



Vaasan yliopisto
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**Evaluating budget accuracy in project-based
logistics: A data-driven approach in global supply
chain management**

School of Technology and Innovations
Master's thesis in Economics and Business Administration
Industrial Management

Vaasa 2025

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ABSTRACT:

This thesis evaluates the accuracy of logistics budgeting in project-based business and examines factors contributing to budget deviations. The study was motivated by recurring discrepancies between planned and actual logistics costs, especially in projects involving complex supply chains and multiple ERP environments following a corporate merger.

A case study approach was adopted, combining quantitative analysis of 752 projects completed between 2020 and 2024 with qualitative insights from internal documents and domain experts. Data were collected from ERP and Power BI systems, covering variables such as Incoterms, market region, and business line. To ensure reliability, the dataset was cross-verified, and measurement bias factors were considered.

The findings reveal systematic underbudgeting, particularly in projects using FCA Incoterms, where logistics costs were often omitted from initial budgets despite actual expenses later occurring. Conversely, some projects showed significant overbudgeting, highlighting inconsistencies in forecasting practices. Differences across product groups, market regions, and business lines further suggest that logistics cost behavior is not uniform. The analysis also indicates that in projects with low sales value or low probability of being won, cross-functional budgeting reviews are not always conducted. In addition, in some cases internal logistics hours have not been recorded in SAP either due to incorrect hour bookings or because local guidance has not required the respective logistics team to book their hours. Logistics cost estimates rely on both historical project data and project-level market rate checks from LSPs, improving predictability of external costs. The transitional use of three ERP systems contributed to data inconsistencies, though the adoption of a new standardized SAP environment is expected to improve budgeting reliability.

Practical recommendations include implementing region-specific budgeting templates, harmonizing WBS structures across business lines, introducing mandatory cost input fields in ERP systems, and promoting interdepartmental collaboration through joint budgeting checkpoints and post-project reviews.

Overall, the study emphasizes the need for standardized, data-driven, and proactive logistics budgeting practices to reduce deviations, improve cost predictability, and strengthen financial control in project-based operations.

KEYWORDS: Budget accuracy, data analysis, cost control, project management, supply chain management

VAASAN YLIOPISTO**Tekniikan ja innovaatiojohtamisen akateeminen yksikkö**

Tekijä:	Elina Suojanen
Tutkielman nimi:	Evaluating budget accuracy in project-based logistics: A data-driven approach in global supply chain management
Tutkinto:	Kauppätieteiden maisteri
Oppiaine:	Tuotantotalous
Työn ohjaaja:	Rayko Toshev
Valmistumisvuosi:	2025 Sivumäärä: 90

ABSTRACT:

Tämä tutkimus arvioi projektipohjaisen liiketoiminnan logistiikkabudjetoinnin tarkkuutta ja tutkii budjettipoikkeamien taustalla olevia tekijöitä. Tutkimuksen taustalla olivat toistuvat erot suunniteltujen ja toteutuneiden logistiikkakustannusten välillä erityisesti monimutkaisissa toimitusketjuissa ja useiden ERP-järjestelmien käyttöympäristöissä yritysfuusion jälkeen.

Tutkimus toteutettiin tapaustutkimuksena, jossa yhdistettiin määrällinen analyysi 752 projektista vuosilta 2020–2024 ja laadulliset havainnot sisäisistä dokumenteista ja asiantuntijahaastatteluista. Aineisto kerättiin ERP- ja Power BI -järjestelmistä, ja se sisälsi muuttujia, kuten Incoterms-toimitusehdot, markkina-alueen ja liiketoimintalinjan. Aineiston luotettavuutta varmistettiin ristiinvarmistuksilla ja mittausvirhelähteet huomioitiin analyysissä.

Tulokset osoittavat järjestelmällistä alibudjetointia logistiikan osalta erityisesti FCA-toimitusehdon projekteissa, joissa logistiikkakustannuksia ei usein sisällytetty alkuperäisiin budjetteihin, vaikka toteutuneet kustannukset kirjattiin myöhemmin. Toisaalta joissakin projekteissa esiintyi myös merkittävää ylibudjetointia, mikä korostaa ennustamiskäytäntöjen epäyhtenäisyyttä. Eroja havaittiin myös tuoteryhmien, markkina-alueiden ja liiketoimintalinjojen välillä, mikä viittaa siihen, ettei logistiikkakustannusten käyttäytyminen ole yhtenäistä. Tuloksiin vaikutti myös se, että alhaisen myyntiarvon tai matalan voittotodennäköisyyden projekteissa monitoimijainen budjetointikatselmus ei aina toteudu, ja että joissakin projekteissa sisäisiä logistiikkatunteja ei ole kirjattu SAP:iin joko virheellisten tuntikirjausten vuoksi tai siksi, että paikallinen ohjeistus ei ole edellyttänyt tuntien kirjaamista. Logistiikan kustannusarviot perustuvat sekä historiallisten projektien tietoihin että projektikohtaisiin markkinahintojen tarkistuksiin LSP:iltä, mikä parantaa ulkoisten kustannusten ennustettavuutta. Kolmen eri ERP-järjestelmän rinnakkainen käyttö lisäsi aineiston epäjohtamukaisuutta, mutta uuden SAP-järjestelmän käyttöönoton odotetaan parantavan budjetoinnin tarkkuutta jatkossa.

Käytännön kehitysehdotuksia ovat aluekohtaiset budjetointimallit, WBS-rakenteiden yhdenmukaistaminen liiketoimintalinjojen välillä, pakolliset kustannuskentät ERP-järjestelmiin sekä osastojen välisen yhteistyön vahvistaminen yhteisillä budjetointitarkistuksilla ja projektien jälkiarvioinneilla.

Tutkimus korostaa standardoitujen, dataohjattujen ja ennakoivien logistiikkabudjetointikäytäntöjen merkitystä poikkeamien vähentämisessä, kustannusten ennustettavuuden parantamisessa ja taloudellisen ohjauksen vahvistamisessa projektipohjaisessa liiketoiminnassa.

AVAINSANAT: Budget accuracy, data analysis, cost control, project management, supply chain management

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Abbreviations

ERP – Enterprise Resource Planning
LSP – Logistics Service Provider
PM – Project Management
SCM – Supply Chain Management
PBI – PowerBI
PLM – Project Lifecycle Management
WBS – Work Breakdown Structure
ML – Machine Learning
EXW – Ex Works
FCA – Free Carrier
CPT – Carriage Paid To
CIP – Carriage and Insurance Paid To
DAP – Delivered at Place
DPU – Delivered at Place Unloaded
DDP – Delivered Duty Paid
FAS – Free Alongside Ship
FOB – Free on Board
CFR – Cost and Freight
CIF – Cost, Insurance and Freight

1 Introduction

Overview of the research field

Supply chain management and budgeting are widely researched topics, serving as critical components in ensuring operational efficiency and cost-effectiveness. However, project-based logistics introduces unique challenges in budgeting due to its project-specific nature. Each project is inherently different, and no two projects are entirely comparable. This variability complicates research efforts, as comparing budget performance across projects often fails to reveal consistent patterns or actionable insights.

Budgeting is essential in ensuring the smooth coordination of sales and logistics activities. This experience sparked a deeper curiosity about understanding the underlying factors that drive budgetary challenges in logistics and inspired me to explore actionable strategies for improving financial predictability in project-based operations. By examining the collaboration, communication, and alignment between sales and logistics functions, I aim to contribute to the more efficient and cost-effective supply chain practices. In terms of communication, I will look at how sales and logistics use each other's knowledge and how they collaborate. I will also look at the current level of joint reporting.

Statement of the research problem

In the context of global supply chain operations, this study investigates how several factors in project-based logistics influence budget accuracy. It seeks to identify strategies to improve cost management and minimize budget overruns, issues that remain persistent and critical in contemporary supply chain systems. By addressing these challenges, the research aims to contribute both theoretical insights and practical solutions to the field of supply chain management.

This research requires an analysis of the project data to understand the variables and how they are impacting logistics costs. It also aims to determine whether further project information should be gathered to better analyze and guide future logistics cost estimations.

Research philosophy and context

This research adopts a pragmatic approach, integrating quantitative and qualitative methods to analyze the complexities of project-based logistics. The study lies at the intersection of operations management, financial planning, and process optimization, aligning with the broader discipline of supply chain management. It draws on theories of cost control, interdepartmental coordination, and decision-making under uncertainty to explore innovative solutions for budgetary challenges in diverse logistics environments.

1.1 Background of the study

Budgeting in project-based logistics involves early cost estimations during the Request for Information (RFI) phase of the sales support process and formalized budget planning during the Request for Quotation (RFQ) phase when logistics suppliers' prices are evaluated. The logistics budget is typically established at the outset of a project, introducing risks due to the uncertainty and variability of future expenses.

This study investigates how several factors influence budget accuracy by analyzing budget deviations within projects monitored through ERP and PowerBI systems. Specifically, it examines whether logistics budgets align with original plans or result in overruns or underruns. The analysis emphasizes identifying quantitative factors, including the accuracy of initial budget estimates, the effectiveness of tracking actual expenses, and the role of budget adjustments.

In the case company, three budget versions are distinguished. The original budget (PLAN / as sold) is established at the beginning of a project, the revised budget (CURRENT / first forecast version) reflects updated expectations as the project progresses, and the actual costs represent the expenditures realized at project completion. While the revised budget provides important managerial insight, this research focuses on comparing the original budget with the actual costs.

Data and qualitative information will be collected from the company's ERP and PowerBI systems. Different logistics costs are listed in below. A customer project entail delivering a project to an end customer and often involves multiple companies. The study evaluates logistics budgeting from estimation to actual costs incurred at project completion.

This research focuses on projects related to equipment deliveries, specifically addressing following logistics costs:

- Transportation Costs
- Warehousing Costs
- Inventory Costs
- Packaging Costs
- Customs and Duties
- Supply Chain Coordination Costs

In company systems, logistics costs are defined to include the work involved in logistics as well as the transport itself. All elements above are part of logistics costs.

1.2 Research gap and problems

Goal is to find answers how do different variables in project-based logistics influence budget accuracy, and what strategies can be implemented to improve cost management and minimize budget overruns in global supply chain operations.

Existing budgeting practices, especially in companies utilizing SAP ERP systems, may overlook the impact of certain factors on budget accuracy. Although ERP systems track detailed financial data, there is limited attention to the specific variables that may contribute to budget deviations. This study addresses this gap by analyzing SAP data to determine whether particular variables influence the accuracy of budget forecasts.

This analysis not only improves our understanding of the reasons behind budget differences but also provides useful insights for improving budgeting practices. By analysing budgeting estimation for this study, we can pave the way for more accurate forecasts and better decision-making processes in the global supply chain.

For example, if project planning focused more on the logistical costs of each project, the budget could be better managed. This research will evaluate how different variables impact budget outcomes and propose adjustments to enhance budget accuracy in project-based logistics, which includes logistics and transportation costs.

This study seeks to uncover information gaps regarding the variables that affect budget accuracy. This study aims to determine how do different variables in project-based logistics impact budget accuracy, and what role do they play in budget overruns or underruns. By proposing solutions to minimize deviations and optimize financial planning, the research provides practical tools for organizations. These tools and ideas can be applied to refine project management processes and strengthen budgetary discipline across various contexts.

By answering following three research questions, the study aims to provide a number of critical insights. The first research question is

1. *“What factors contribute to budget adherence in project-based logistics, and how can data analysis provide insights into the reasons for budget discrepancies?”*

This study examines the factors influencing budget adherence in project logistics, specifically focusing on accurate initial cost estimation and supply chain stability. It explores how data analytics can help identify the causes of budget discrepancies, particularly in these areas, and assess their impact on financial compliance. By identifying cost drivers, and analyzing supply chain dynamics, data analysis provides valuable insights into budget discrepancies. Visualization tools and dashboards are leveraged to present these findings effectively. By focusing on the accuracy of cost estimation and the reliability of

the supply chain, this study highlights how improved decision-making can lead to better budget management. It demonstrates how data-driven insights can support proactive adjustments and enhance budgeting accuracy in project logistics.

This study takes several factors into account. First, it seeks to identify which factors contribute. And secondly, how the selected factors influence.

The following factors/variables are analyzed: Business Line, Delivery term, Product group (linked to the business line) and Market Region/destination country.

The data is collected from timeframe 1/2016-1/2025.

The second research question is

2. *“What lessons can be learned from analyzing budget successes and failures in company’s project-based logistics?”*

The second research question seeks to analyse budgetary successes and failures in project logistics to identify key patterns and effective practices. Data analysis will be applied to examine selected variables to better understand cost variations and the broader drivers of budget performance. The insights gained from the analysis will provide recommendations for improving budgeting. In addition, data-driven approaches improve the accuracy of budgeting by identifying factors that influence cost variations and overall budget performance.

The third research question is

3. *“What practices and strategies can be developed to enhance budgeting accuracy in project-based logistics?”*

By proposing solutions to minimize deviations and optimize financial planning, the research provides practical tools for organizations. These tools can be applied to refine

project management processes and strengthen budgetary discipline across various contexts.

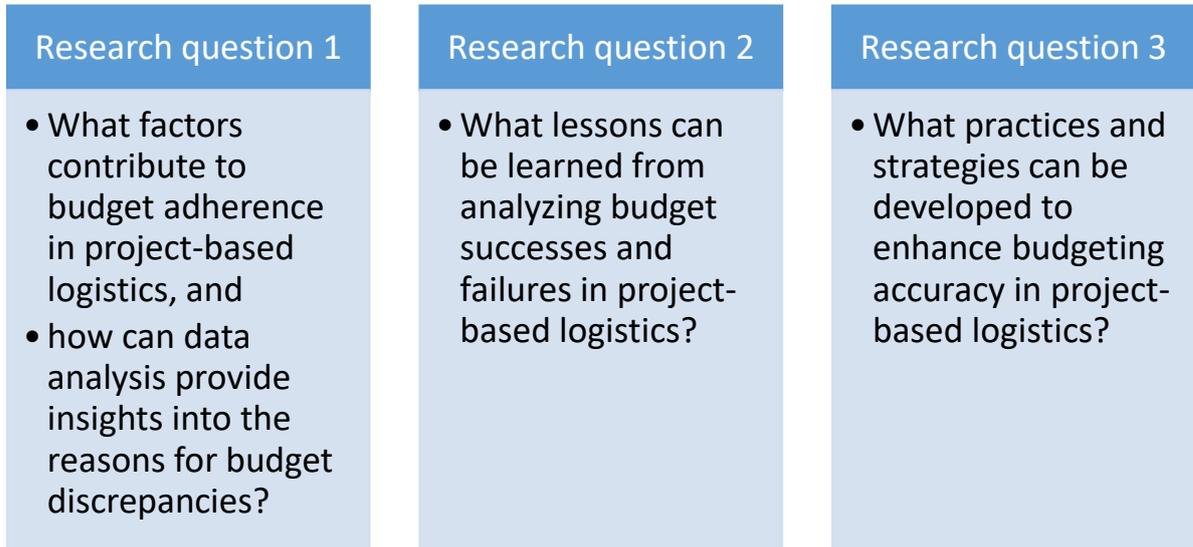


Figure 1. Research questions

Together, these research questions explore key elements of budget accuracy and performance in project-based logistics. By addressing critical areas such as project planning, cost estimation, risk management, and the role of technology, they lay the foundation for a comprehensive framework that integrates both theoretical insights and practical applications. This framework aims to improve budget management practices and drive better outcomes in the company.

Need for filling the research gaps

Gaining a better understanding of the factors behind budget underruns and overruns will enable companies to make more informed decisions. Identifying these variables will also help companies manage budget-related risks more effectively.

1.3 Research aim and objectives

The primary aim of this study is to understand why certain projects deviate from budgeted costs, and to assess the role of different logistical and operational variables in these variances.

Supporting objectives

To achieve this aim, the study will:

1. Conduct a literature review on project-based logistics and budgeting practices.
2. Collect and analyze budgetary data from ERP and PowerBI systems to identify patterns in budget adherence.
3. Evaluate the impact of key factors on budget outcomes.
4. Propose recommendations to enhance budget accuracy in project-based logistics.

1.4 Significance of the study

Contribution to academia and industry

This research contributes to both academic and practical knowledge in the fields of supply chain management and budgeting. By offering a data-driven approach to improving budget accuracy in project-based logistics, the findings may influence budgeting practices and support more effective project management strategies.

