty period and distributed to warranty-related cost accounts.

One key limitation in freight cost tracking is the fragmentation of logistics data. As seen across the projects, cost entries may be scattered across different systems or fiscal years – especially when purchase orders span long project timelines. Additionally, when internal tools or email-related bookings are archived or removed, it becomes challenging to trace historical decision-making or cost justifications. This pattern highlights documentation gaps and missing cost details within project records.

Overall, the analysis highlights the need for improved transparency and unified cost tracking in project logistics. The observed system fragmentation makes it difficult to monitor logistics costs or evaluate performance consistently.

4.1.2 Booking and Delivery Timelines

In the case of the company's logistics operations, freight bookings are typically initiated through manual coordination via email, with forwarding partners managing the quoting and execution processes. While a part of standard deliveries utilizes an integrated Transportation Management System (TMS), more complex project shipments often require customized handling that falls outside routine workflows. This hybrid approach results in variation in how logistics information is gathered and recorded across projects.

Delivery timelines differed significantly depending on the project type, shipment size, and geographical destination. Intra-European deliveries are usually completed within a few days, whereas shipments involving non-EU countries or oversized cargo can extend over several weeks due to customs formalities, route planning complexity, and coordination with third-party logistics providers (3PLs). Data collected from internal booking records and project reports indicates that shipment lead times in complex projects can be up to three times longer than for standard deliveries.

A recurring issue observed in the data and stakeholder feedback is the lack of standardized booking procedures. Delays in initiating freight bookings were common, particularly when responsibilities between the project and logistics teams were unclear. Email correspondence showed that essential shipment details were often finalized only after purchase orders were placed, limiting the time available for freight planning. This reactive booking behavior has contributed to last-minute actions and increased administrative workload.

To address these inefficiencies, the case company launched an internal development initiative in the spring of 2025. As part of this initiative, a role clarification (RACI) table was conducted to define responsibilities between project management and logistics (see Appendix 3). In addition, standardized data templates were introduced to ensure that necessary shipment details are transferred consistently at the project planning stage. Regular meetings between project managers and logistics personnel are also being implemented to improve mutual visibility and ensure early involvement of logistics in projects. These steps aim to reposition logistics from a reactive service role toward a proactive, integrated project stakeholder. Together, these process improvements aim to enhance predictability and reduce administrative delays across project-based logistics.

4.1.3 Use of ERP and supplementary tools

The case company primarily relies on an on-premises ERP system to manage procurement and order processing. The ERP serves as the central tool for recording purchase orders, tracking incoming goods, and handling invoice-related logistics data. However, due to the complexity and project-specific nature of the unit, the ERP system is not fully equipped to support all logistical needs – particularly those requiring cross-functional coordination, detailed shipment tracking, or real-time freight status updates.

To compensate for these gaps, logistics functions make extensive use of supplementary tools. These include Sharepoint-Based tracking documents, internal Excel templates, email threads, and a custom legacy application developed to manage project-specific logistics data. While these tools enable flexibility and localized control, they also result in duplicated work and inconsistent information across platforms. The coexistence of multiple parallel tools has created fragmented data structures, making it difficult to maintain unified and traceable logistics records.

Monitoring logistics performance is further complicated by the absence of standardized templates and inconsistent data storage practices. In several cases, project documentation was distributed across different folders or systems, making retrospective analysis time-consuming and incomplete. Some logistics information was missing entirely due to the reliance on personal tracking files or email-based updates.

Recognizing these limitations, the case company has started steps to improve system usage practices. While full system renewal has not yet been implemented, ongoing development efforts include standardizing templates, enhancing internal documentation, and aligning logistics tools more closely with project management timelines.

4.2 Qualitative Insights from Stakeholders and Observations

Following Braun and Clarke's (2006) six-phase framework, qualitative data from stakeholder insights, internal observations, and document analysis were systematically coded to identify recurring themes. The analysis revealed four key areas of concern that reflect operational, systemic, and human-related challenges in logistics coordination and information management.

Theme Identification Process:

After familiarization with the material, recurring expressions related to logistics coordination, system usage, and communication were coded manually. These initial codes were then grouped into broader conceptual categories that reflected patterns across participants. From this process, four overarching themes were derived:

(1) System Underutilization and Fragmentation

(2) Communication Gaps and Manual Effort

(3) Documentation and Customer Visibility, and

(4) Demotivation and Perceived Inefficiency.

Each theme represents a synthesis of multiple coded extracts rather than a single participant statement, ensuring reliability through pattern-based comparison.

Theme 1: System Underutilization and Fragmentation

A consistent issue across feedback was the limited use and capability of existing digital systems. The internal legacy tool, while offering functionalities such as packing list exports and proof-of-delivery tracking, operates independently of the ERP system. The ERP itself provides only basic logistics data and lacks shipment visibility. The absence of a united dashboard for real-time logistics status forces employees to manually transfer data between systems, increasing the risk of errors and duplicated work.