1.5 Limitations of the study

Methodological, conceptual, and theoretical limitations

The study's scope is limited to a single company's business area, so findings may not be generalizable across industries. Another challenge is the inherent variability in projects—no two are identical, making cross-project comparisons less straightforward. Machine

learning and external systems were not allowed to use in this research due to sensitivity of data.

1.6 Thesis structure

Layout of the chapter

This section outlines the overall structure of the thesis and briefly describes the content of each main chapter. The logical progression of the research is illustrated in Figure 2, which presents the main components and flow of the study.



Figure 2. Thesis structure

- **Introduction:** Provides an overview of the research field, outlining the research problem, aims, objectives, significance, and limitations of the study.
- **Literature review and theoretical framework:** Examines relevant theories and previous research on budgeting in project-based logistics, setting the foundation for understanding factors that influence budget accuracy.
- **Methodology:** Describes the research design, including data collection and analysis methods, detailing how ERP and PowerBI data were gathered and analyzed.
- **Empirical research:** Presents the findings from the analysis of ERP and PowerBI data. This section highlights specific variables and trends that impact budget accuracy in project-based logistics.
- **Discussion and conclusion:** Summarizes the key findings, offering a detailed discussion of how these results align with or differ from previous research. Practical implications are presented, along with recommendations for improving budget accuracy in project-based logistics. The section concludes by addressing study limitations and suggesting areas for future research.

2 Literature review and theoretical framework

2.1 Project management and budgeting

Budgeting for logistics has been studied especially in the context of construction. There has also been research on transportation projects related to worksites. While there is ample research on project budgeting, it typically does not focus solely on logistics budgets. Often, the projects covered in these studies are of a nature that does not isolate logistics as a separate area. On the other hand, logistics budgeting in unrelated projects may not provide a sufficient basis for this study, which focuses on international project logistics across diverse types of projects, ranging from very small to extremely large ones.

According to Tikkanen and Aspara (2008, p. 99) a key issue for many project companies today is that the probability of return on resources that may be used or committed to a sales project, as well as changes in these probabilities, is not monitored closely enough, either for individual items or for the intermediate stages of the project.

Yang and Su (2009) discuss the impact of enterprise resource planning (ERP) systems on company performance, particularly in terms of cost management within supply chain management (SCM). Their research showed that ERP systems provide companies with benefits on strategic, tactical, and operational levels, which positively influence company performance in SCM cost management. In Yang and Su's (2009) study, company performance was measured through metrics such as return on capital, inventory turnover rate, and total logistics costs. In their case study, Yang and Su (2009) found that using an ERP system led to cost reduction, increased company market value, and revenue growth.

Key findings in Yang and Su's (2009) study included that cost reduction improved company profits, increased sales, strengthened market share, and enhanced customer satisfaction. Additionally, the ERP system enabled the company to lower business costs and stabilize operations. SCM expertise within the company was also found to be important for leveraging the operational benefits of ERP systems (Yang & Su, 2009). The ERP system

promoted the use of activity-based costing, performance indicators, and budgeting, providing a comprehensive view of the cost-revenue ratio and supporting control over logistical processes across functional and organizational boundaries (Yang & Su, 2009).

2.1.1 Cost estimating

Doloi (2011) has studied cost overruns in project management in several of his research works. His research focuses on the construction industry, but it includes several aspects that can be applied in other areas of project management, such as project logistics.

Doloi (2011) emphasizes that modern projects are increasingly complex, with numerous stakeholders each having different interests, which makes it extremely difficult to avoid cost overruns. He argues that early involvement of these stakeholders and the establishment of effective communication channels for sharing essential project knowledge are critical from the outset.

As the project moves from design through execution and eventually to the handover phase, managing contract changes and ensuring effective contract administration become crucial to controlling costs (Doloi, 2011). According to Doloi (2011), this highlights the need to move away from relying solely on traditional cost estimation models and instead adopt more innovative approaches that are better suited to managing and accessing the costs of complex projects.

2.1.2 Work Breakdown Structure

According to Project Management Institute [PMI] (2013), a WBS, or Work Breakdown Structure, is a hierarchical representation of all the work included in a project's scope, aimed at achieving the project's objectives and delivering the required outcomes. PMI (2013) highlights that each level of the hierarchy provides a more detailed definition of

the work, helping to clarify the overall structure of the project. Work packages are assigned to control accounts, each with a unique account code to enable systematic management (PMI, 2013). These codes facilitate effective tracking of costs, schedules, and resources (PMI, 2013).

PMI (2013) emphasizes that control accounts integrate the project scope, budget, and schedule, and allow performance to be assessed using earned value metrics. Each work package belongs to only one control account, although a single control account may include multiple work packages and planning packages (PMI, 2013). According to PMI (2013), planning packages represent known work activities that lack detailed schedules.

According to Heagney (2012) developing the Work Breakdown Structure (WBS) is one of the project planning steps. Heagney (2012) also highlights that scheduling is definitely a key tool in project management, but its importance is clearly second to creating a common understanding of project objectives or a clear WBS that identifies all the work to be done. As Heagney (2012) points out, without careful project management, a detailed schedule really does nothing more than enable accurate documentation of failures.

The biggest challenge in project planning is figuring out the duration of tasks and what they will cost to complete (Heagney, 2012). Faulty estimates are one of the main causes of project failure, and exceeding cost targets often leads to stress and blame in project management (Heagney, 2012). To address these issues, the most useful tool is the Work Breakdown Structure (WBS) (Heagney, 2012).

As Heagney (2012) explains, the basic idea of the WBS is straightforward. He explains that a complex task is divided into smaller tasks until a level is reached where the task cannot be further broken down. It is easier at this stage to estimate how much time it will take to complete a small task and what it will cost (Heagney, 2012). The WBS allows for improved accuracy, especially in situations where making estimates from higher

levels would be difficult. However, estimating task durations is never entirely without challenges, particularly for activities that have never been executed before (Heagney, 2012).

Heagney (2012) explains that the WBS lists all the tasks that need to be fulfilled in order to achieve the defined objectives of the project. It shows the scope of the project in a graphical representation. Heagney adds that the WBS does not specify the order in which the work is to be carried out, but the work distribution structure. The order of execution is determined when the schedule is drawn up. According to Heagney (2012) a WBS typically has 3 to 6 levels. Below is the example of level naming below (Figure 3). Depending on the project, more levels may be required, but twenty levels are considered an upper limit (Heagney, 2012).

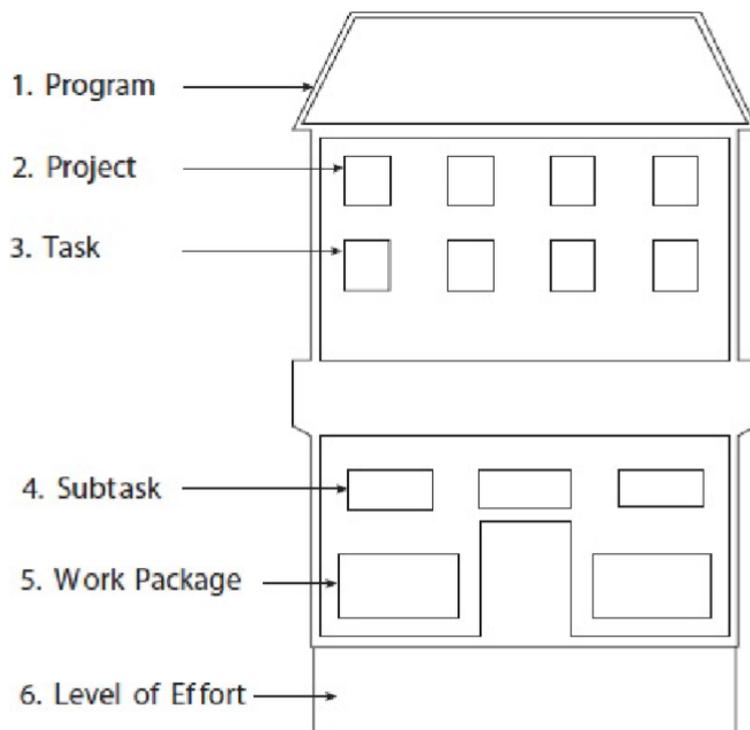


Figure 3. Names of WBS levels (Heagney, 2012).

Heagney (2012) advises to stop breaking up a job when the cost or time can be estimated with the needed accuracy. The WBS is recommended for use in dividing work into smaller

chunks. According to Heagney (2012) this makes it easier to develop more accurate estimates of resource requirements, duration and costs. Heagney (2012) argues that cost or time estimates cannot be made without considering who is carrying out the task. In addition, the estimate needs to be based on a mental model or primarily on historical data.

2.1.3 Logistics costs

There are numerous definitions of logistics costs, and they differ significantly. Engblom et al. (2012) state that logistics costs represent a substantial and relevant portion of business expenses, frequently surpassing 10 percent of a company's turnover. In their research, Engblom et al. (2012) identify six key components that make up total logistics costs: indirect logistics costs, transport packaging, logistics administration, inventory carrying, warehousing, and transportation.

Engblom et al. (2023) examined trading and manufacturing companies in Finland, identifying turnover, time, degree of internationalization, industry, and employee count as statistically significant factors influencing logistics costs. Their findings indicate that, while larger companies generally have lower logistics costs, diseconomies of scale can eventually offset these savings. Overall, the study highlights the importance of interpreting logistics cost changes carefully and controlling for the impact of background variables simultaneously (Engblom et al., 2012).

2.2 Project management

Kerzner (2013) describe the evolution of project management from a limited management philosophy, once seen as optional and confined to a few functional areas, into an essential enterprise-wide system that impacts all areas of an organization. They explain that project management has transformed from a process focused solely on project

execution to a core business process integral to company operations. Increasingly, companies view project management as essential for their survival (Kerzner, 2013).

According to Kerzner (2013), nearly all companies now employ some form of project management, recognizing the connection between project management and productivity. Businesses have shifted to managing operations as a collection of projects. Additionally, Kerzner (2013) emphasizes that project management is fundamentally more about managing people than using tools, highlighting its behavioral rather than purely quantitative nature.

Kerzner (2013) describe project management as a relatively modern approach, defined by strategies for restructuring management and applying specialized techniques to achieve better control and more efficient use of existing resources.

Kerzner (2013) also refers to the PMBOK (Project Management Body of Knowledge) Guide, which identifies five main process groups that structure project management activities throughout a project's life cycle. These include project initiation, project planning, project execution, project monitoring and control, and project closure, as illustrated in Figure 4.

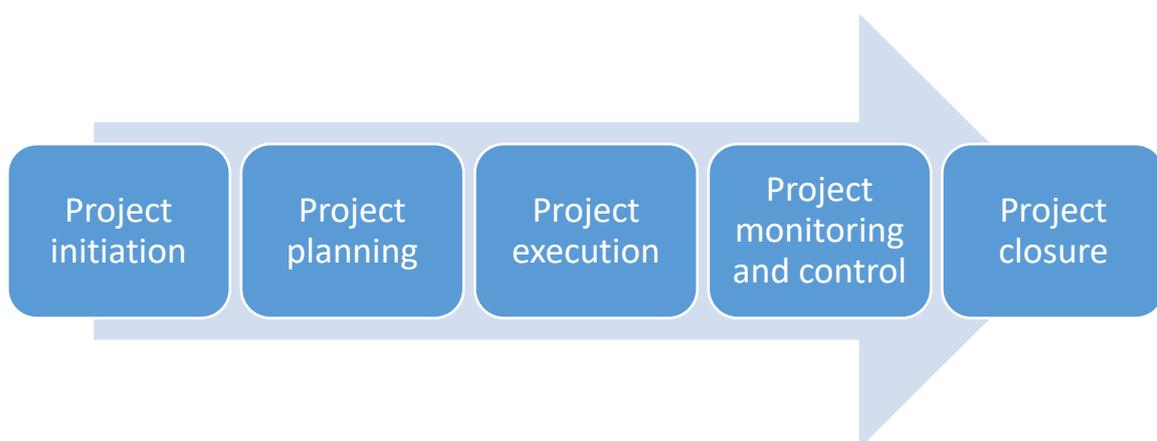


Figure 4. Five process groups from PMBOK Guide (Project Management Institute, 2013).

Successful project management, as defined by Kerzner (2013), is achieved by fulfilling project objectives through:

- Completing the project on schedule,
- Staying within budget,
- Achieving the required performance or technology standards,
- Making effective and efficient use of the allocated resources, and
- Gaining customer acceptance.

2.2.1 Typical stakeholders of supply chain

Petkevičiūtė-Stručko and Yauhen (2018) mention some supply chain stakeholders. They include freight forwarders, insurance companies, banks, authorities, customers and agents among others.

Turbaningsih et al. (2022) state that key stakeholders in project logistics include the manufacturing company, the transporter, and the cargo buyer. They emphasize that effective integration between the manufacturing company and the cargo transporter is essential. They also point out that the on-time delivery of the project's freight transport affects the project's schedule. Turbaningsih et al (2022) suggested an integrated digital ecosystem for multimodal transport to enhance logistics stakeholders' perceived expectations.

2.3 Managing project life cycles and product life cycles

According to Stark (2011) project management approaches enable companies to handle product-related projects efficiently. Project management is one of the product-related activities in the product lifecycle (Stark, 2011). He lists also for example delivery, packing, part storage among other activities.

According to Li et al. (2015), the concept of Product Lifecycle Management (PLM) emerged in the early 2000s. It was used as a control tool for knowledge-intensive processes, mainly including recycling, after-sales support, use, distribution, manufacturing, process development, product design, market analysis. PLM facilitates the management of products throughout their life cycle (Li et al, 2015). Li et al (2015) tell that product lifecycle management has three main phases which are beginning of life, middle of life and end of life.

The authors point out that the PLM encourages the creation of new products and reduces manufacturing costs by controlling the life cycle of products, so PLM plays a major role. According to Li et al. (2015), typically the product life cycle includes a series of stages including design, production, logistics, use, maintenance and recycling.

According to Li et al (2015), in the design phase, an idea in the designer's mind is refined into a detailed plan, which then serves as the basis for producing the final product during the production phase. They state that in the logistics phase, the product is stored and delivered to customers. In the utility phase, customers use the product while manufacturers provide remote support when needed. If problems arise, the product moves into the maintenance phase, and at the end of its lifecycle, it is processed through recycling or disposal (Li et al, 2015).

In his study, Bryde (2003) analyzed the performance of project management (PM) using the PMPA model. The PMPA consists of six elements, one of which is project lifecycle management processes. According to Bryde (2003), project lifecycle management processes relate to the nature of critical business process models and their application throughout the project lifecycle. They also involve the ability to recognize the significance of lifecycle models in developing the characteristics of project culture and the capacity to mitigate the impacts caused by the absence of certain processes on the evolution of project culture. Furthermore, lifecycle management processes include the planning and implementation of processes and documented procedures that cover all stages

of the project lifecycle, including pre-implementation and post-implementation phases. Finally, these processes and procedures are assessed based on how effectively they are updated and how well they are benchmarked against other comparable practices (Bryde, 2003).

According to Bryde (2003), managing the project life cycle encompasses overseeing processes during both the pre-implementation and post-implementation phases. This approach places greater emphasis on pre-implementation tasks, such as defining and planning, rather than post-implementation activities like performance evaluations and handovers (Bryde, 2003).

2.3.1 Project logistics and solution business

Project-based firms are increasingly positioning themselves as solution providers by offering a blend of products and services that function as life-cycle solutions, delivering ongoing value to clients over time, as Momeni (2019) highlights. Solution-oriented businesses need to focus on client needs and integrate various components to enhance the overall value delivered (Momeni, 2019). However, incorporating services within these solution offerings is complex, introducing new challenges and requiring significant adjustments for project-based organizations (Momeni, 2019).

According to the Council of Supply Chain Management Professionals (CSCMP) (2013), logistics refers to the systematic approach of planning, executing, and managing procedures that ensure the efficient and effective movement and storage of goods, services, and associated information from their source to the final destination, all in order to satisfy customer needs. This definition encompasses various types of movement, including inbound, outbound, internal, and external logistics.

Logistics management acts as an integrating function that optimizes and coordinates all logistics activities while connecting these operations with other areas, including marketing, sales, manufacturing, finance, and information technology (CSCMP, 2013).

2.3.2 International logistics and global supply chain management

According to Shibasaki et al (2021), in today's world, with the rapid globalization of trade and economic activity, research on logistics increasingly requires a global or international perspective to support sustainable economic development. They emphasize that critical global logistics issues include cross-border challenges, international cooperation, and the analysis of global shipping networks, along with intermodal transport, supply chain integration and coordination, information technologies, and intelligent transport systems. Additionally, green and reverse logistics, as well as the impacts of China's Belt and Road Initiative (BRI), are highlighted as crucial areas (Shibasaki et al., 2021). Moreover, the authors point out that advancements in information technology now enable the use of big data within global logistics, making innovative approaches to big data analysis highly relevant in this field (Shibasaki et al., 2021).

2.3.3 Logistics Service Providers

According to Nitsche (2020), the expansion of rail transport between Europe and China has introduced significant challenges for logistics service providers (LSPs). One major issue is the volatility of rail transport prices, driven by China's inconsistent subsidy policies. These subsidies are allocated to rail terminals on a quarterly basis, resulting in substantial cost variations. As Nitsche (2020) notes, transport costs from a specific Chinese terminal can shift dramatically between quarters, necessitating frequent rerouting of domestic transport flows.

Nitsche (2020) reports a problem, while LSPs are used to offering fixed pricing for volumes routes, the lack of predictability brings challenges. Changes to the subsidy system make this even more difficult. Once a stable and profitable connection is established, it is again necessary to change terminals domestically to remain profitable. These changes often disrupt logistics planning (Nitsche, 2020).

This issue is also a major concern for potential customers. Nitsche (2020) explains that although LSPs are capable of offering fixed pricing, they often include a risk premium to compensate for the unpredictability of subsidy fluctuations. As a result, their pricing becomes less competitive, discouraging potential customers from selecting rail freight.

Dependence on subsidies also raises questions about the long-term sustainability of rail transport markets. According to Nitsche (2020) in the absence of these subsidies, demand for rail transport between China and Europe would likely decrease substantially. This creates a dual challenge for LSPs: they must navigate the disruptions caused by subsidy-driven rerouting while simultaneously struggling to maintain competitiveness as they work to stabilize their pricing models (Nitsche, 2020).

In summary, Nitsche's (2020) study highlights how an unstable subsidy regime creates significant challenges for rail freight logistics providers. It disrupts operational planning, complicates pricing strategies, and weakens market competitiveness, ultimately hindering the long-term growth and reliability of this mode of transport.

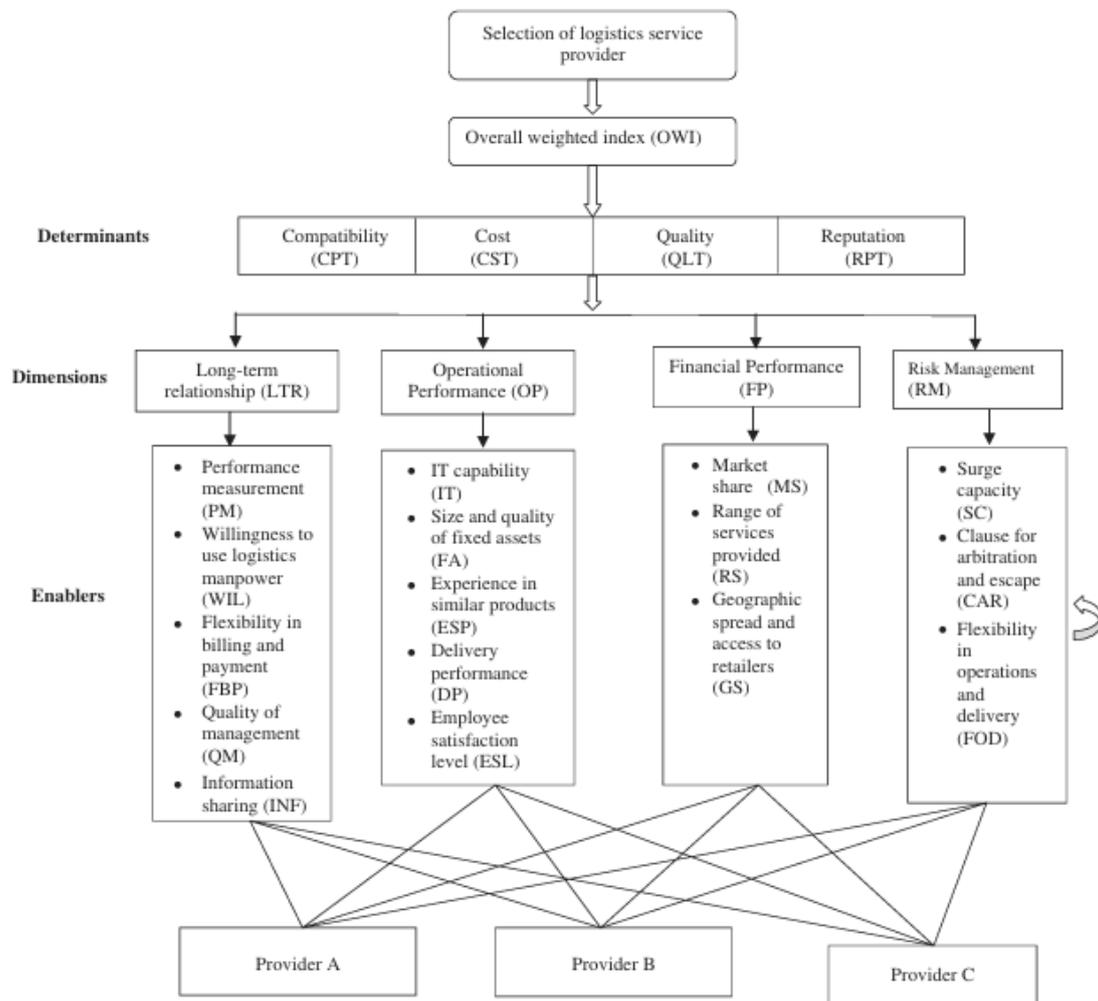


Figure 5. ANP-based model for logistics service provider selection (Jharkharia & Shankar, 2007).

Figure 5 presents an ANP-based model for selecting a logistics service provider, as proposed by Jharkharia and Shankar (2007). At the top of the model is the primary objective: the selection of a logistics service provider. This process is driven by the Overall Weighted Index (OWI), which integrates various factors to assess and rank potential providers.

Jharkharia and Shankar (2007) used an ANP-based model for the selection of a service provider, identifying four key determinants that influence the selection process. The model considers several determinants, such as compatibility, cost, quality, and reputation, and categorizes various enablers into four main dimensions.

At the bottom of the model used by Jharkharia and Shankar (2007), three potential logistics providers—Provider A, Provider B, and Provider C—are listed. Each enabler is connected to multiple providers, indicating that each factor can influence several providers. This linkage structure enables a comparative evaluation of providers based on the overall weighted index. The ANP-based model thus provides a comprehensive, criteria-driven approach for selecting a logistics service provider by integrating various performance metrics and capabilities across dimensions and enablers.

2.3.4 Incoterms 2020

As previously noted, Finnish Customs defines Incoterms, also known as delivery terms, as trade rules developed by the International Chamber of Commerce (ICC) that clarify the responsibilities of sellers and buyers regarding costs, risks, and delivery obligations (Finnish Customs, 2024). The Incoterms 2020 edition includes 11 rules, some applicable to all modes of transport and others designed specifically for maritime transport (ICC, 2020; Logistiikan Maailma, 2024). These rules specify how responsibilities for transportation, insurance, and risk transfer are allocated between the seller and the buyer (Bustamante Morales, 2024a, 2024b; Yang, 2021).

In general terms, seven of the rules (EXW, FCA, CPT, CIP, DAP, DPU and DDP) can be applied to any mode of transport, while the remaining four (FAS, FOB, CFR and CIF) are intended for sea and inland waterway transport (ICC, 2020; Logistiikan Maailma, 2024). Each term defines at which point the risk passes from the seller to the buyer, which party is responsible for arranging transport and insurance, and how costs are shared. The 2020 revision introduced improvements in clarity, particularly regarding unloading responsibilities, insurance obligations, and the allocation of contractual and risk-related duties (Kim, 2022; ICC Academy, 2020).

Research indicates that despite their long history, Incoterms continue to present practical challenges in global trade. Davis and Vogt (2021) found that many contracts adopt delivery terms without a full understanding of when the risk transfers from the seller to the buyer or what financial implications follow from the chosen rule. This lack of clarity can lead to unexpected costs and legal disputes. Babaie et al. (2024) provide empirical evidence on how delivery points, risk transfer, and cost allocation vary across the 11 Incoterms 2020 rules, demonstrating the significant effect that contractual choices have on logistics performance and financial outcomes.

Other studies emphasize the broader knowledge gap within companies. Vogt and Davis (2020) note that while Incoterms are widely used, many organizations lack the expertise to apply them effectively in risk mitigation or cost control. Vogt and Davis (2024) further observed that knowledge alone does not guarantee effective use because contractual practices and commercial habits often diverge from the formal provisions of the ICC rules.

Insurance requirements have received specific attention. Lee (2024) highlights how the 2020 revision clarified the seller's insurance obligations under the CIP term, introducing a higher level of coverage compared to the CIF term. This change was intended to align the rules with modern insurance standards and to reduce financial uncertainty in international trade. Polat (2021) also notes that risk management practices have become increasingly important because companies face rising complexity in cross-border logistics, making clear allocation of responsibilities essential for operational efficiency.

Bergami and Tichá (2022) analyze the risks associated with export transactions under Incoterms 2020, concluding that many firms still underestimate the contractual and logistical consequences of their delivery term choices. Churilov (2020) adds that in some jurisdictions, practical implementation challenges arise because domestic regulations and business practices sometimes conflict with the standardized international rules.

Finally, Kim (2022) explains that the replacement of the DAT term with DPU in 2020 clarified the seller's responsibilities regarding unloading. In addition, the updated rules explicitly recognize the seller's right to use its own means of transport in terms such as FCA, DAP, DPU, and DDP, reflecting changes in modern logistics operations. Overall, the ICC (2020) states that the 2020 revision was designed to address growing demands for transparency in cost and risk allocation, evolving security requirements, and the need for practical guidance in international commercial contracts.

2.3.5 Distribution

According to Mathur (2008), industrial goods can either be sold directly to the customer or through a distributor. Typically, capital goods are sold directly to the customer due to several reasons. For one, Mathur (2008) points out that capital goods often require a detailed explanation to customers, which is best carried out by the manufacturer. Furthermore, the sale of such products usually involves substantial amounts of money, and customers are keen to secure the best price without paying additional commissions to intermediaries (Mathur, 2008). Installation and commissioning of these goods also require specialized knowledge, which is most effectively provided by the manufacturer's engineers. Additionally, Mathur (2008) notes that after-sales services tend to be more complicated and are often more effectively managed when handled directly by the manufacturer. In contrast, manufacturers typically sell raw materials and components through a network of distributors. Mathur (2008) observes that the size and structure of this network are determined by the geographical areas that need to be covered by the manufacturer.

The main distribution channels for industrial goods are illustrated in Figure 6, which distinguishes between direct and indirect sales pathways.

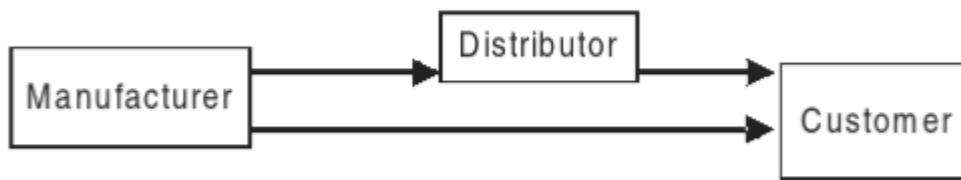


Figure 6. Industrial goods channels (Mathur, 2008).

2.4 Budgeting and cost control in projects

Implementing ERP system reduces costs and increases revenues which leads to market value improvements as Yang and Su (2009, p. 23) found out in their case study.

Cost planning, as Koster (2009, p.163) explains, is similar to scheduling because it involves estimating and controlling costs within a budget framework. The budget functions as a financial plan to allocate resources to specific project tasks, ensuring that resources are distributed efficiently (Koster, 2009). Cost estimates can be drawn from historical data, like bills of materials from comparable projects, or based on recent quotations and pricing information (Koster, 2009). Moreover, Koster (2009) notes that direct costs are unique to the project for which the budget is prepared, making it easier to ensure all financial resources are appropriately targeted.

Koster (2009, p. 164) explains that in many international projects, certain materials may need to be imported, requiring the project manager to plan for extended lead times in transportation and customs clearance as well as to review import regulations and taxes.

Incorporating inflation is prudent when different cost components are anticipated to experience varying inflation rates (Koster, 2009, p. 165). As highlighted in Koster's work, this was particularly applicable in 2009 for raw materials such as steel, oil, and gas, which exhibited distinct inflation trends. Furthermore, it is critical to consider inflation if the project's final product or service is intended for markets in countries with exceptionally

high inflation rates (Koster 2009, p. 165). Overall, project managers should be cognizant of the diverse inflation rates across the countries involved in the project (Koster, 2009). Inflation therefore also affects logistics costs, for example due to fuel prices and changes in supply and demand.

Along with the quantifiable cost items, the overall budget will include an estimating allowance or contingency (Koster, 2009, p. 165). This allowance is meant to cover any oversights or uncertainties, particularly those connected to risk management (Koster, 2009, p. 165).

According to Koster (2009), resource-loaded Gantt charts form a foundational input for budgeting, as they facilitate the determination of labor costs needed for the project (Koster, 2009). Logistics costs can include the labor costs of logistics. Koster's (2009) approach allows project planners to calculate resource costs simply by multiplying each resource's rate by its allocated time within the project.

More broadly, project budgets should align with the project schedule, which itself is generally derived from the Work Breakdown Structure (WBS), ensuring that budget allocations are comprehensive (Koster, 2009). Utilizing the WBS in budget planning helps prevent significant oversights that might lead to cost overruns during implementation (Koster, 2009). In a nutshell, the project budget represents the financial interpretation of the project plan, which is derived from the Work Breakdown Structure (Portny et al., 2008, as cited in Koster, 2009).

In managing international projects, it is crucial for the project manager to monitor currency exchange rates closely, as these can fluctuate considerably throughout the project timeline (Koster, 2009). To prepare budget estimates, the organization's financial policy typically requires using a predetermined exchange rate based on a specific date, with guidance from the financial department (Koster, 2009).

According to Koster (2009), organizing budgets within spreadsheets allows for a detailed breakdown of essential cost components, including materials, labor, travel, training, and transportation. For international projects, however, budgeting becomes more challenging. Koster (2009) highlights that monitoring currency exchange rate fluctuations is critical to ensuring accuracy in cost estimates.

2.4.1 Cost control in large project

Jayaraman (2016) pointed out in his research that ground realities change significantly during the 2–3-year large-scale projects. This has significant impacts on project schedule and budget overruns. He underlined the importance of collaboration in cost control.

Jayaraman (2016) explains that in large-scale projects, the overall project cost is composed of multiple "packages," which are usually defined during the planning phase while developing the Work Breakdown Structure (WBS). These packages represent either the entire cost or a substantial part of the cost for each WBS element.

According to Jayaraman (2016), each package consists of a clearly defined set of tasks that need to be completed in a specific area of the project, and these packages are linked to one another, either directly or indirectly. It is generally recommended to allocate all project costs to one or more packages and assign a project manager to supervise the work within each package. This approach ensures that designated authority figures are accountable for particular areas of the project. By doing so, the project manager assumes both the authority and responsibility for the management of the assigned packages.

Jayaraman (2016) highlights that the next stage in the process involves creating a comprehensive list of all packages along with their respective work contents. The detailed breakdown of the work within each package develops progressively, making it an evolving process. Initially, an approximate cost estimate is produced, followed by the creation

of a preliminary Bill of Materials (BOM) (Jayaraman, 2016). This BOM is then refined using historical data to form an internal cost estimate (Jayaraman, 2016). After improving the work definition, budgetary quotes are sought, which leads to multiple rounds of detailed quotations and discussions with vendors to finalize the cost (Jayaraman, 2016).