This fragmented system landscape has also contributed to role ambiguity and reliance on informal knowledge, particularly after staff turnover. Logistics personnel reported uncertainty about when and how to engage in project workflows, often depending on memory or email chains to retrieve delivery information.

Theme 2: Communication Gaps and Manual Effort

Communication breakdowns were cited as a barrier to effective logistics execution. The logistics team is not consistently involved in early project planning, which limits their ability to anticipate shipment volumes, timelines, and documentation requirements. Freight bookings are often coordinated via email with limited inconsistent information flow. Manual data handling remains prevalent, particularly in packing documentation and serial number tracking, contributing to frequent errors and delays. Despite the availability of logistics systems, their use is often bypassed due to low trust in functionality or entrenched habits from earlier practices.

Theme 3: Documentation and Customer Visibility

Stakeholders consistently highlighted challenges in producing structured, customer-facing logistics documentation. Key logistics events – such as dispatch confirmations or arrival updates – are not reliably recorded in centralized systems. As one project manager noted, “Logistics doesn’t produce documentation usable for customer reporting, just scattered emails.” Even when internal tools capture shipment data, the information is often incomplete or formatted for internal use only, making it unsuitable for customer communication or performance tracking.

In this context, documentation refers to delivery-related records – such as packing lists, shipment labels, and dispatch notes – that ensure traceability across project deliveries. When such documentation relies solely on supplier-provided material, without the company’s own labels or identifiers, customers may perceive that the contractual party does not deliver the goods. This creates risks for accountability, especially during warranty claims or when items go missing.

At the same time, data management – how logistics information is stored and shared between sales, project, and logistics team – remains fragmented. For example, readiness updates and shipping notes are often managed via email rather than stored in structured systems. These gaps reduce transparency both internally and externally, weakening the company’s ability to demonstrate delivery performance or provide timely updates to project customers.

The lack of structured documentation and consistent data management undermines customer trust and complicates internal coordination. The findings indicate a need to establish standardized documentation templates, clearer ownership for logistics reporting, and improved data-sharing practices across departments to ensure full visibility throughout the delivery chain.

Theme 4: Demotivation and Perceived Inefficiency

The cumulative effect of manual processes, fragmented systems, and unclear responsibilities can lead to staff demotivation. Employees have expressed frustration with current workflows, noting that logistics coordination was perceived as more efficient in the past. The dependency on project managers to resolve logistics issues was also seen as unsustainable. Feedback emphasized that the effort required to manage logistics manually detracts from value-added work, reinforcing the need for improved digital tools such as real-time tracking and automated booking flows.

Table 4 summarizes the four themes that were developed from qualitative material, including internal surveys, stakeholder feedback, and observation notes. The quotations are anonymized and paraphrased for clarity while maintaining their original meaning. The table illustrates how qualitative data supports each theme. The numbers in parentheses refer to the theme order presented in this section.

Table 4 Summary of identified Themes and Supporting Qualitative Evidence.

Theme	Explanatory quotes	Source
System Underutilization and Fragmentation (Theme 1)	"ERP doesn't show delivery status"	Survey (Project Manager)
System Underutilization and Fragmentation (Theme 1)	" We must check several systems to find one delivery"	Survey (PMs, Logistics Personnel) & Observations (Logistics Workflow)
System Underutilization and Fragmentation (Theme 1)	"The legacy tool and ERP don't talk to each other"	Observations (Logistics Workflow)

Communication Gaps and Manual Effort (Theme 2)	“We use email for everything”	Workshop (Project Manager)
Communication Gaps and Manual Effort (Theme 2)	“Project managers assume logistics knows everything”	Workshop (Logistics personnel)
Communication Gaps and Manual Effort (Theme 2)	“Information doesn’t flow well”	Survey (Sales)
Documentation and Customer Visibility (Theme 3)	“We don’t have documentation suitable for customers”	Survey (Project Manager)
Documentation and Customer Visibility (Theme 3)	“Delivery confirmations are scattered across emails”	Survey (Project Manager)
Documentation and Customer Visibility (Theme 3)	“Documentation lacks important references or serial numbers”	Workshop (Project Manager)
Demotivation and Perceived Inefficiency (Theme 4)	“Everything was easier before”	Survey (Project Manager)
Demotivation and Perceived Inefficiency (Theme 4)	“Manual work takes too much time”	Survey (Logistics Personnel)
Demotivation and Perceived Inefficiency (Theme 4)	“We spend more time searching for information than doing actual work”	Workshop (Logistics Personnel)

The four themes collectively illustrate how system fragmentation, communication barriers, and limited documentation capabilities constrain logistics efficiency in the study’s case company. These findings provide the empirical foundation for the subsequent discussion and link directly to the study's research question on system integration, data management, and cost-effectiveness in project logistics.

4.3. Cost-effectiveness and System Integrations

This section presents empirical findings on the cost-effectiveness and system integration of logistics operations within the case company's unit. The analysis is based on quantitative and qualitative data gathered from internal ERP and financial systems (2022-2025), procurement records, and stakeholder observations. The aim is to examine how the current hybrid logistics model – combining internal coordination and outsourced services – affects cost visibility, operational efficiency, and system integration.