Jayaraman (2016) also emphasizes the significance of pre-bid conferences, during which the project owner invites a group of vendors to participate. In these sessions, vendors present their proposals, which are based on the information provided by the owner, helping to estimate the scope of work and its associated costs. These conferences serve to enhance communication between the owner and the vendors, ensuring that both parties have a shared understanding of the project's requirements and expectations (Jayaraman, 2016).

2.5 Monitoring costs and Cost performance in projects

2.5.1 Project Management KPIs

Bryde (2003) discusses the complex nature and methods for managing the main metrics of project management. His study confirmed the multidimensional nature of PM key performance indicators, with multiple tasks and psychosocial outcomes. Formal methods focused on the management of the two main KPIs, namely customer perception and achievement of defined project objectives (Bryde, 2003).

In his study, Bryde (2003) also examined the performance of project management (PM) in relation to key performance indicators (KPIs) used in managing projects. Developing and applying methods to track and handle these KPIs is a vital aspect of project management performance.

According to Bryde (2003), the effectiveness of these methods in managing critical PM KPIs is a key factor. These techniques should also be capable of linking project objectives

with the realization of benefits after the project's completion. Another significant factor is the creation and use of methods to assess stakeholder perceptions. Moreover, these methods must be flexible enough to cover a wide variety of KPIs, especially those focused on improving organizational capabilities. Ultimately, the success of these methods is determined by their ability to measure and track KPIs effectively, ensuring ongoing improvements in project management practices (Bryde, 2003).

2.5.2 Sales force

According to Rynänen et al. (2013), project sales processes are usually complex, involving a combination of business and non-business stakeholders, and can extend from just over a year to several years. The key stages of this process including project initiation, customer engagement, solution development, negotiation and contract closure are illustrated in Figure 7.



Figure 7. Key stages in the supplier company's project sales process (Rynänen et al., 2013).

The sales force plays a crucial role in a company's strategic planning and implementation (Cron et al, 2014). According to Cron et al (2014), senior sales managers perceive that

the strategic role of salespeople requires salespeople to have significant information processing skills. In their study, the interviewed executives portrayed their sales team as engaging with various functional areas such as areas such as operations, logistics and IT, new product development, customer service, and marketing.

Cron et al. (2014) list the sales performance drivers. In supply chain management, one of these is delivery service & support, which is ranked 8th out of 37 attributes. Just ahead of it is sales force knowledge. Together, these attributes encompass the accumulated experience of the sales force, as well as factors such as the speed and flexibility of deliveries and services.

Cron et al (2014) describe delivery services and support capability as an inherently complex systems that require careful management. Their impact on the performance of the sales team, however, depends on how effectively they complement and support the team's ability to build and maintain customer relationships. Cron et al (2014) point out that this collaboration determines whether (1) the value promised to customers is fully realized and (2) the company achieves customer loyalty and cost efficiency. Just like the resources available to the sales team, the seamless integration of sales and other operational capabilities is crucial in many scenarios (Cron et al, 2014).

Cron et al (2014) describe that innovative product development, customer service support, delivery services, technical support, partnerships and alliances, and marketing expertise are complex organizational processes that play a crucial role in creating customer value and improving sales performance. They mention that while the sales team is often involved in these processes to some degree, it is not the primary leader or driver of them. Even though these functions do not directly fall under the sales team's responsibilities, their close interaction with sales is so significant that it directly impacts the results and success of the sales function (Cron et al, 2014).

According to Cron et al. (2014), taking a broader perspective into account when assessing the sales team's performance is necessary. In this context, relevant resources encompass functional capabilities and resources, such as logistics and marketing, and are therefore not limited to just those under the sales team's control.

2.6 Organizations internal environment

Johnston and Marshall (2016) suggest that an organization's policies, resources, and capabilities play a crucial role in shaping the marketer's environment. They underline that while sales managers can influence higher-level organizational factors through their involvement in planning, sales programs must be developed to align with the existing organizational context and constraints in the short term. The main variables in the internal environment affecting sales force management, as classified by Johnston and Marshall (2016) into six categories including research and development and technological capabilities, service capabilities, production and supply chain capabilities, financial resources, human resources, and goals, objectives, and culture, are illustrated in Figure 8.

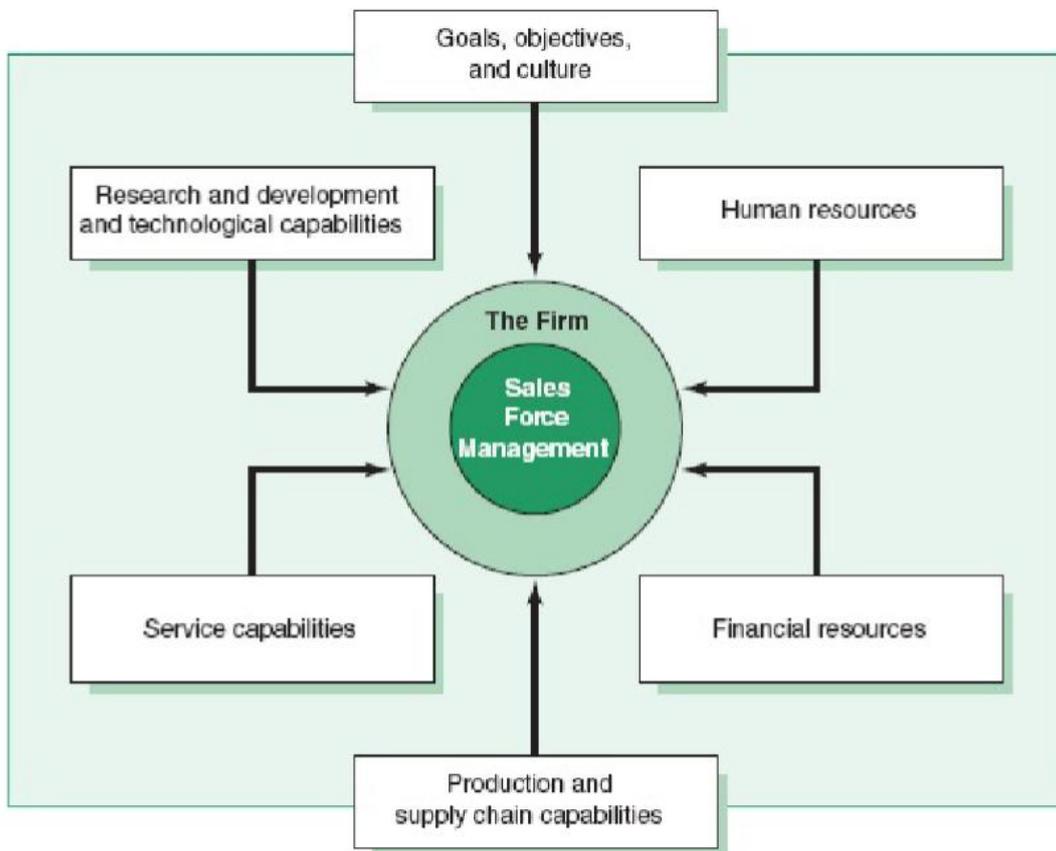


Figure 8. Components of the internal environment affecting sales force management (Johnston & Marshall, 2016).

Importance of communication and cooperation

Ryynänen et al. (2013) highlight the importance of the project sales process, emphasizing the role of a supplier's internal communication network during this phase. According to Lecoeuvre-Soudain and Deshayes (2006), internal communication plays an important role during the whole project sales process.

Ritter and Gemünden (2003) highlight the importance of a corporate culture that promotes openness, which encourages flexibility, initiative, and accountability. This enables employees to build and maintain relationships with external organizations. They also stress that integrating formal and informal communication structures ensures vital information flows to those engaging with external partners, supporting task execution and skill development.

The study by Ryyänen et al. (2013) identifies key aspects of the project sales process, emphasizing the formation of a non-centralized and dense communication network during its early phases. According to Ryyänen et al. (2013), a small group of key individuals, including the sales director and unit directors, play pivotal roles in managing information flow, which significantly impacts the process's efficiency. However, as noted by Ryyänen et al. (2013), several barriers hinder progress, including unregulated technical systems, unsystematic documentation, neglecting cultural differences, and personal politicking. On the other hand, Ryyänen et al. (2013) highlight several drivers of efficiency: an open communication atmosphere, non-hierarchical structures, a variety of communication channels, and communication training, all of which enhance collaboration across organizational units. Together, these contribute to the success of the project sales process.

Cooper and Budd (2007) describe how a request for proposal (RFP) outlines the necessary project deliverables and provides a price estimate based on what the client is willing to pay. According to Meredith and Mantel (2003), a thorough proposal should address several critical aspects, including an overview of the technical challenge and the recommended solution, a roadmap for executing the project once it receives approval, a strategy for managing the logistics and administrative tasks associated with the project, and a summary of the team involved with an emphasis on their past experiences with similar work.

2.7 Quality management

Koster (2009) suggests ensuring that specifications are clear. It is often beneficial to include as many illustrations as possible, even beyond the drawings that typically accompany the specifications.

Logistics budgeting is also influenced by the quality of planning and preparation work. Product drawings and transport documentation must be carefully prepared to avoid

unforeseen issues at later stages. Accuracy in dimensions, weights, and quantities is critical for effective transport planning. Proper preparation, precise documentation, and structured decision-making enhance the reliability of logistics cost estimates and reduce deviations between budgeted and actual costs (Trojahn, Coello Machado & Pfohl, 2022; Asmussen, Kristensen & Wæhrens, 2018).

While Trojahn et al. (2022) emphasize the importance of thorough logistics planning in improving operational efficiency, Asmussen et al. (2018) demonstrate how decision-making complexity and management attention affect cost estimation accuracy. In particular, decision-makers' aspirational levels, which define the precision standards they aim for, shape the effort and resources allocated to achieving accurate logistics budgeting outcomes.

3 Research methodology

This chapter describes the research design, including the case study method and a mixed-methods approach combining qualitative and quantitative data collection and analysis. It also discusses data quality, reliability, and analytical techniques used in this empirical study.

3.1 Research strategy

3.1.1 Case study research

According to Schell (1992) a case study is an in-depth investigation of a particular instance or phenomenon, encompassing individuals, groups, events, or organizations. This research strategy enables researchers to explore complex issues in real-life contexts, allowing for a comprehensive understanding of the subject matter (Schell, 1992). Unlike traditional quantitative methods that often focus on numerical data and generalizability, case studies emphasize the richness and depth of qualitative data, providing insights into the underlying processes, relationships, and influences within the case being studied.

Data collection in case studies is multifaceted and can utilize various methods, including interviews, observations, document analysis, and questionnaires. Schell (1992) highlights the importance of triangulating data from different sources to enhance the richness and validity of findings. By employing multiple data collection techniques, researchers can gain a holistic view of the case, ensuring a more comprehensive analysis.

The case study approach provides depth of understanding, flexibility in research design, and rich descriptive data that reveal patterns and insights not easily captured by quantitative methods. This qualitative strategy allows researchers to explore complex real-world issues in detail, adapt the research design as new findings emerge, and gain a holistic view of the context and underlying processes (Schell, 1992).

3.1.2 Mixed method

Mixed methods research combines quantitative and qualitative approaches to comprehensively address research questions. This integration leverages the strengths of both methodologies, providing a nuanced understanding of complex phenomena (Fàbregues & Molina-Azorín, 2017; Matovic & Ovesni, 2021). Qualitative methods offer insights into participants' experiences, while quantitative methods identify relationships across larger populations. Triangulation is used to enhance validity by corroborating evidence from multiple sources and methodologies (Fàbregues & Molina-Azorín, 2017; Matovic & Ovesni, 2021).

3.1.3 Secondary data

According to Saunders et al. (2023), it is not feasible to gather data from the entire population, so selecting a sample is necessary. Changes in how data are collected may reduce data trustworthiness. Secondary data refers to information that has been previously collected, often compiled, selected, or summarized, and can be reanalyzed to derive new insights, interpretations, or conclusions (Saunders et al., 2023).

Organizations frequently gather and maintain extensive and diverse datasets on an ongoing basis to facilitate daily operations. Examples include payroll details, financial records, organizational charts, correspondence, meeting minutes, and business transactions such as sales inquiries and purchases (Saunders et al., 2023).

Secondary data can include both quantitative (numerical) and qualitative (non-numerical) information (Saunders et al., 2023). This data may be raw, with little processing, or compiled, having already been selected or summarized. Most secondary data is available digitally, either as structured data stored in relational databases or spreadsheets for efficient processing, or as unstructured data, which lacks a predefined format and is therefore more difficult to process or search. Unstructured data formats include text, visual,

audio, and audiovisual content, as well as dates and numerical data. Many digital secondary datasets are created by combining various sources into larger, multi-source datasets, and some are continuously updated with data from diverse origins, which can be categorized as big data (Saunders et al., 2023).

Secondary data is commonly utilized in business and management research, particularly in case studies and survey-based research approaches (Saunders et al., 2023). One of the major benefits of secondary data, especially for addressing research questions and achieving objectives, is its cost and resource efficiency compared to collecting primary data.

Another crucial consideration for secondary data is its coverage. Researchers must ensure that the data adequately represents the population or sample required for their study, spans the necessary time frame, and is capable of addressing the research objectives. Coverage involves two key factors:

- Ensuring irrelevant data is excluded
- Confirming enough relevant data is retained for analysis after exclusion

When working with secondary survey data, it is also essential to identify and remove any data unrelated to the specific research questions or objectives (Saunders et al., 2023).

3.1.4 Data Reliability and Quality

Saunders et al. (2023) emphasize that, despite organizational claims regarding the dependability of their records, inconsistencies and inaccuracies are often present. To address this, it is crucial to assess how the data was originally collected and ensure it met the detail and accuracy requirements of the primary user. This evaluation not only highlights potential flaws in the data but also aids in understanding its suitability for secondary analysis, providing a more reliable foundation for research findings.

Measurement bias and the low reliability of secondary data can be influenced by several factors (Saunders et al., 2023). According to Saunders et al. (2023), the three measurement bias factors identified by Hair et al. (2016) can decrease the trustworthiness of data. These factors include failure of the technique used for data collection to accurately measure the intended topic, deliberate distortion of the data, and changes in the methods or procedures used to collect data. One key factor is deliberate distortion, which involves the intentional recording of data inaccurately. This is particularly common in secondary data sources, such as organizational records. However, not all distortions are aimed at gaining an advantage. Recognizing such distortions, whether intentional or unintentional, is crucial for assessing the accuracy and reliability of secondary data (Saunders et al., 2023).

3.2 Case study application

The case study focuses on the organization's key operational processes within a defined timeframe, providing a practical context to explore the impact of its logistics processes. This approach enables a detailed examination of factors influencing the logistics budget, identification of challenges, and development of practical solutions, thereby addressing the research questions effectively.

3.3 Mixed method application

Based on the theoretical framework presented in section 3.1.2, this study applies a mixed-method approach to combine qualitative and quantitative data for a comprehensive analysis. Qualitative data, including internal documents and training materials, provided a current state analysis of the sales process structure and stages. Quantitative data were analyzed using numerical information from the project database and ERP systems, accessed via transaction codes CN41, CNS41, and YPCCR, which provide key operational metrics.

3.3.1 Secondary data

In this study, secondary data were collected from the company's ERP and Power BI systems, as described in section 3.1.3. To ensure accuracy, selected data were cross-verified against primary sources where needed. The dataset includes logistics-related variables (e.g., project name, number, value, destination country, incoterm, original budget, and actual costs) from projects completed between 2020 and 2024. Primarily quantitative, the data also contain qualitative details such as project descriptions, enabling a comprehensive analysis of logistics performance.

3.4 Data Reliability and Quality

The following section applies the principles of data reliability and quality discussed in section 3.1.4 to the current study, describing how the secondary data was evaluated and measures taken to ensure accuracy and consistency. As noted by Saunders et al. (2023), organizational records are often considered reliable but may still contain inconsistencies or inaccuracies. To address these concerns, this study evaluates how the secondary data was originally collected and assesses its alignment with the research objectives.

Measurement bias, including both deliberate and unintentional distortions (Hair et al., 2016; Saunders et al., 2023), is also taken into account. For instance, employees responsible for recording working hours may estimate time spent on major tasks without tracking every detail, resulting in data inaccuracies. To mitigate such risks, data from multiple systems are cross-verified, and insights from domain experts within the organization are used. These steps help improve the accuracy and dependability of the secondary data used in this analysis.

3.5 Data analysis techniques

The collected data will be analyzed using Excel, which enables structured processing of both quantitative and qualitative data in line with the research objectives.