4.3.1 Logistics Cost Structure

The case company's logistics operations are organized through a hybrid model that combines internal management with outsourced service elements. Internally, part-time employees coordinate freight-related tasks, supported by external forwarding, warehousing, and customs service providers. This lean structure minimizes fixed personnel costs but requires powerful system connectivity and clear cost allocation to maintain efficiency.

Quantitative cost data was extracted from ERP cost centers and procurement reports for seven closed projects. To protect confidentiality, absolute figures are not disclosed; instead, cost levels are presented qualitatively according to their relative budget shares. The summarized structure is shown in Table 5.

Table 5 Internal vs outsourced logistics cost distribution.

Cost Category	**Resourcing Approach**	**Cost Nature**	**Data Source /Notes**
Forwarding coordination	Internal	Fixed (moderate)	Logistics staff costs /Primarily manage project logistics and documentation.
Freight Booking	Outsourced (service provider)	Variable (per use/ per project)	3PL invoices and booking records/Includes quotations, bookings, and shipment execution.
Trade Compliance	Internal	Fixed (role for personnel)	personnel costs/ Monitoring export/import regulations, ensuring documentation compliance, sharing information
Warehousing	Outsourced 3PL	Variable (per project)	Costs depend on storage duration and volume, and invoices to system.
Intrastat Reporting	Mixed: internal + outsourced	Low	Data collected internally, reported by external provider.
Customs Declarations	Outsourced (broker services)	Low	Includes clearance and declarations. Customs broker invoices

ERP System (per user)	Internal	Fixed (license-based)	IT Costs - Standard enterprise tool with limited logistics visibility.
Legacy Internal Tool	Internal (maintained in-house)	Fixed (maintenance)	IT maintenance records, customized tool for logistics; dependency on one developer.

Analysis of the cost data shows that 70-80% of logistics activities are outsourced, representing around 60-65% of total logistics expenditure. Outsourced services provide scalability and flexibility but introduce complexity in cost tracing and system visibility. Costs related to external services – such as warehousing, customs, and freight forwarding – are often recorded under separate accounts, which complicates the consolidation of logistics costs into a single project overview.

This fragmentation reduces transparency in total cost ownership (TCO). Several indirect costs remain hidden within supplier invoices or general overhead categories, making it difficult for management to evaluate the true financial performance of logistics operations. These findings indicate a strong need for integrated cost reporting and automated linkage between ERP and outsourced service platforms.

4.3.2 Integration Challenges and Observed Inefficiencies

Qualitative insights from logistics staff, project managers, and internal documentation revealed recurring challenges related to system integration and cost control. These challenges were observed across different projects between 2022 and 2025 and align with ERP-based cost analysis and document review.

Key findings include the reliance on manual data entry and email-based coordination for freight bookings, which hinder real-time visibility. The absence of a unified tracking system means that project-level logistics data must be reconciled manually from ERP exports, Excel sheets, and forwarding partners. This approach increases the risk of missing or delayed cost updates.

In addition, outsourcing functions such as freight booking, Intrastat reporting, customs declaration, and warehousing introduces variability in data access and reporting quality. While outsourcing provides cost flexibility, it also creates dependency on external data sources that are not fully integrated into the company's ERP. The legacy tool supports some logistics documentation but relies on a single developer for maintenance, posing long-term sustainability risks.

Overall, this hybrid operating model offers flexibility but also generates structural inefficiencies. The lack of standardized integration, inconsistent data flows, and partial system use limit cost transparency and performance monitoring. Table 6 summarizes these integration-related challenges based on the study's data and internal observations.

Table 6 Identified challenges related to logistics integration and cost visibility.

Identified Challenge	**Data Source**	**Description**
Limited real-time cost visibility	ERP reports, internal observations	Logistics cost visibility only after invoice posting; prevents proactive monitoring
Manual coordination and data transfer	Survey answers, documents	Email-based booking and Excel tracking cause duplicate work and delays
Hidden costs	-	Certain logistics expenses are embedded in supplier invoices (e.g., DAP deliveries, logistics costs, packing etc).

Fragmented tool environment	System observation	ERP, legacy tool, and 3PL portals operate separately without shared reporting
Unclear role boundaries	RACI documentation, staff feedback	Responsibility overlaps cause uncertainty in booking and follow-up processes
Sustainability of legacy tool	IT records	Dependency on internal developer for updates and maintenance.

4.4. Decision-Making Framework for Logistics Optimization

To guide future system and process development, a decision-making framework was created based on case findings and supported by relevant literature. The goal is to provide a structured lens for evaluating logistics optimization initiatives – such as tool upgrades, outsourcing strategies, or system integrations – within the project-based logistics environment.

The framework was derived by synthesizing recurring challenges (Table 6) and aligning them with evaluation dimensions frequently discussed in supply chain digitalization research (Chan & Choi, 2024; Herold et al., 2021; Maheshwari et al., 2021). Each dimension captures a key aspect influencing both the cost-effectiveness and strategic alignment of logistics decisions.

Table 7 Evaluation framework for logistics system and process improvement.

Evaluation Dimension	**Description**	**Relevance to Case Company / Example Indicators**
Cost-efficiency	Total cost of ownership including tools, licenses, services	Necessary to identify hidden costs from outsourcing and legacy system maintenance. Indicators: annual logistics system costs
Integration potential	Compatibility with ERP, TMS, and partner platforms	Fragmented integration currently limits visibility and collaboration. Indicators: number of data transfers done manually, interface coverage %
Scalability	Ability to adapt to increasing project complexity or regulatory requirements	Important - trade compliance and project size are expected to expand. Indicators: capacity to add new project siters or partner systems without system redesign
Usability	Ease of use for logistics staff and project managers	Currently manual tools frustrate users and increase workload. Indicators: user feedback, ratings, average time per booking or document upload

Visibility & Transparency	Real-time tracking, reporting, and access to shared delivery data	Currently lacking; essential for proactive project management. Indicators: access rate to shipment tracking, reporting accuracy, frequency of missing data
Flexibility	Ability to adjust workflows or data interfaces with partners	Enables responsiveness to client and supplier requirements. Indicators: ease of modifying workflows, number of customizable fields/interfaces.

This framework is not intended as a numerical scoring model but rather as a comparative decision tool to support cross-functional discussions. It reflects both the empirical findings of this study and the strategic needs of a project-based logistics organization where multiple systems, actors, and service providers interact across the project life cycle. Applying this framework will help the case company systematically assess trade-offs between insourcing and outsourcing, manual and automated workflows, or maintaining legacy systems versus adopting new digital platforms.

5 Discussion

This chapter interprets the results presented in Chapter 4 in relation to the research questions and theoretical framework. The discussion connects empirical findings to existing literature on supply-chain digitalization, logistics integration, and outsourcing, and highlights both theoretical and practical implications.

5.1 Addressing the Research Questions

RQ1: What are the key factors and challenges influencing the successful implementation and utilization of integrated information systems and data management in supply chain management and logistics operations?

The empirical results, elaborated in section 4.2 and summarized in Table 6, demonstrate that system fragmentation, underutilized tools, and inconsistent workflows constitute the primary barriers to successful integration. Logistics coordination in the case company still relies heavily on email communication and informal knowledge sharing, particularly following personnel changes. These patterns reveal that technological limitations are fundamentally intertwined with organizational and behavioral factors such as unclear responsibilities and low trust in digital data.

Previous studies (e.g., Herold et al., 2021; Maheshwari et al., 2021) have similarly identified that user behavior, lack of process alignment, and low trust in data hinder digital transformation. In line with these observations, this study confirms that underutilization of existing digital tools is not caused by a lack of technology, but by cultural inertia and resistance to new routines.

The theoretical contribution lies in extending the socio-technical perspective in supply chain digitalization by demonstrating how fragmented responsibility and reliance on informal communication perpetuate inefficiency – even in organizations with sufficient technical infrastructure. This underscores that integration challenges in project-based logistics are primarily organizational and cultural rather than technical.

RQ2: How do integrated information systems and data management contribute to optimizing the efficiency and cost-effectiveness of logistics operations?

As shown in the freight-cost comparison (Figure 6, Section 4.1.1), the projects analyzed exhibited substantial cost variability, with deviations ranging from significant under-budget performance to notable overruns. This inconsistency indicates that fragmented data flows and weak visibility undermine cost control. Specifically, although all cost entries are eventually logged in the ERP, manual coordination and the absence of linked freight and customs data make holistic and accurate cost tracking almost impossible.

These findings echo the work of Durst and Evangelista (2018) and Nicoletti and Appolloni (2024), who note that incomplete data visibility is a key source of cost uncertainty in supply chain operations. The lack of interoperability between the ERP, the legacy tool, and external partner platforms directly prevented holistic performance monitoring and contributed to this instability.

This study extends prior research by empirically linking fragmented digital processes to measurable financial outcomes in a project-based trading environment. The contribution lies in demonstrating that data integration affects not only operational transparency but also cost variance and decision accuracy. In this sense, the quality of data integration is shown to be a hidden driver of logistics cost stability, making effective integration between ERP, TMS, and partner systems a prerequisite for cost-effective logistics governance.

RQ3: How do third-party logistics providers leverage advanced information systems and data management for the case company?

Qualitative feedback and process analysis revealed that external partners utilize their own advanced booking or tracking portals, yet these are rarely connected to the case company's internal systems. Information exchange occurs manually via email, resulting in a clear "digital boundary" between the internal logistics team and its external partners. Consequently, the company lacks direct access to 3PL performance metrics, real-time status updates, or granular cost details embedded in subcontractor invoices. This demonstrates that the benefits of advanced provider systems are unrealized due to this limited interoperability.