Quantitative data from the ERP and Power BI systems will first be cleaned and organized to ensure consistency. Excel functions such as filtering and sorting (e.g., averages, sums, medians) will be used to identify trends, patterns, and outliers in logistics operations. Visualizations like bar charts, scatter plots, and line graphs will be created to present findings clearly.

A complementary approach will be used to integrate qualitative insights with quantitative results. For instance, if the quantitative data reveal a trend in logistics costs, relevant qualitative data will be reviewed to explore underlying causes. This iterative process supports a more comprehensive understanding of the studied phenomena.

4 Empirical research

This chapter presents the empirical analysis conducted to explore the factors influencing logistics budgeting accuracy in project-based settings within the case company. The analysis utilizes a dataset of 1,400 projects to examine how various variables impact logistics costs and to identify potential causes of budgeting deviations.

The primary objective is to assess the effectiveness of the current budget planning process and to uncover opportunities for improving logistics cost estimations. Furthermore, this section evaluates whether additional project data could enhance future budgeting accuracy and guides risk assessment to support potential logistics savings.

The empirical research is structured as follows: first, the case company is introduced, followed by a current state of budgeting practices. The chapter then details the quantitative part and discusses the key findings and their implications for logistics budgeting.

4.1 Case company

The case company is a global technology company that provides solutions for the aggregates, mining and metals refining industries, offering a comprehensive range of equipment and services. Sustainability is a core focus, with efforts aimed at helping customers reduce energy and water consumption. The company operates in approximately 50 countries worldwide.

The company has set an ambitious goal of achieving zero emissions by 2030, which will directly affect its logistics and supply chain management processes. Consequently, carbon footprint considerations must be integrated into the budgeting process in the future. This sustainability goal will also influence sales and procurement activities.

Among the company's strategic priorities for growth, supply chain competitiveness is one of the four focus areas is supply chain competitiveness, so logistics budgeting is also important.

The case company was selected for this study due to its complex global supply chains, which involve multiple regions, long transportation distances, a wide network of logistics service providers and varying market conditions. These characteristics create challenges and development opportunities for project-based logistics budget estimation. The insights gained from the research aim to determine whether the company's logistics cost estimation processes can be improved and how such improvements could be implemented.

4.2 Current state of budgeting practices

The logistics budget consists of transportation, storage, and the man-hours required for logistics activities. Budgeting can therefore be divided into external costs (e.g. transportation and storage) and internal costs (e.g. logistics work hours). The work effort is budgeted either as an agreed percentage of the sales price or by applying a specific calculation formula. Additionally, insurance costs are allocated to projects individually, depending on the Incoterms 2020 of the project.

There is an established process and set of tools for logistics budgeting. However, a minor issue was identified: the sales team does not always submit a logistics sales support request to a designated logistics solution manager. As a result, certain relevant aspects may be overlooked, or cost estimates may be less accurate than they could be.

There are internal guidelines for estimating logistics costs for sales cases across different business lines. In general, logistics costs are divided into two categories: direct logistics costs (e.g. transportation) and logistics work hour costs. A predefined percentage is used for each category, tailored to the specific business line. For transportation and other

direct costs, the Incoterms used in the sales case directly influence the applicable percentage (e.g. x% of the sales case value).

A pricing tool in Power BI is used to support transport cost estimation. It contains historical data and contract prices from several freight forwarders, which are used as a basis for cost estimation. It is often beneficial to compare RFI/RFQ pricing with the estimates from the tool, as this helps identify discrepancies and understand the reasons behind potential differences.

4.2.1 Introduction to current state analysis

The aim of the current state analysis is to define the existing operating model of the project-based logistics budgeting process within the company. The purpose is to understand how logistics budgeting is carried out in practice, what stages it involves, who participates in the process, what kinds of tools are used, and how the budgeting practices support overall project management and sales. This section lays the foundation for the subsequent data analysis. Once the process has been clearly described, the collected data can be used to assess which aspects are functioning well and where there is room for improvement. Based on this assessment, recommendations can be made to enhance accuracy and predictability in future budgeting.

Understanding the current state is particularly important, as managing budget deviations in project-based logistics requires accurate initial estimates, transparent processes, and effective collaboration across departments. For this reason, the analysis also considers the role of logistics in the sales process, the use of systems, the division of responsibilities, and the extent to which steps are handled manually or automatically.

Reviewing logistics budgeting practices is essential for evaluating budget accuracy. It helps identify potential sources of inaccuracy and process steps that may contribute to budget deviations. This enables the development of improved practices that enhance the predictability and accuracy of budgeting in the future.

The analysis is based on the company's internal guidelines and process descriptions related to logistics cost estimation, as well as sales support instructions intended for logistics solution experts. These materials help clarify how budgeting is currently organized and how different departments collaborate during various stages of the process.

The scope of the analysis is limited to project logistics within a single business area, focusing specifically on the processes and practices related to logistics budgeting in project environments. This delimitation enables a more detailed analysis and allows for targeted examination of elements that directly impact budget accuracy and predictability.

The current state analysis pays particular attention to the following variables that influence budgeting accuracy:

- Incoterms: how the selected delivery term influences logistics costs and the budgeting process
- Market region: how different target regions impact the assessment and budgeting of logistics costs
- Product group: how specific characteristics and requirements of different product groups affect logistics costs
- Business line: how variation between business lines influences cost evaluation and budgeting approaches

This analysis aims to determine how these factors are considered in practice and how they impact the accuracy of logistics budgeting.

The following variables are present in the data set:

Business Line (6 categories): A, B, C, D, E and F

Delivery Term (Incoterm): CFR, CIF, CIP, CPT, DAP, DDP, FAS, EXW, FCA, FOB

Product Group: 14 categories

Market Region: Americas, Asia and EMEA

Difference (%): *Original Cost Plan / Orig. AS* and *Total Actual Logistics Cost* difference

Only completed projects are considered in the analysis. Cancelled, upcoming, ongoing and on-hold projects are excluded.

4.2.2 Logistics role in the quotation and sales process

Logistics becomes involved in the quotation process when sales submits a sales support request to the logistics solution manager. At this stage, logistics evaluates the resources and costs associated with transportation, warehousing, and logistics work hours. Cost estimation is based on data from previous projects and various budgeting tools. Typically, cost estimates are based on established percentages depending on the Incoterms, which are defined according to the company's internal guidelines. These percentages account for transportation, warehousing, and other logistical costs defined by contractual terms.

Historical data from past quotations and projects can also be used to support cost estimation. For instance, if Power BI's pricing tool is available, it helps compare current estimates against previous pricing data. In addition, logistics teams perform project-level checks of current market rates by requesting updated quotations from Logistics Service Providers (LSPs). These checks ensure that estimates reflect prevailing transport prices, currency effects, and capacity conditions, and they form a fundamental part of the cost estimation process. When estimating costs, it is also important to account for potential risks related to supply chains and customer schedules, as underestimating logistics costs can endanger target margins.

In quotation preparation, sales usually aims for a defined margin percentage. As logistics costs directly affect the selling price, any increase in these costs must be accounted for in pricing to avoid losses. To mitigate the risk of fluctuating transport prices, the company applies the cost-plus method in contracts.

The company has established calculation models, such as percentage allocations for logistics costs across different business areas, which help estimate logistics costs. These may include commonly used calculation methods, such as determining transportation prices based on previous pricing data. If Power BI's pricing tool is in use, it can serve as a predictive framework that helps determine logistics costs based on previous price histories and early quotation data.

To create a logistics cost estimate, the following information is required:

- Delivery address and market region: Destination country and region influence transport and storage costs.
- Incoterms 2020: Define responsibilities for transport costs and transfer of goods.
- Product characteristics: Size, stackability, weight, temperature sensitivity, and special requirements all affect costs.
- Timelines and delivery schedules: Urgency may require faster, more expensive shipping options.
- Modes of transport: Road, sea, or air freight influence pricing.

Smooth cooperation between sales and logistics is essential to ensure accurate cost estimates and consideration of all relevant factors. If sales fails to submit a logistics support request on time, it may result in incorrect estimates and budget overruns. Clear communication and defined responsibilities between sales and logistics are critical throughout the quotation process. A clear division of responsibilities helps avoid delays and errors. For example, if a logistics support request is not submitted, it may cause misaligned estimates.

Logistics follows a structured sales support process to support quotations. Sales relies on accurate cost estimates, timeframes, and logistics solutions when preparing customer offers. When the origin and destination countries are known, a reasonably accurate cost estimate can be made. However, logistics support may be requested years before actual

deliveries, introducing a high risk of changes in scope or costs, which may necessitate later budget revisions. At the project level, the logistics budget may not involve multi-function reviews due to low sales value or low probability to win. Similarly, some projects may not have internal logistics costs recorded if logistics hours were not booked into SAP according to local guidance. The structured logistics sales support process, showing the six key steps from request submission to cost evaluation and feedback to sales, is illustrated in Figure 9.

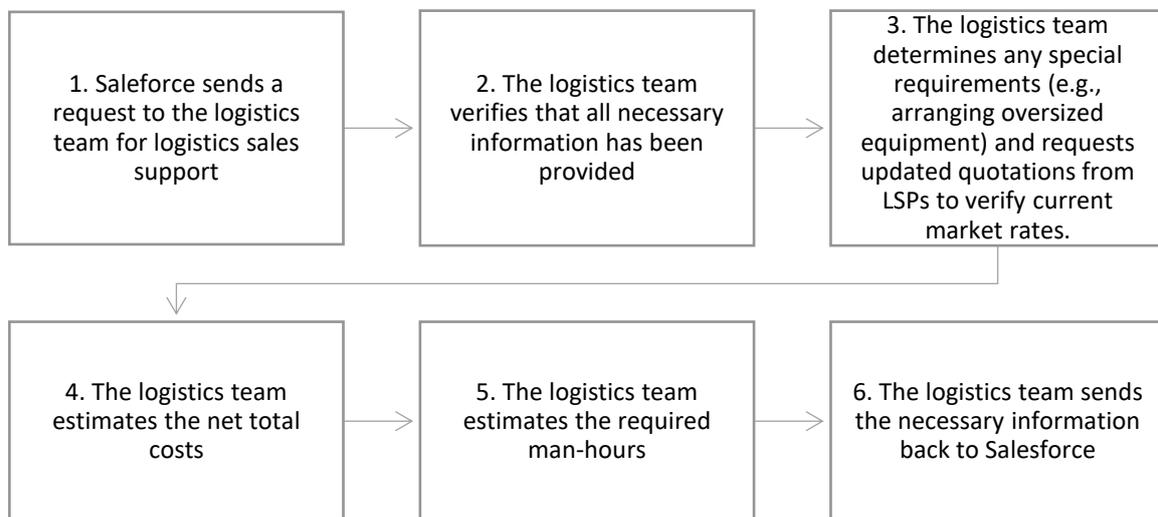


Figure 9. Structured logistics sales support process showing the six key steps from request submission to cost evaluation and feedback to sales (Company internal documentation).

The process begins when Salesforce sends a request for logistics sales support. Logistics checks that all required information has been provided, including Incoterms, equipment details, and the due date. The logistics solution is then selected, including how price estimates will be requested and defining specific requirements such as oversized transport. Next, the net total cost is evaluated, covering external costs such as storage, transport, and handling, and the required work hours are estimated, including internal costs. Finally, the completed information is sent back to Salesforce.

4.2.3 Logistics budgeting process in project deliveries

The logistics budget is typically prepared in the early stages of a project, often during the tendering phase or immediately after project approval and contract signing. If logistics has not been budgeted during the tender phase, estimates can be made based on previous projects, market prices, Incoterms agreements, and established calculation models. In such cases, initial accuracy may be lower, but the budget becomes more precise as additional information becomes available during project execution.

It is essential to consider potential logistics risks already during the tender phase and to account for them when updating the budget. If the logistics budget remains undefined, it is advisable to proceed cautiously with pricing and allocate sufficient margin for possible cost changes.

The logistics team is primarily responsible for preparing and maintaining the logistics budget, but collaboration with the project manager, sales, and finance departments is crucial. Logistics provides cost estimates and optimization suggestions, while the project manager may be responsible for tracking and updating the budget as the project evolves.

The logistics budget includes both internal and external costs. Internal costs may cover logistics work hours, which are typically estimated as a percentage of the sales price or through case-specific calculations. However, some projects may not have internal logistics costs if hours are not booked into SAP or are excluded based on local guidance. External costs include transportation, packaging, customs clearance, storage, and other outsourced logistics services. These can vary significantly depending on Incoterms, project location, and supply chain requirements.

As part of estimating external logistics costs, logistics teams routinely verify current market rates by requesting updated quotations from Logistics Service Providers. These market-based checks are performed at project level and ensure that cost estimates reflect prevailing transport prices, currency effects, and capacity conditions. This step is a

fundamental part of the budgeting process and helps improve the accuracy of external cost forecasts.

Logistics documents (e.g., transport and customs-related paperwork) are typically categorized under transportation costs in project budgeting. Although document handling may involve internal work, the documents themselves are directly linked to external services and are therefore considered part of external costs.

Example Logistics Cost Categories in the WBS:

Logistics Work & Documentation

- Logistics Work (includes also "logistics work EXT")
- Logistics Documents
- Brokerage Costs

Packing & Transportation

- Packing Costs (also includes "export packing" and "packing & transportation")
- Transport Costs (also includes "shipping & freight costs", "outbound shipping", "outbound freight", "inbound freight", "delivery")

Warehousing & Storage

- Storage Costs (also includes "Additional Warehousing" and "storage")
- Containers

Customs & Duties

- Customs Clearance (includes also "customs", "customs duties and taxes", "duties / taxes", "import duty")

Compliance & Certifications

- EAC Certification Work
- Product Compliance

Other / Miscellaneous

- Miscellaneous
- Contingency for Logistics

Roles in the Budgeting Process:

- Sales evaluates preliminary logistics costs during the bidding phase and includes them in the initial estimate but is generally not responsible for the final budget
- Logistics prepares more accurate cost estimates using defined pricing models and tools such as Power BI.
- Finance reviews the budget and ensures alignment with financial goals and budgeting practices.
- The Project Manager coordinates all parties and ensures the budget is realistic and deviations are considered.

4.2.4 Budgeting approaches and updates

Both standardized estimates and case-specific calculations can be used. Standardized estimates are based on predefined percentages (e.g., logistics cost as a share of sales price) or data from similar past projects. Case-specific calculations are used particularly when the project is complex and requires more accurate estimates, for example based on different market regions or Incoterms agreements. In such cases, the logistics team prepares the calculations by considering the project's specific characteristics and potential changes, such as transportation needs and customer-specific requirements.

The budget is updated regularly throughout the project as new information becomes available. Updates may be triggered by:

- Changes in transportation volumes, deadlines, or supply chain structure
- Market price or freight rate fluctuations
- Customer changes to delivery requirements (e.g., location, schedule)
- Additional external costs or services (e.g., special packaging or transport)

Regular updates help ensure the budget reflects the current situation and allows for timely identification and management of deviations.

4.2.5 Systems and tools in use

Several systems support logistics budgeting by enabling budget creation, tracking, and optimization. The company uses tools like Power BI to manage logistics processes and budgeting. SAP systems provide the underlying data, while Power BI creates visual dashboards and enables real-time budget monitoring. These tools help track transportation and storage costs, logistics labor hours, generate reports and forecasts, and perform more accurate calculations using historical project data.

Data collection and analysis in systems like SAP and Power BI can be automated, though creating initial estimates and handling deviations often requires manual work. The logistics team may input and verify data manually, but automated tools assist in reporting and forecasting. The more historical data is available, the more reliable the forecasts become.

Effective data transfer between the sales team, logistics, and project management is crucial for accurate budgeting. During the tender process, sales provides key inputs such as customer delivery requirements, Incoterms, and project deadlines. Project managers and logistics use this data to refine the budget and manage potential changes in timelines or the supply chain. Smooth and timely data transfer is essential to ensure the logistics budget is prepared on time and without errors.

Systems like SAP and Power BI support the budgeting process by offering efficient tools and clear visualizations. Power BI dashboards enable tracking budget progress and detecting deviations, which supports forecasting and risk management. System-generated reports aid in decision-making and provide visibility into budget development throughout the project.