Earlier outsourcing research (e.g., Song et al., 2022; Shi et al., 2024) has correctly emphasized that information sharing and trust are essential for Third-Party Logistics (3PL) performance. The present findings support these claims but also advance them: even when the external partner's own technological capability is high, efficiency and visibility gains remain unrealized if integration is absent. In other words, technological capability on the supplier's side cannot compensate for missing interoperability on the buyer's side.

This study thus extends outsourcing theory into the digital era by showing that digital connectivity – rather than contractual structure alone – determines value creation and guaranteed efficiency in hybrid logistics models. The case contributes to understanding how this inter-organizational IT alignment becomes a critical, often hidden, barrier to shared logistics visibility, cost tracking, and effective coordination.

5.2 Theoretical Contributions

This study contributes to logistics and SCM research by offering a contextualized understanding of how system fragmentation and outsourcing practices shape logistics coordination in project-based organizations, thereby filling key gaps in existing digitalization and outsourcing frameworks.

First, the study extends the socio-technical view of digitalization. Previous literature (e.g., Herold et al., 2021; Maheshwari et al., 2021) identified behavioral barriers such as low user engagement and lack of process alignment. This study provides contextual depth by empirically demonstrating how these factors – specifically fragmented responsibilities, informal communication, and low trust in digital data – manifest in hybrid project settings. The case evidence shows that partial system integration (where tools exist but are not interoperable) can be as detrimental as lacking systems altogether, causing redundant manual work and cost variance. This provides an empirical mechanism linking integration quality to operational performance.

Second, the research advances outsourcing theory in the digital era. Building on the work emphasizing trust and information exchange (Song et al., 2022; Shi et al., 2024), the findings reveal that digital connectivity determines the effectiveness of outsourced logistics. In contrast to assumptions that outsourcing automatically enhances flexibility, this study demonstrates that without interoperable data systems, even capable 3PL providers cannot enhance efficiency. This insight bridges the discussion between digital transformation and outsourcing management by showing that technological and contractual integration must evolve together. Furthermore, it provides a counterpoint to optimistic models (Nicoletti & Appolloni, 2024) by showing that digital ecosystem potential remains underrealized when organizational alignment is lacking.

Third, the study highlights human and organizational dimensions often overlooked in digitalization research. It supports the arguments of Durst and Evangelista (2018) regarding the critical role of knowledge management. The case evidence shows how demotivation, unclear roles, and reliance on personal memory limit the adoption of digital tools. This perspective contributes to a more holistic theory of logistics digitalization where employee engagement, process clarity, and data ownership are prerequisites for technical success, even when modern systems like cloud-based ERP (Bitkowska et al., 2024) are technically accessible.

In summary, the study strengthens the theoretical bridge between logistics digitalization, system integrations, and outsourcing efficiency by empirically showing how the interplay between digital infrastructure, human behavior, and interorganizational relationship produces – or constrains – cost efficiency and visibility in a project-based context.

5.3 Practical Implications

The findings of this study provide several actionable insights for practitioners seeking to improve logistics coordination, system integration, and cost transparency in project-based environments.

1. **Strengthening System Integration and Data Flow**

One of the most pressing implications is the need for enhanced system integration between internal tools and external platforms used by service providers. The case company currently operates with a fragmented digital infrastructure, which has led to duplicated work, limited logistics visibility, and challenges in cost monitoring. To address this, decision-makers should prioritize investments in integration middleware or API-based data exchange solutions that allow real-time updates between ERP, transport management systems (TMS), and external forwarding platforms. Improved data flow would reduce manual interventions, enhance delivery tracking, and support cost control throughout project execution.

2. **Clarifying Roles and Standardizing Processes**

Logistics coordination has often been reactive rather than proactive, partly due to unclear role boundaries and ad-hoc communication. The introduction of a RACI matrix and standardized project data templates represents a crucial step toward structured logistics planning.

3. **Optimizing Outsourcing Practices**

While outsourcing logistics has provided flexibility, the case study reveals that efficiency gains depend heavily on the quality of coordination and system integration with these service providers. An additional challenge identified during this study concerns the differing priorities between the case company and its outsourced partners. Since the service provider's contractual customer is the case company, not the project's end customer, project-specific requirements and customer expectations may receive less attention. This misalignment can lead to suboptimal coordination, particularly when project deliveries require exceptional accuracy, documentation, or responsiveness to end-customer needs. Establishing clearer service-level expectations and feedback loops would help align supplier performance with project-level satisfaction.

The company should also reassess its partnerships with third-party logistics providers to evaluate their digital capabilities, integration potential, and reporting structures. Conducting regular performance reviews and platform compatibility assessments can support better outsourcing governance, transparency, and accountability.

4. Leveraging Digital Dashboards for Project Logistics

Currently, the lack of unified dashboards limits the project team's ability to monitor shipment statuses or assess logistics performance in real time. Implementing a lightweight dashboard solution – even if separate from ERP – could improve internal communication, reduce reliance on email threads, and allow project managers and logistics personnel to track milestones and delivery progress collaboratively. This aligns with employees' desire for more modern, intuitive, and traceable tools, as expressed during stakeholder discussions.

5. Preparing for Regulatory and Sustainability Demands

The study also identifies that internal roles such as trade compliance are managed with minimal redundancy. As sustainability reporting and regulatory requirements increase, these roles will require more capacity and better system support. Management should evaluate future resource needs and explore digital compliance solutions to prevent bottlenecks in documentation, customs, and reporting workflows.

Together, these practical implications provide a roadmap for improving logistics effectiveness and digital maturity in the case company. They also suggest that achieving long-term cost-efficiency requires not only technical upgrades but also process redesign, capability development, and active collaboration across internal and external stakeholders.

5.3.1. Comparison of Current Logistics Practices

To contextualize the company's current practices, Table 8 extends the earlier theoretical comparison (Table 1, Section 2.1) by contrasting the characteristics of traditional and modern logistics management with the current state observed in the case company. The traditional and modern features were derived from the literature summarized in Table 1, which synthesizes key studies on supply-chain digitalization and logistics transformation (E.g., Durst & Evangelista, 2018; Maheshwari et al., 2021; Nicoletti & Appolloni, 2024; Saberi et al., 2019; Winkelhaus & Grosse, 2020). The "Case Company Current State" column is based on empirical findings from Chapters 4.1-4.3, combining cost analysis, thematic insights, and internal documentation.

This comparative synthesis bridges theoretical and empirical perspectives, highlighting where the case company's logistics maturity currently stands in its transition toward digital integration and data-driven coordination.

Table 8 Comparison of Traditional, Modern, and Case Company Logistics Practices. Source: Author, adapted from literature (see Table 1) and empirical findings from Chapter 4.1-4.3.

Feature	Traditional	Modern	Case Company Current State
Visibility	Limited visibility, information silos, and delays in data sharing.	Real-time tracking, visibility across the entire supply chain through IoT, blockchain, and cloud-based supply chain	Limited visibility; no real-time dashboards. ERP lacks logistics execution data, and tracking depends

		management systems.	on freight partner emails or portal checks.
Process Efficiency	manual workflows, high lead times.	Automated processes, Robot Process automation, streamlined workflows.	Manual workflows dominate; bookings via email, documentation managed manually, limited automation in routine tasks.
Data Management	manual processes, duplicates, many places for data	digitalized, automated, IoT, AI-driven	Fragmented data between ERP, legacy tools, and email archives; minimal integration or automation
Decision-Making	Based on incomplete or outdated information	Data-driven decisions with real-time insights	Decisions are based on partial data; limited collaboration
Automation	Reliant on manual work, prone to errors	Automated processes for increased efficiency and accuracy	Manual coordination for most shipments and documentation; limited TMS integration only for standard deliveries

Risk Management	Higher risk of errors and delays	Reduced risks with real-time monitoring and data analysis	High operational risk from system gaps and manual processes; lack of proactive tracking tools.
Forecasting and planning	Experience-based, reactive, and partly manual. Forecasting relies on historical trends and expert intuition.	Data-driven, proactive, and automated. Uses AI, machine learning, and 3D modeling for accurate predictions.	Planning is reactive; logistics involvement in projects is often delayed, limiting proactive scheduling.
Sustainability	Traditional fuels, high carbon footprint	Green technologies, CBAM, calculations, optimization, goals to be carbon neutral, etc.	Sustainability considerations not systematically integrated into logistics decisions; future regulatory increases expected.
Customer experience	Relationship-driven, reliant on personal trust and interpersonal chemistry between buyer and seller	Fast, proactive and well customized solutions	Customer communication is mostly via project managers; logistics sends notifications.

5.4 Limitations and Suggestions for Future Research

This study provides a detailed view of logistics coordination, system integration, and outsourcing practices within a single project-based trading unit. However, several limitations must be acknowledged, which also serve as a foundation for future research.

Case-Specific Context and Limited Generalizability

The research focused on a single organizational unit operating within a project business. While the findings reflect challenges encountered in fragmented digital environments and partial outsourcing models, they may not be fully generalized to larger organizations or manufacturing-oriented supply chains. Additionally, the scope of available information from selected units was limited.

Nevertheless, the results hold analytical generalizability rather than statistical generalizability (Yin, 2018). This means that the insights drawn from this case can still be transferred to other contexts that share similar characteristics – such as project-based organizations, companies with hybrid outsourcing models, or firms facing integration gaps between ERP and logistics tools. The study findings therefore provide a conceptual understanding of challenges that are likely to emerge in comparable industrial environments, making them relevant for practitioners and researchers beyond the specific case company.

Limited Quantitative and Systematic Data

A key limitation relates to the availability and structure of data. Logistics costs, delivery timelines, and system usage records were inconsistently documented, which made it difficult to conduct detailed performance analysis or time-based comparisons. This reflects the very challenges the study seeks to highlight – namely, poor data visibility and lack of integration – but it also limits the depth of empirical analysis, especially in assessing the full budgetary impact of system inefficiencies.