The accuracy of logistics budgeting relies heavily on the quality and timeliness of data. Inaccurate or outdated data can lead to poor cost estimates, ultimately affecting

profitability and schedules. For example, transportation cost estimates depend on current market prices and past project data—if these are outdated, the estimates will be unreliable. Accurate, up-to-date data enables better forecasting and more precise calculations, resulting in more reliable and predictable budgets. Overall, global logistics is a highly complex system influenced by many variables affecting costs and timelines.

4.3 Quantitative research: case company data analysis

4.3.1 Data quality and scope

It should be noted that the number of projects included in each analysis varies due to data availability, as some projects had missing or incomplete entries for certain variables, such as internal costs

This study does not examine in detail the transfer of data between different systems or potential data loss during those transfers. Cost data is based on the SAP system, which is considered to provide the most accurate and up-to-date cost records.

Manual data entry increases the risk of errors and lowers data reliability. In addition, the variation in Work Breakdown Structure (WBS) configurations, where logistics costs may appear under a single cost element or be distributed by product, complicates data transfer to analytical tools like Power BI. This variability can negatively affect the consistency and accuracy of reporting. Furthermore, inconsistencies have been found between SAP systems and reporting documentation, which makes it difficult to determine the correct cost figures. Due to these challenges, the study focuses on total logistics costs instead of separately analyzing transport and labor components.

In this research, logistics costs are treated as a whole and separated into internal and external costs. Due to missing or inconsistent entries in the Work Breakdown Structure, a reliable separation between labor and transport costs could not be achieved across all

projects. Contractual differences and changes have been excluded from the scope, although significant changes during the project can affect budget accuracy.

4.3.2 Work breakdown structure and data integration

Another challenge is the lack of clarity and standardization in WBS elements. Some WBS names are vague or inconsistent, which poses difficulties for reporting. In some cases, logistics work is explicitly defined, while in others it is not. This inconsistency reinforces the need to treat logistics costs holistically in this analysis, without splitting them into transport and administrative categories.

In several projects, logistics costs are either missing or listed as zero in both the estimate and the actual cost records. Travel management related to logistics is excluded from this analysis.

Data quality plays a critical role in cost estimation and budgeting. Since reports and databases rely on available inputs, the more accurate the data, the more reliable the resulting estimates. The data used in this study was retrieved from various internal sources, including Excel reports, Power BI, and SAP. The focus is on projects within a specific business area, with variables such as contract value, delivery term, business line, product group and market region taken into consideration. Contract changes and cost-plus content are excluded.

A further complication stems from the company's recent merger, which has resulted in data being stored across multiple systems with inconsistent reporting practices. In addition, many projects lack sufficient detail in WBS structures to allow a clear breakdown of logistics costs. Human error in data entry also affects data reliability. Therefore, while the findings provide valuable insights, they should be considered indicative rather than definitive.

4.3.3 Data sources and selection criteria

Depending on the source, the data was either collected or revised to ensure a minimum level of quality. Information was retrieved from three different SAP systems using several reports: YPCCR (Project Cost Control Report), CNS41 (Project Info System: Structure Overview), and a customer-specific Y-transaction (Selection: Plan Comparison of Eight Plan Versions).

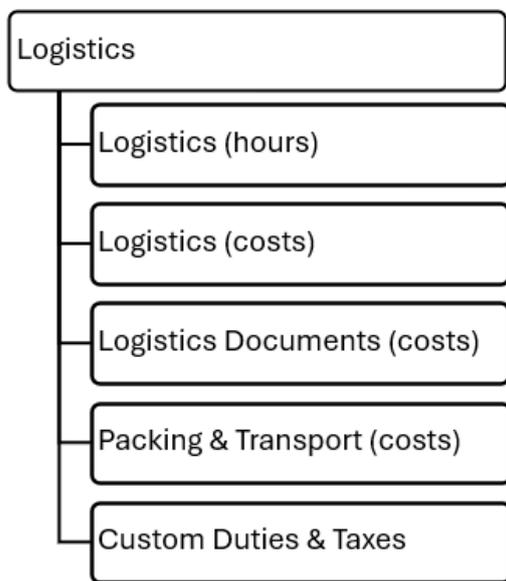


Figure 10. Example of logistics costs in Work Breakdown Structure

Each project has its own Work Breakdown Structure (WBS) in SAP. Most projects include a dedicated WBS element for logistics costs and a network that breaks down the various logistics-related components. In some cases, however, logistics costs are recorded directly under the main project WBS element. Often, there is a specific logistics level within the project structure where logistics hours, logistics costs, packing and transport costs, logistics document costs, and customs duties and taxes are itemized, as illustrated in Figure 10.

The success of the sales process plays a significant role in whether the logistics budget remains accurate throughout the project. If cost estimations during the sales phase are incomplete or inconsistent, the likelihood of budget deviations increases.

The structure and terminology used in WBS elements vary between projects. While small projects typically present fewer problems, large and complex WBS structures may cause inconsistencies. For example, element names can differ across systems: in SAP1, logistics-related items may be labeled as "shipping & freight," "DDP Delivery," "transportation," or by specific equipment names followed by "(LOG)." In SAP2, the element may appear as "Forwarding and shipp" and include a variety of cost categories such as forwarding work, documentation, packing, transport, site logistics, and additional deliveries. All estimated and actual logistics costs for each project have been aggregated for comparison. These totals include logistics man-hours, provided they are explicitly defined in the WBS. However, not all projects separate labor and transport costs, which limits the granularity of the analysis.

The accuracy of data transfers between SAP and Power BI must also be verified. If there are major differences in WBS structures between systems, this can lead to incorrect reporting or mismatches in budget data.

There is also ongoing internal discussion about whether the SAP Project Management (PM) module would be suitable for project logistics. It has previously been considered inadequate, but this could warrant further evaluation.

Assessing the accuracy of original logistics estimates is only meaningful if those estimates are clearly entered in the WBS. Without an initial logistics budget in the WBS, especially in smaller projects, it is not possible to track or evaluate the success of the budgeting process. In SAP1, the placement of logistics work is sometimes unclear, as it is not always explicitly listed.

4.3.4 Budget accuracy and contributing factors

The accuracy of logistics budgets in project deliveries varies significantly, with actual costs often deviating from initial estimates. In the context of the company analyzed in this study, the original logistics budget rarely aligns perfectly, partly due to the uncertainties inherent in international supply chains and the limitations of the calculation models and forecasting templates used.

Budget overruns may result from inaccurate or incomplete initial data during the tender and design phases, where not all factors related to transport routes, packaging requirements, or export orders are yet known. Furthermore, external disruptions in the supply chain, such as strikes at ports, geopolitical conflicts (e.g., the war in Ukraine or restrictions on Black Sea navigation), natural disasters (such as earthquakes or storms), pandemics (e.g., COVID-19), or logistical bottlenecks (e.g., congestion or blockages in the Suez or Panama Canals), can increase costs unpredictably. In these situations, particularly urgent transport solutions, such as air freight, may significantly raise total costs. Internal factors also impact budget accuracy. For example, production delays may result in the need for expedited delivery schedules, which increases transport costs. If sufficient risk contingencies are not considered in the original budget, such situations can easily lead to overruns.

Delivery terms play a crucial role in budgeting logistics costs. They define the extent of the seller's responsibility for delivery and determine how much of the supply chain costs are included in the selling party's budget. For example, under an EXW term, the seller is only responsible for internal logistics costs, such as packaging, documentation, and transfer from the factory, whereas in DDP or DAP terms, the cost responsibility extends to international transport and possible customs procedures. However, it is important to note that regardless of the selected delivery term, the seller's organization almost always incurs internal logistics costs (e.g., packaging, handling, transfers, documentation, and

export clearances), which must be included in the budget. These aspects require planning, work, and resources.

The delivery term (Incoterms) plays a significant role in the allocation of logistics costs and budget accuracy. If the delivery term is defined late in the tender process or clarified only during contract negotiations, it may cause challenges in the accuracy of the original budget. Similarly, if the delivery term changes later, for instance, due to the customer's request, this may lead to significant deviations from the original budget. A budget prepared for EXW terms is not compatible with DAP execution without updating the budget. It is essential to account for such changes to ensure that the budget remains realistic and reflects actual costs.

In some cases, costs may be undercut, which can result from the risk margins included in the original budget or because the anticipated risks do not materialize. For example, competitive transport rates obtained through tendering or route changes may reduce actual costs. However, it should be noted that cost savings are not always a result of effective optimization and may also indicate budget caution or overestimated risk contingencies.

Therefore, the accuracy of logistics budgets is a complex phenomenon influenced by both changes during the delivery project and the rapid fluctuations in the global operating environment. Accurate budgeting requires not only consideration of delivery terms and internal processes but also the ability to anticipate and model risks effectively. Additionally, the budget must be flexible, particularly in multi-phase and long-term project deliveries where conditions can change rapidly.

Overall, the accuracy of logistics budgeting is fundamentally dependent on how well risks and uncertainties are identified during the budgeting process and how up-to-date information is incorporated as the project progresses. In practice, this means the need to continually develop more systematic and data-driven evaluation models that leverage

historical performance data and consider key variables affecting costs already during the tender phase.

The original dataset consisted of 1429 projects. From this, 752 projects were selected for analysis. These projects belonged to a specific business region and were limited to six business lines. Projects with more than one delivery term or with a contract value or original cost plan of 0 or 1 euro were excluded. Likewise, projects that had multiple Incoterms recorded in the data were removed, as they complicated the clear comparison between the budget and the actuals. The aim was to evaluate the accuracy of the logistics budget in relation to actual costs and to identify factors influencing budget deviations.

The analysis revealed that projects delivered under the FCA Incoterm posed particular challenges in budgeting. In total, 158 projects had an original logistics cost plan of 0 euros. Of these, 110 had FCA as the delivery term. In only two of these FCA projects were the actual logistics costs also 0 euros. This means that 108 projects incurred real logistics costs despite lacking an original cost plan. Among these 110 FCA projects, 84 had entries for internal costs (logistics hours), and 76 had external logistics costs. Based on these findings, it can be concluded that especially FCA projects should have a clearly defined and comprehensive logistics budget that includes both internal work resources and external costs such as transport and possible local handling charges.

One possible reason for missing budget allocations may be that the delivery term changed during the course of the project, but the change was not updated in the key systems, such as the WBS structure or the log plan Excel. The original budget may have been created while the delivery term was still undecided—or based on incorrect information. This highlights the importance of data accuracy and the role of systems in ensuring correct delivery term documentation during budgeting.

Particular challenges arise in situations where goods are procured from subcontractors under FCA terms and shipped directly to the end customer. In such cases, the supplier's responsibility ends at the FCA point, and all subsequent transport and logistics costs fall under the project's responsibility. If this has not been accounted for in the original budget, significant discrepancies between the budget and the actuals may occur.

The analysis also identified the opposite scenario: 20 projects had budgeted logistics costs but no actual logistics expenses. Of these, 16 used the FCA delivery term, and an equal number were in the EMEA market region. Additionally, 13 of these 20 projects belonged to the same business line. This may indicate cases of overbudgeting or situations where the project scope changed during execution, and the logistics services initially planned were no longer needed.

Budget accuracy was assessed by comparing original cost plans to actual logistics costs as percentage differences. For 930 projects, this difference could be calculated. However, projects with a difference of exactly -100% (i.e., the budget existed but no actuals were recorded) or 0% (i.e., actuals matched the budget exactly) were excluded. Projects with incomplete or non-comparable data were also removed. This left 731 projects for analysis. Among these, the average budget overrun was 105%, indicating significant underbudgeting for logistics costs. The most extreme observed overrun was 7,428% compared to the original cost plan.

There were also individual projects where the original and actual costs were identical. For example, one project with only internal logistics costs had matching original and actual values. This suggests that the original budget was not created at the project's outset, but instead the realized costs were later recorded as the budget. Such cases distort the evaluation of budgeting accuracy, as they do not reflect forward-looking planning. To maintain the reliability of analysis, it is essential that budgeting and execution phases are clearly separated in the system records.

In summary, several factors affect the success of logistics budgeting: delivery terms, project location, business line, and changes during the project lifecycle. FCA projects appear particularly prone to budgeting challenges, emphasizing the need for a systematic, data-driven, and proactive budgeting process. Clear cost breakdowns, consistent practices, and accurate system entries are key to improving budget reliability. It should also be noted that logistics costs typically represent only a minor portion of the total project budget. As a result, even in cases where logistics costs exceed the original estimates, the overall project may still be delivered within budget.

It is also important to acknowledge structural limitations in project-level budgeting. For some projects, a full multifunction review is not feasible due to low sales value or a low probability of winning the contract. Additionally, certain projects may include no internal logistics costs, either because logistics operations did not book hours correctly or because, according to local guidance, the responsible logistics team was not required to record hours in SAP. These factors contribute to apparent discrepancies and incomplete cost coverage in the dataset.

Another factor influencing deviations is the lead time between the creation of the budget and actual delivery. Longer lead times increase exposure to market rate fluctuations, which may cause the actual costs to differ significantly from the original estimates.

4.3.5 Market regions

Table 1. Comparison of internal and external logistics budget accuracy across market regions

Internal and external

Market region	Average	Median	Number of projects
All:	104,58 %	-7,68 %	731
Americas:	186 %	13,34 %	140
EMEA:	114 %	-10,23 %	435
Asia:	5 %	-21,58 %	156

Internal

Market region	Average	Median	Number of projects
All:	219,86 %	-19,05 %	277
Americas:	3433 %	92,70 %	16
EMEA:	29,23 %	-19,05 %	227
Asia:	-12,44 %	-32,46 %	29

External

Market region	Average	Median	Number of projects
All:	128,51 %	-16,71 %	498
Americas:	153,43 %	9 %	88
EMEA:	186,37 %	-26,40 %	279
Asia:	-11,44 %	-21,16 %	131

As shown in Table 1, the accuracy of logistics budgeting varied clearly across different market regions. In the full dataset (n = 731), the median was -7.68%, indicating that projects typically came in slightly under budget. In Table 1 and all following tables, negative values indicate budget underruns, while positive percentages indicate budget overruns. In a regional breakdown, the Americas region (n = 140) stood out with a notably different trend: the median was +13.34%, meaning that projects more frequently exceeded their budgets compared to other regions. This trend was particularly visible in internal costs, where the median for the Americas was +92.70%. EMEA (n = 435) had a total cost median of -10.23% and an internal cost median of -19.05%. Asia (n = 156) showed a total cost median of -21.58% and an internal cost median of -32.46%. The mean value for internal costs in the Americas was also extremely high (+3433%), likely influenced by a few outliers, and therefore not a reliable representation of the overall distribution.

The EMEA region, which comprised the largest share of the data, showed a typical tendency to stay under budget. External logistics costs in EMEA (n = 279) were especially overestimated, with a median of -26.40%.

Projects in the Asian region showed the smallest average budget overrun (+5%) but the most systematic budget underrun, with a median of -21.58%. This pattern was consistent across both internal (-32.46%, indicating systematic overestimation) and external (-

21.16%) cost categories, suggesting that logistics costs in Asian projects have generally been estimated too optimistically.

These results demonstrate that geographical location has a significant impact on the accuracy of logistics budgeting. For example, internal logistics costs in the Americas have been systematically underestimated, while in Asia, budgets tend to include larger safety margins but still end up being overestimated. EMEA represents the middle ground of the dataset but still shows a consistent tendency to underestimate external logistics costs.

In interpreting these results, it is essential to distinguish between mean and median values. While several regions show positive average cost deviations, the medians are often negative. This indicates that although a few projects significantly exceeded their budgets, most stayed below the original estimates. A positive deviation of +50% means the project exceeded its logistics budget by half, whereas a negative deviation of -20% implies the project came in 20% under budget. This highlights the importance of the median as a more reliable indicator of typical performance, as it is not distorted by extreme outliers like the mean often is.

Out of the 731 projects analyzed, 277 included both planned and actual internal logistics costs, and 498 included corresponding data for external costs. This reveals that internal logistics work is frequently left unbudgeted, despite being necessary in most delivery projects. For instance, even DAP deliveries typically require internal work such as preparing packing lists, sharing transport drawings, coordinating with freight forwarders, or verifying packing and transport visuals. These activities consume resources regardless of the agreed delivery terms.