Narrow Scope Regarding External Platforms and Partners

Although outsourcing was discussed from an internal coordination and integration perspective, the study did not include an in-depth analysis of external logistics providers' capabilities. No interviews, contractual reviews, or system demonstrations were conducted with external service providers. As a result, the assessment of digital maturity or platform compatibility among service providers remains speculative. This limitation was acknowledged at the outset (section 1.3), but its implications became more evident during the interpretation of RQ3.

Suggestions for Future Research

Given the complexity of project-based logistics, future studies should adopt a more focused scope – for example, by evaluating the cost-benefit impact of system integration, tracking performance metrics after process design etc. Investigating platform capabilities of specific 3PL or 4PL providers could also inform outsourcing decisions and digital strategy. Moreover, longitudinal research following digital implementation – such as introduction of real-time dashboards or automation pilots – would offer valuable insights into change management, employee adaptation, and measurable outcomes.

Finally, future research should account for project size and complexity. As observed in the project cost analysis, logistics processes vary significantly depending on delivery scope, geography, and stakeholder involvement. Tailoring digital solutions and outsourcing strategies to these project profiles would enhance the strategic alignment of logistics operations.

In the coming years, emerging technologies such as AI-driven automation, decentralized blockchain networks, and edge computing are expected to improve the scalability, speed, and security of data management in SCM. These innovations may enable more agile, resilient, and intelligent supply chains capable of responding to disruptions and demands in real time. However, achieving such advancements will require not only technical investment but also enhanced cross-organizational collaboration and governance frameworks. Future studies should therefore explore how these technologies can be applied in project-based logistics contexts, particularly in improving system integration, visibility, and resilience.

6 Conclusion

This thesis examined how integrated information systems and data management contribute to the efficiency and cost-effectiveness of logistics operations in a project-based trading unit. The research was driven by three key questions concerning (1) the challenges of implementing integrated systems, (2) their operational impact, and (3) the role of third-party logistics providers in digitalized logistics networks.

Using a mixed-methods case study that combined project cost analysis, stakeholder insights, and thematic interpretation of internal processes, the study identified several critical findings. Fragmented systems, limited ERP visibility, and inconsistent digital practices emerged as primary barriers to efficient logistics coordination. Manual workflows, reliance on email, and unclear responsibilities created inefficiencies in cost tracking, delivery performance, and customer communication. Moreover, document analysis showed that logistics-related records were often incomplete or informal, reinforcing the need for structured data governance and standardized documentation.

The analysis further revealed that while the case company benefits from a lean internal logistics setup supported by outsourced services, the lack of integration between internal and external systems weakens visibility and performance evaluation. Cost flexibility alone does not guarantee efficiency when information flow is disconnected.

A key takeaway from this study is that logistics and project management should be viewed as an integrated whole rather than separate functions. Their interdependence means that early logistics involvement, shared data access, and aligned digital tools are essential for effective planning and execution. Viewing them as a unified system enables proactive decision-making, reduces administrative delays, and enhances customer transparency.

Overall, the study highlights that optimizing logistics in project-based environments requires more than adopting new tools – it calls for process standardization, clear ownership, and alignment between people, systems, and strategy. While internal development efforts such as role clarification and improved communication routines represent progress, long-term improvement depends on deeper system integration, real-time visibility, and data-driven governance.

The thesis contributes both theoretical and practical insights by demonstrating how fragmented information management affects logistics coordination and cost-effectiveness in complex, project-driven settings. Future research should explore how advanced technologies such as AI, automation, and integrated 4PL-5PL platforms can support resilient, transparent, and sustainable logistics networks.

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Appendices

Appendix 1. Summary of Qualitative Data Sources

Table 9 Summary of Qualitative Data Sources

Source	**Description**	**Purpose**	**Period**
Process status survey	Internal survey on logistics coordination	Identify bottlenecks & perceptions	2025
RACI	Clarified roles and responsibilities	Map current process ownership	2025
Observations	Notes from daily operations	Understanding workflow	2022-2025
Lessons learned reports	Internal project summaries	Identify recurring logistics issues	2025

Confidential internal materials.

Appendix 2. Process Status Survey Form

Purpose

The internal process status survey was conducted in early 2025 to map the current state of logistics processes and identify development needs. Responses were collected from sales personnel (response rate a bit lower than 50%) and project managers (answer rate 80%). The questions addressed logistics coordination, documentation, cost control, and communication between departments. The survey was conducted in Finnish. English summaries of responses are provided in study.