In total, 910 projects were assessed for internal budgeting practices, and 605 of them lacked an original internal logistics cost plan. This is a significant proportion across all three SAP systems in use, including the one introduced after the company merger, suggesting a structural issue in internal cost budgeting. Within the Americas region,

differences also emerged between business lines: in Business Line F, actual internal logistics costs (n=6) were lower than originally planned, whereas Business Line C showed the opposite trend (n=8). Among product groups, Group N had the highest budget overrun, followed by Group M. These observations highlight the importance of both budgeting completeness and project-specific cost awareness when evaluating budget accuracy in project logistics.

The analysis of internal logistics costs reveals notable regional differences. Americas stands out with exceptionally high average deviations and a positive median, suggesting frequent and significant budget overruns, although the small sample size (n = 16) makes the results sensitive to outliers. EMEA and Asia display more controlled patterns, with predominantly negative medians indicating systematic budget underruns. Particularly in Asia, the internal logistics budget tends to be consistently overestimated. Overall, the results underline the need for more accurate internal cost planning in the Americas region and emphasize the importance of accounting for regional variation in budgeting practices.

External logistics costs also show distinct regional patterns. In the Americas (n = 88), both the average and median were positive, indicating that most projects exceeded their budgets. In contrast, EMEA (n = 279) had a high average overrun (+186.37%) but a clearly negative median (-26.40%), suggesting that a few large outliers distort the overall picture. Asia (n = 131) showed the most consistent budget underruns, with both average and median being negative, and a median of -21.16% indicating a strong tendency to stay below budget. These findings highlight that Americas requires particular attention in external cost planning, while EMEA and Asia appear more controlled, though EMEA contains notable individual overruns. As before, the median proves to be a more reliable indicator of typical project performance than the average.

4.3.6 Incoterms

Logistics budget overruns were analyzed from the perspective of different Incoterms by separating internal and external costs and examining their combined effect. The dataset included the following delivery terms: CFR, CIF, CIP, CPT, DAP, DDP, FAS, EXW, FCA, and FOB.

Total costs (internal and external)

The overall average for all delivery terms was 104.58%, while the median was -7.68% (Table 2), suggesting that a few exceptionally high overruns significantly inflated the mean. This skew is particularly evident in the FAS term (mean 476.25%, only 3 projects) and CPT (mean 200%, 41 projects). Most delivery terms had a negative median, indicating that budgets were often underspent, even if individual large overruns distorted the average. For instance, the DAP and DDP medians were -12.75% and -24.50%, despite their high means (104% and 76.3%). FCA was the most common term (355 projects), and its median was slightly negative (-4.46%) despite a mean of 107.32%.

Table 2. Total internal and external logistics budget accuracy by Incoterm

Incoterm	Average	Median	Number of projects
All:	104,58 %	-7,68 %	731
CFR	-25,67 %	-19,57 %	11
CIF	79 %	-11,43 %	54
CIP	-19 %	-32,16 %	5
CPT	200 %	3,74 %	41
DAP	104 %	-12,75 %	176
DDP	76,30 %	-24,50 %	63
EXW	-6,77 %	-6,77 %	2
FAS	476,25 %	-5,70 %	3
FCA	107,32 %	-4,46 %	355
FOB	83 %	23,36 %	21

Internal costs

The discrepancies became even more pronounced in internal logistics costs (Table 3). The overall mean was 219.86%, while the median was -19.05%, again pointing to a

heavily skewed distribution. FCA, for example, had a mean of 355.54% and a median of -16.88%. The FAS term showed a positive median of 113.67%, but with only 3 projects, the sample is too small for generalization. The DDP and DAP medians were significantly negative (around -41%), which may suggest overestimation in internal workload budgeting or a conservative budgeting practice for these terms.

Table 3. Internal logistics budget accuracy by Incoterm

Incoterm	Average	Median	Number of projects
All:	219,86 %	-19,05 %	277
CFR	57,97 %	57,97 %	1
CIF	36,15 %	3,38 %	12
CIP	-47,52 %	-66,53 %	4
CPT	115,29 %	-2,98 %	12
DAP	1,12 %	-41,33 %	57
DDP	23,18 %	-41,86 %	17
EXW	-	-	0
FAS	68,15 %	113,67 %	3
FCA	355,54 %	-16,88 %	164
FOB	51,28 %	21,68 %	7

External costs

For external costs, the overall mean was 128.51%, while the median remained negative at -16.71% (Table 4), reflecting a similar skewed distribution. FCA had a mean of 169.55% and a median of -16.64%, implying that while a few projects had high external costs, the majority stayed within budget. A notable exception was the FOB term, with both the mean (15.67%) and median (7.67%) being positive, indicating moderate but consistent overruns. Similarly, the CIP term (5 projects) had a positive median (5.74%), but the small sample size limits generalizability.

Table 4. External logistics budget accuracy by Incoterm

Incoterm	Average	Median	Number of projects
All:	128,51 %	-16,71 %	498
CFR	-14,16 %	-13,22 %	8
CIF	89,60 %	-21,42 %	48
CIP	7,67 %	5,74 %	5

CPT	193,22 %	-20,40 %	35
DAP	108,50 %	-16,02 %	139
DDP	97,03 %	-19,62 %	49
EXW	-	-	0
FAS	-13,72 %	-13,72 %	1
FCA	169,55 %	-16,64 %	194
FOB	15,67 %	7,67 %	19

Conclusion

Overall, the comparison of Incoterms reveals that average values may give a misleading impression of budgeting performance, as the median for many terms was negative. This suggests that logistics budgets are often prepared with safety margins or overestimated figures. Individual extreme overruns, particularly under CPT, FCA, and FAS, significantly raise the average values. Going forward, it would be beneficial to focus especially on delivery terms that show high variability or a higher risk of large overruns, such as CPT and FCA. Reviewing both medians and averages provides a more realistic view of budgeting accuracy.

4.3.7 Business lines

Logistics budget accuracy varied notably across business lines. Across all projects (n = 731), the average deviation from the original logistics budget was +104.58%, while the median was -7.68%. This large difference indicates a skewed distribution caused by a few substantial overruns (Table 5).

Total costs (internal and external)

Table 5 shows total internal and external cost accuracy by business line. Median values describe typical performance, while averages reveal the effect of outliers. Business Line B exhibited the highest deviations, with both the average (+369.00%) and median (+129.51%) indicating significant overruns. Business Line C had a median near zero (-0.01%), suggesting accurate budgeting despite a moderately high average (+52.10%).

Other lines showed varying degrees of deviation, from moderate overruns to systematic underruns.

Table 5. Internal and external logistics budget accuracy by business line

Business line	Average	Median	Number of projects
All business lines	104,58 %	-7,68 %	731
Business line A	98,00 %	25,89 %	31
Business line B	369,00 %	129,51 %	10
Business line C	52,10 %	-0,01 %	102
Business line D	208,27 %	-14,09 %	141
Business line E	60,53 %	-21,94 %	276
Business line F	107,20 %	-5,80 %	171

Business Line A (n = 31) demonstrated consistent budget overruns, with a total median deviation of +25.89%. Internal costs showed a median overrun of +28.93%, and external costs +32.15%.

Business Line B (n = 10) had the highest overall deviations, with a total median of +129.51% and an external cost median of +112.89%. Internal costs were slightly below budget (-12.44%), indicating that external costs primarily drove the overruns. The small sample size limits generalization.

Business Line C (n = 102) showed strong budget discipline, with a total median of -0.01%. Internal costs had a median of +6.10% and external costs -4.72%, reflecting balanced forecasting.

Business Line D (n = 141) had a total median of -14.09%, internal -5.85%, and external -27.81%, suggesting consistent overbudgeting, especially for external costs. Business Line E (n = 276) consistently stayed under budget, with medians of -21.94% (total), -23.39% (internal), and -31.37% (external), likely reflecting conservative planning assumptions.

Business Line F (n = 171) showed a total median of -5.80%, with particularly low internal costs (-42.03%) and slightly underestimated external costs (-13.36%).

In summary, Business Lines A and B exhibited the most notable overruns, while Line C achieved nearly balanced performance. Lines E and F tended to overbudget, and Line D showed moderate underruns with skewed averages. Median values provide the most reliable insight given the varying sample sizes across business lines.

Table 6. Internal logistics budget accuracy by business line

Business line	Average	Median	Number of projects
All business lines	219,86 %	-19,05 %	277
Business line A	75,62 %	28,93 %	22
Business line B	44,99 %	-12,44 %	4
Business line C	1828,87 %	6,10 %	30
Business line D	28,43 %	-5,85 %	35
Business line E	22,99 %	-23,39 %	168
Business line F	-37,03 %	-42,03 %	18

Table 6 presents internal logistics budget accuracy. The results show considerable variation between business lines, partly reflecting differences in project scope and cost structure. Business Line A (n = 22) showed consistent internal cost overruns (median +28.93%), while Business Line B (n = 4) performed slightly below budget (-12.44%). Business Line C (n = 30) had an extremely high average (+1828.87%) due to outliers, although its median (+6.10%) suggests stable performance overall. Business Line D (n = 35) remained close to budget (median -5.85%). Business Line E (n = 168) showed systematic overbudgeting (median -23.39%), and Business Line F (n = 18) the strongest overbudgeting tendency (median -42.03%), indicating persistent overestimation of internal costs or underutilized resources.

Table 7. External logistics budget accuracy by business line

Business line	Average	Median	Number of projects
All business lines	128,52 %	-16,71 %	498
Business line A	64,53 %	32,15 %	19
Business line B	129,04 %	112,89 %	4
Business line C	55,16 %	-4,72 %	68
Business line D	350,72 %	-27,81 %	122
Business line E	61,14 %	-31,37 %	152
Business line F	49,24 %	-13,36 %	132

Table 7 summarizes external logistics budget accuracy. Compared to internal costs, external budgets were generally more stable and closer to planned levels. Business Line A (n = 19) showed moderate overruns (median +32.15%), while Business Line B (n = 4) had substantial deviations (median +112.89%) due to underestimated service costs. Business Line C (n = 68) achieved near-perfect accuracy (median -4.72%). Business Lines D (n = 122) and E (n = 152) consistently stayed under budget (medians -27.81% and -31.37%), reflecting conservative cost estimates. Business Line F (n = 132) showed small deviations (median -13.36%) and relatively consistent forecasting performance.

When comparing internal and external logistics costs across business lines, internal budgets appear to have been more difficult to estimate accurately. Internal costs showed greater variability and more frequent overbudgeting, particularly in Business Lines E and F, suggesting challenges in forecasting labor-related expenses or allocating internal resources. External costs were generally more predictable, although certain lines, such as A and B, experienced clear overruns driven by service cost underestimation. Overall, budgeting accuracy depended not only on the business line but also on the cost type, with internal cost forecasting requiring particular attention in future budgeting practices.

The number of projects per business line is also an essential consideration when interpreting these results. For instance, Business Line C (n = 102) provides a much more reliable basis for generalization than Business Line B (n = 10). In small samples, individual outliers can significantly affect both the average and the median. Therefore, this analysis

prioritizes the median as the primary indicator of typical performance, using the average only as a complementary measure.

4.3.8 Product groups

Analyzing logistics budget accuracy across product groups allows for an assessment of how content-specific project characteristics influence forecasting reliability. The review was conducted for three cost categories: total logistics costs, internal costs, and external costs. Both average and median values were used to better understand skewed distributions.

Product groups with only one project (Groups C and N) were excluded from the following analysis due to low statistical reliability and the likelihood of representing outliers or data entry errors.

Total logistics costs

Substantial variation in budget accuracy was observed across product groups. Average deviations ranged from 27% over budget (Group O) to 530% (Group B). In many groups, the median was clearly below the average, suggesting right-skewed distributions. This indicates that a few extreme outliers significantly inflated the average even though most projects stayed within or under budget.

For example, Group A had an average of 146% but a median of -14%, while Group J showed an average of 2% with a median of -30%. These discrepancies imply either systematic overestimation or the impact of a few extreme cases. Conversely, groups with clearly positive medians, such as D (+232%), I (+21%), and F (+39%), may indicate recurring overruns due to underbudgeting, complex delivery content, or unexpected external cost drivers.

Table 8. Internal and external logistics budget accuracy by product group

INTERNAL AND EXTERNAL			
Product group	Average	Median	Number of projects
A	146 %	-14 %	117
B	530 %	-33 %	23
C	122 %	122 %	1
D	418 %	232 %	9
E	46 %	17 %	9
F	120 %	39 %	22
G	60 %	-11 %	94
H	39 %	-17 %	33
I	266 %	21 %	43
J	2 %	-30 %	145
K	184 %	13 %	73
L	87 %	-15 %	8
M	48 %	-5 %	49
N	-23 %	-23 %	1
O	27 %	-1 %	59
P	86 %	5 %	43

Internal costs

The internal cost analysis reinforces earlier observations: several product groups show negative median values, which may point to conservative or overestimated internal budgeting. For instance, Group G had an average of -38% and a median of -41%, while Group I showed -57% and -45%, respectively. In larger groups such as J (122 projects), results suggest that although some overruns exist, internal costs were mostly well controlled.

A notable exception is Group P, with an average of +3016% and a median of +9%, indicating a single extreme overrun that heavily distorted the average. A similar effect is seen in Group L (+379% / -15%). These examples highlight the importance of using median values alongside averages for a more accurate interpretation.

Table 9. Internal logistics budget accuracy by product group

INTERNAL

Product group	Average	Median	Number of projects
A	36 %	-43 %	24
B	5 %	9 %	10
C	93 %	93 %	1
D	45 %	-12 %	4
E	93 %	-6 %	7
F	68 %	33 %	15
G	-38 %	-41 %	11
H	-7 %	-23 %	3
I	-57 %	-45 %	4
J	7 %	-32 %	122
K	30 %	0 %	30
L	379 %	-15 %	4
M	47 %	8 %	12
N	no data	no data	no data
O	49 %	-26 %	12
P	3016 %	9 %	18

External costs

External costs showed high variability across product groups. Group B stood out with an average of +1467% and a median of -30% across 20 projects, clearly indicating the influence of one or more extreme outliers. Similar patterns were seen in Groups A (+132% / -30%) and K (+154% / +7%).

Several groups showed both negative averages and medians—such as Group J (-30% / -45%) and G (+42% / -20%)—suggesting a consistent tendency to overbudget external costs. Positive medians were found in Groups F (+38%), E (+18%), and I (+18%), possibly reflecting systematically underestimated external costs due to fluctuating market prices or Incoterm-related factors.

Table 10. External logistics budget accuracy by product group

EXTERNAL			
Product group	Average	Median	Number of projects
A	132 %	-30 %	101
B	1467 %	-30 %	20

C	123 %	123 %	1
D	89 %	-3 %	5
E	78 %	18 %	7
F	56 %	38 %	12
G	42 %	-20 %	83
H	23 %	-23 %	24
I	99 %	18 %	25
J	-30 %	-45 %	54
K	154 %	7 %	55
L	-22 %	-26 %	7
M	76 %	-17 %	35
N	-25 %	-25 %	1
O	20 %	-3 %	43
P	116 %	-6 %	25

Summary and future research opportunities

The product group analysis reveals notable differences in the accuracy of logistics budgeting across various project types. Exceptionally large individual overruns distort average-based interpretations in several groups, highlighting the importance of including median values in the analysis. In larger samples (e.g., Group J), repeatedly negative medians suggest systematic conservatism in budgeting, whereas clearly positive medians in some groups may indicate a risk of underbudgeting.

Future research could examine how these cost deviations correlate with other variables such as Incoterms, market region, or project size. Such analysis would support the development of more accurate forecasting models for logistics costs in project-based organizations. Additionally, it would be valuable to determine whether significant budget overruns stem from inaccurate budgeting practices or from external factors beyond planners' control. A deeper understanding of these drivers would enhance both forecasting accuracy and budget management in future projects.

5 Discussion and conclusion

5.1 Interpretation of results

The analysis reveals several critical insights regarding the accuracy and practices of logistics budgeting in project-based operations. One of the key findings is the systematic underbudgeting of logistics costs, particularly in projects with the FCA delivery term. A total of 158 projects had an original logistics cost plan of 0 euros, of which 110 used FCA Incoterms. Despite the missing budget, actual logistics costs were recorded in 108 of those FCA cases, often consisting of internal labor hours or external transport costs. This pattern suggests that FCA projects are particularly vulnerable to budgeting inaccuracies, likely due to the division of logistics responsibility between supplier and customer and the complexity of cost allocation.