Section A: Sales Department Survey

Questions:

1. Paljonko aikaa käytät logistiikka-asioiden selvittämiseen tarjousprosessin aikana?
2. Onko jotain mitä logistiikkaosasto voisi mielestäni tehdä, jotta se auttaisi sinua tarjouksen teossa?
3. Mitkä ovat suurimmat haasteet, joita kohtaatte toimitusprosessien suhteen kaupanteon aikana?
4. Oletko saanut asiakkailta palautetta, että toimitusvaihtoehdot/hinnat vaikuttaisivat ostopäätökseen?
5. Onko teillä havaintoja siitä, että jotkin asiakkaat toivoisivat parempia logistiikkaratkaisuja, tai vaihtoehtoisia toimitustapoja?
6. Onko teillä ehdotuksia tai ajatuksia logistiikkaprosessien parantamiseksi, jotta voisimme paremmin tukea myyntiä ja asiakastyytyväisyyttä?

Key findings:

1. Time usage with logistics related things depends and varies much based on project scope. Ocean freight with multiple containers takes more time than basic courier.

2. Sales wish to get precise cost indications and information related to whole delivery process.
3. Challenges are mostly related to costs and tight schedules.
4. Rarely any feedback related to logistics

Section B: Project Managers Survey

1. Miten kuvailisit nykyistä projektilogistiikkaa?
2. Miten arvioisit nykyisten logistiikkapalveluiden toimivuutta projekteissasi asteikolla 1-5? (1=erittäin huono, 5=erinomainen) Miksi?
3. Mitkä ovat mielestäsi suurimmat haasteet logistiikan sujuvuudessa projektien aikana?
4. Oletko havainnut viivästyksiä tai häiriöitä projektisi logistiikkaprosessissa? Jos kyllä, mitkä ovat olleet niiden yleisimmät syyt?
5. Missä vaiheessa projektia annat logistiikalle tiedot tulevista toimituksista?
6. Miten seuraat logistiikkakustannusten toteutumista projektissasi? (kuljetuskustannukset)?
7. Oletko kommunikoinut kustannuksista huolintaan?
8. Ovatko logistiikkakustannukset pysyneet budjetissa? Jos eivät, missä on ollut poikkeamia?
9. Kuinka hyvin nykyiset kuljetusaikataulut vastaavat projektien tarpeita?
10. Missä vaiheessa projektia yleensä teet kuljetussuunnitelman ja miten kommunikoit sen huolinnalle?
11. Onko logistiikkatoiminta tarpeeksi joustavaa projektien muuttuvien tarpeiden kannalta? Jos ei, millaisiin tilanteisiin toivoisitte parempaa reagointikykyä?
12. Mitkä ovat nykyisen toimintamallin vahvuudet?
13. Mitä sellaista toivoisit logistiikkatoiminnoilta, että se helpottaisi työtäsi?
14. Kuinka yleistä on, että joudut projektissa hoitamaan kuljetuksesta aiheutuvaa reklamaatiota?
15. Jos asiakas ilmoittaa kuljetusvahingon, kenelle laitat viestiä?
16. Kuinka paljon sinulla menee aikaa logistiikkaan liittyvien toimintojen hoidossa?

17. Miten ohjeistat vastaanottavaa tahoa siitä, minkälaisia vaatimuksia meillä on tavaran vastaanottamiselle?
18. Miten seuraat projektisi tavaroita, niiden kuljetuksia, entä toteutuneita kustannuksia?
19. Millaisia parannusideoita sinulla on kommunikointiin toimittajille ja asiakkaille?
20. Millaista keskustelua käyt huolinnan kanssa projektin logistiikkavaatimuksista?
21. Miten huomioit projektin toimitukset EU:n ulkopuolelta tai EU:n ulkopuolelle?
22. Minne ja miten tallennat projektiin liittyvät tiedot, jotka liittyvät toimituksiin?
23. Onko jotain muuta mitä haluaisit korostaa aiheeseen liittyen?

Summarized key findings:

1. Loss of systematic coordination, project logistics was described as fragmented.
2. Complex, multi-layered logistics chain.
3. Communication and information flow gaps. Communication relies on email and shipment data is often across systems or missing.
4. Logistics documentation is incomplete or inconsistent.
5. Delays were frequently reported, mostly caused by late scheduling, incomplete information, incorrect shipment addresses, and slow quotation processes.
6. Logistics are often informed too late.

Appendix 3. RACI

A RACI matric was used to clarify roles and responsibilities in the logistics process. AS the real RACI done within internal process development project is strictly confidential, this Appendix is simplified version of that.

R = Responsible (Performs the task or is directly involved in executing the work

A = Accountable (Ultimately answerable for the completion of the task)

C = Consulted (Provides input, advice, or subject matter expertise)

I = Informed (Receives communication about the outcome or status)

Process Step / Information flow	Project Management	Logistics / SCM	Logistics Partner / Freight Forwarder	Trade Compliance / Finance etc.
Planning & Scope Definition	A/R	R	C	I
System-Based Freight Booking	I	R/A	R	C
Documentation & Customs Prep	I	R/A	C	C
Cost Data Entry & Validation	C	A	R	I
Order Confirmation & Tracking	I	A	R	-

Proof of Delivery (POD) Archiving	C	A	R	I
Invoice Verification & Approval	A	C		R