A related observation is the reverse situation: 20 projects had a logistics budget but no actual costs. Most of these were also FCA and located in the EMEA region, with 13 projects clustered within a single business line. This could indicate that budgeted services were ultimately not needed or reflect overbudgeting caused by misaligned planning assumptions. It is also important to note that significant budget underruns are not inherently desirable, as they may indicate inaccurate forecasting or misallocated resources.

The product group analysis showed that outliers, such as single projects with budget overruns exceeding 7,000 percent, can significantly distort the average budget deviation. This highlights the importance of median values in identifying consistent patterns. In some product groups, repeatedly negative medians suggest overbudgeting, while strongly positive medians in others indicate recurring underbudgeting. The variation in accuracy between product groups implies that logistics cost behavior is not uniform, which supports the development of more tailored forecasting models.

The dataset used in this study reflects a transitional period in which the merged company operated with three different SAP systems: two inherited from the original organizations

and a new SAP platform implemented after the merger. Due to this, differences in WBS structures and budgeting practices were still present during the study period, even within individual SAP environments. These inconsistencies complicated the identification and categorization of logistics costs, reducing the reliability of budget comparisons and reporting. However, in the new SAP environment, WBS structures have been more clearly standardized, which is expected to improve consistency and data quality in future projects.

These findings support earlier literature that emphasizes the complexity and contextual nature of logistics cost planning in project business, particularly when multiple systems, delivery terms, and market conditions are involved. They also reinforce the importance of detailed and proactive cost breakdowns during the budgeting phase.

5.2 Practical implications

The results carry several practical implications for improving the accuracy and reliability of logistics budgeting. First, the study suggests that logistics costs should be budgeted in all projects where such costs are likely to occur, even if preliminary estimates are uncertain. FCA projects, in particular, require greater attention, as the current underbudgeting trend can lead to significant deviations between planned and actual expenses.

In addition, the analysis highlights several more concrete strategies that could support improved budgeting accuracy. First, while business line-specific budgeting models already exist (e.g., percentage allocations of logistics costs based on sales price), further region-specific budgeting templates could help refine estimates for different market environments. These models would take into account regional cost structures, such as local surcharges, customs fees, or transport-related constraints.

Second, the budgeting process should include a clear distinction between internal and external costs, ideally with mandatory input fields or drop-down selections in ERP tools. This would help planners avoid omissions and improve cost tracking consistency.

Third, harmonizing WBS structures across all business lines and SAP environments is essential. Using standardized terminology and structure would enhance comparability and reduce the risk of misclassification. In addition, incorporating region-specific templates or adjustment factors based on historical data would help create more realistic and evidence-based logistics budgets.

In addition to improving accuracy, more proactive and data-driven budgeting could also help identify potential logistics savings by anticipating avoidable costs and aligning resources more effectively.

Finally, promoting collaboration between departments by implementing joint budgeting checkpoints and post-project reviews would enhance collective ownership of budget accuracy. This would also allow lessons learned to be captured and applied in future projects.

5.3 Limitations and future research

This study is limited by the quality and structure of the available data. For example, logistics costs were sometimes not broken down clearly in the WBS, or budgets were missing entirely for small projects. Although efforts were made to clean the data and remove ambiguous entries, the inconsistencies in cost categorization across three different SAP systems remain a potential source of error. These issues are specific to the period under study, and future data extracted from the standardized new SAP system is expected to be more consistent.

Moreover, while the quantitative data provided strong indications of budgeting accuracy, it did not reveal the root causes behind all deviations. For example, the extent to which cost overruns stem from poor forecasting versus external disruptions remains unclear. The limited number of explanatory variables in the dataset, such as Incoterm, product group, and market region, restricts the analysis.

Future research could expand on these findings by including additional variables, such as delivery complexity, subcontracting level, or supplier performance. Furthermore, the development of a machine learning-based forecasting tool using internal cost data could enhance prediction accuracy in logistics budgeting. Business line-specific practices should also be further analyzed to identify whether some approaches are more successful than others and if best practices could be adopted more widely across the organization.

In addition, future research could incorporate a comparison between the original budget and the revised budget. This would provide insights into how budget accuracy develops during project execution and whether revisions improve forecasting reliability before final project costs are realized.

5.4 Conclusion

This thesis set out to evaluate the accuracy of logistics budgeting in project-based business and to identify the factors contributing to budget deviations. By combining qualitative insights with quantitative data from 752 projects completed between 2020 and 2024, the study aimed to answer the following research questions:

1. What factors contribute to budget adherence in project-based logistics, and how can data analysis provide insights into the reasons for budget discrepancies?

The findings show that logistics budgets frequently deviate from actual costs. Projects using FCA Incoterms are particularly susceptible to underbudgeting, especially when no logistics costs were planned but significant actual costs later occurred. In contrast, some projects showed signs of overbudgeting, often linked to specific market regions or business lines. These patterns suggest that budgeting practices are not yet fully aligned with the logistical realities of project execution.

2. What lessons can be learned from analyzing budget successes and failures in the company's project-based logistics?

The study contributes to both academic and practical knowledge by highlighting how inconsistencies in delivery terms, system structure, and planning practices can undermine budget accuracy. While the transition to new SAP has already introduced more standardized WBS structures, continued focus on consistency across business lines remains important. Similarly, although historical data is already used in budgeting tools, its application could be further optimized to support more project-specific cost forecasts. Strengthening interdepartmental collaboration also remains essential in reducing budget deviations and improving predictability.

3. What practices and strategies can be developed to enhance budgeting accuracy in project-based logistics?

Looking ahead, future research could explore more advanced forecasting models using historical project data and AI-supported tools. Additionally, comparative analysis between business lines may reveal process-level differences that could be used to improve practices company-wide. Overall, ensuring consistent and transparent logistics budgeting remains a key element in strengthening project performance and financial control.

References

AI tools were used in this thesis for general structural and linguistic assistance.

- Asmussen, J. N., Kristensen, J., & Wæhrens, B. V. (2018). Cost estimation accuracy in supply chain design: The role of decision-making complexity and management attention. *International journal of physical distribution & logistics management*, 48(10), 995-1019. <https://doi.org/10.1108/IJPDLM-07-2018-0268>
- Babaie, M., Kordzadeh, N., & Yadollahi, M. (2024). Identifying factors affecting delivery points, risk transfer and costs in international commerce with emphasis on Incoterms 2020. *Journal of Value Chain & Business Management*, 12(1), 45–61. https://www.jvcbm.ir/article_195064_en.html
- Bergami, R., & Tichá, L. (2022). Managing Incoterms® 2020 export risks. *International Journal of Economics and Business Research*, 23(2), 255–273. <https://doi.org/10.1504/IJEER.2022.120651>
- Bryde, D. J. (2003). Modelling project management performance. *The International journal of quality & reliability management*, 20(2), 229-254. <https://doi.org/10.1108/02656710310456635>
- Bustamante Morales, M. A. (2024a). *Incoterms® 2020: FAS or FOB?* ICC Academy. <https://academy.iccwbo.org/incoterms/article/incoterms-2020-fas-or-fob/>
- Bustamante Morales, M. A. (2024b). *Incoterms® 2020: FCA or FOB?* ICC Academy. <https://academy.iccwbo.org/incoterms/article/incoterms-2020-fca-or-fob/>
- Churilov, A. Y. (2020). Peculiarities of using Incoterms 2020 in international commercial practice. *Russian Federation Economics Journal*, 2020(7), 47–57. https://ideas.repec.org/a/alg/rufejo/rfej_2020_07_47-57.html
- Cooper, M. J., & Budd, C. S. (2007). Tying the pieces together: A normative framework for integrating sales and project operations. *Industrial marketing management*, 36(2), 173-182. <https://doi.org/10.1016/j.indmarman.2006.03.005>
- Council of supply chain management professionals. SCM Definitions and Glossary of Terms. https://cscmp.org/CSCMP/CSCMP/Educate/SCM_Definitions_and_Glossary_of_Terms.aspx

- Cron, W. L., Baldauf, A., Leigh, T. W., & Grossenbacher, S. (2014). The strategic role of the sales force: Perceptions of senior sales executives. *Journal of the Academy of Marketing Science*, 42(5), 471-489. <https://doi.org/10.1007/s11747-014-0377-6>
- Davis, J., & Vogt, J. (2021). Hidden supply chain risk and Incoterms®: Analysis and mitigation strategies. *Journal of Risk and Financial Management*, 14(12), 619. <https://doi.org/10.3390/jrfm14120619>
- Doloi, H. K. (2011). Understanding stakeholders' perspective of cost estimation in project management. *International journal of project management*, 29(5), 622-636. <https://doi.org/10.1016/j.ijproman.2010.06.001>
- Engblom, J., Solakivi, T., Töyli, J., & Ojala, L. (2012). Multiple-method analysis of logistics costs. *International journal of production economics*, 137(1), 29-35. <https://doi.org/10.1016/j.ijpe.2012.01.007>
- Fàbregues, S., & Molina-azorín, J.,F. (2017). Addressing quality in Mixed methods Research: A review and recommendations for a future agenda. *Quality and Quantity*, 51(6), 2847-2863. doi:http://dx.doi.org/10.1007/s11135-016-0449-4
- Finnish Customs. (2024). Incoterms 2020. Retrieved December 17, 2024, from <https://tulli.fi/en/businesses/services-for-businesses/codes-customs-declarations/incoterms>
- Finnish Customs. (2024). *Delivery terms (Incoterms)*. <https://tulli.fi/en/delivery-terms>
- Hair, J.F., Celsi, M., Money, A.H., Samouel, P. and Page, M.J. (2016) *Essentials of Business Research Methods* (3rd edn). New York: Routledge.
- Heagney, J. (2012). *Fundamentals of project management* (4th ed.). American Management Association.
- ICC. (2020). *Incoterms® 2020: ICC rules for the use of domestic and international trade terms*. International Chamber of Commerce. <https://iccwbo.org/business-solutions/incoterms-rules/incoterms-2020/>
- ICC Academy. (2020). *Incoterms® 2020 versus 2010: What has changed?* <https://academy.iccwbo.org/incoterms/article/incoterms-2020-vs-2010-whats-changed/>

- Jayaraman, R. (2016). Project cost control: A new method to plan and control costs in large projects. *Business process management journal*, 22(6), 1247-1268. <https://doi.org/10.1108/BPMJ-10-2014-0102>
- Jharkharia, S., & Shankar, R. (2007). Selection of logistics service provider: An analytic network process (ANP) approach. *Omega (Oxford)*, 35(3), 274-289. <https://doi.org/10.1016/j.omega.2005.06.005>
- Johnston, Mark W., and Greg W. Marshall. *Sales Force Management: Leadership, Innovation, Technology*, Taylor & Francis Group, 2016. ProQuest Ebook Central, <https://ebookcentral-proquest-com.proxy.uwasa.fi/lib/tritonia-ebooks/detail.action?docID=4507430>.
- Kerzner, H. (2013). *Project management: A systems approach to planning, scheduling, and controlling* (11th ed.). John Wiley & Sons.
- Kim, J. H. (2022). The comparative study of Incoterms® 2020 and 2010. *Journal of Korea Trade*, 26(2), 123–138. <https://doi.org/10.35611/jkt.2022.26.2.123>
- Koster, K. (2009). *International Project Management*. SAGE Publications Ltd. <http://ebookcentral.proquest.com/lib/tritonia-ebooks/detail.action?docID=743676>.
- Lecoeuvre-Soudain, L., & Deshayes, P. (2006). From Marketing to Project Management. *Project management journal*, 37(5), 103-112. <https://doi.org/10.1177/875697280603700511>
- Lee, J. (2024). Study of marine cargo insurance under the Incoterms 2020 CIP term. *Global Trade and Customs Journal*, 19(4), 145–159. <https://kluwer-lawonline.com/journalarticle/Global%2BTrade%2Band%2BCustoms%2BJournal/19.4/GTCJ2024022>
- Li, J., Tao, F., Cheng, Y., & Zhao, L. (2015). Big Data in product lifecycle management. *International journal of advanced manufacturing technology*, 81(1-4), 667-684. <https://doi.org/10.1007/s00170-015-7151-x>
- Logistiikan Maailma. (2024). *Incoterms 2020*. <https://www.logistiikanmaailma.fi/sopimukset/toimituslausekkeet/incoterms-2020/>

- Mathur, U. C. (2008). *Sales Management*. New Age International.
- Matović, N., & Ovesni, K. (2021). Interaction of quantitative and qualitative methodology in mixed methods research: Integration and/or combination. *International Journal of Social Research Methodology*, doi:10.1080/13645579.2021.1964857
- Meredith, J. R., & Mantel, S. J., Jr. (2003). *Project management: A managerial approach*. New York: John Wiley & Sons, Inc.
- Nitsche, B. (2020). Decrypting the belt and road initiative: Barriers and development paths for global logistics networks. *Sustainability*, 12(21), 1-23. <https://doi.org/10.3390/su12219110>
- Petkevičiūtė–Stručko, M., & Yauhen, I. (2018). THE COMPLEXITY EFFECT OF FREIGHT FORWARDING TRADE INSTRUMENTS IN PROJECT LOGISTICS. *Intelektine ekonomika*, 12(1).
- Polat, G. (2021). An evaluation on Incoterms® 2020 in the context of risk management in international trade. *Afyon Kocatepe University Journal of Economics and Administrative Sciences*, 23(2), 209–224. <https://dergipark.org.tr/en/pub/akui-ibfd/issue/64545/935602>
- Project Management Institute. (2013). *A guide to the project management body of knowledge: (PMBOK guide) (5th ed.)*. Project Management Institute.
- Ritter, T., & Gemünden, H. G. (2003). Network competence: Its impact on innovation success and its antecedents. *Journal of business research*, 56(9), 745-755. [https://doi.org/10.1016/S0148-2963\(01\)00259-4](https://doi.org/10.1016/S0148-2963(01)00259-4)
- Ryynänen, H., Jalkala, A., & Salminen, R. T. (2013). Supplier's Internal Communication Network During the Project Sales Process. *Project management journal*, 44(3), 5-20. <https://doi.org/10.1002/pmj.21341>
- Saunders, M., Lewis, P., & Thornhill, A. (2023). *Research methods for business students*. Pearson Education.
- Schell, C. (1992). *The Value of the Case Study as a Research Strategy*. Manchester Business School.
- Shibasaki, R., Watanabe, D. and Kawasaki, T. (2021). *Global and International Logistics*. MDPI - Multidisciplinary Digital Publishing Institute.

- Stark, J. (2011). Product Lifecycle Management. https://doi.org/10.1007/978-0-85729-546-0_1
- Tikkanen, H., & Aspara, J. (2008). *Projektimarkkinointi: Projektiliiketoiminnan asiakas-suhteet, verkostot ja ansainta*. Talentum.
- Trojahn, C., Coello Machado, R., & Pfohl, H.-C. (2022). *Enhancing logistics budgeting through integrated planning and preparation: A supply chain perspective*. *Journal of Business Logistics*, 43(2), 110–128. <https://doi.org/10.25673/85945>
- Turbaningsih, O., Buana, I. S., Iqbal Nur, H., & Pertiwi, A. (2022). The multimodal transport analysis for project logistics: Export of Indonesia's train manufacturer. *Cogent social sciences*, 8(1). <https://doi.org/10.1080/23311886.2022.2095081>
- Venkataraman, R. R., & Pinto, J. K. (2023). *Cost and value management in projects* (Second edition.). John Wiley & Sons Ltd.
- Vogt, J., & Davis, J. (2020). The state of Incoterm® research: A review and future research agenda. *International Journal of Logistics Management*, 31(3), 765–783. https://www.researchgate.net/publication/343754119_The_State_of_IncotermR_Research
- Vogt, J., & Davis, J. (2024). An exploratory study of Incoterms® knowledge and effective use in trade. *International Journal of Trade and Global Markets*, 2024, 193–212. <https://doi.org/10.1504/IJTGM.2024.137743>
- Yang, C., & Su, Y. (2009). The relationship between benefits of ERP systems implementation and its impacts on firm performance of SCM. *Journal of enterprise information management*, 22(6), 722-752. <https://doi.org/10.1108/17410390910999602>
- Yang, J. H. (2021). A study on the reasonable choice and utilization of Incoterms 2020 in international trade. *Journal of International Trade and Commerce*, 17(3), 45–61. <https://koreascience.kr/article/JAKO202118248677517.pdf>