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Managing Supplier Vulnerability in Low Volume Critical Supply: Designing a Resilient Sourcing and Governance Framework

An Embedded Single Case Study in the Swedish Industrial Sector

Authors
Anders Björklund — M.Sc. in Industrial Engineering and Management, Lund University
Jakob Zachariassen — M.Sc. in Industrial Engineering and Management, Lund University

Supervisors
Louise Bildsten, Lund University
Tomislav Kezovski, Tetra Pak

Examiner
Andreas Norrman, Lund University

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Anders Björklund

Jakob Zachariassen

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Abstract

Tetra Pak is a world leading food processing and packaging company. Their manufacturing operations often rely on specialized and highly customized equipment. While the purchasing volumes for such equipment are typically low and irregular, the equipment itself is critical for operational continuity. This creates situations of asymmetric dependence where supplier bankruptcy, product discontinuation, or withdrawal of support may severely disrupt production. High levels of customization, asset specificity, and accumulated investments further constrain Tetra Pak's ability to switch suppliers or rapidly develop alternative solutions. The purpose of this thesis is therefore to analyze how asymmetric buyer–supplier dependence affects Tetra Pak's exposure to supplier vulnerability and supply disruption risk for low volume, critical components, and to develop a decision framework for mitigating such risks and improving supply chain resilience.

The study is conducted as an embedded single-case study at Tetra Pak, where two supplier relationships constitute the embedded units of analysis. The first case concerns a supplier of industrial motors that recently announced the discontinuation of a customized critical product. The second concerns a supplier of highly customized printing equipment facing severe financial distress and bankruptcy risk. Data was collected primarily through semi-structured interviews with personnel involved in sourcing, engineering, supplier management, and risk management, supported by internal documentation and supplier-related data.

Through a narrative literature review, relevant research on risk and resilience, resource dependence theory and supplier relationship management was studied to create an analytical framework, which served as the basis for the presentation of the findings and subsequent analysis.

The findings show that power asymmetry & bargaining power, knowledge & asset concentration, predisposing factors & precipitating events, low & irregular volumes, high switching barriers and other context-specific mechanisms can potentially cause supplier vulnerability and supply disruption risk in the given context. Of these, high switching barriers have the strongest influence on supply disruption impact by limiting flexibility and constraining response alternatives. However, the findings also demonstrate that these mechanisms rarely create substantial risk in isolation. Instead, supplier vulnerability emerges through the interaction and reinforcement of multiple mechanisms operating simultaneously. Along with the Dutch windmill and the supplier's financial health, these aspects provide a good basis for identifying vulnerable suppliers.

Actions to mitigate the risk can be interpreted along two lines of logic: dependence management and dependence reduction. The most feasible and effective strategies for managing vulnerable suppliers in a low volume, critical context are not singular tools but a synchronized combination of dependence management and dependence reduction measures. In the short term, continuity-

preserving measures such as buffering, governance structures, and relationship management are the most feasible approaches for managing exposure. Over longer time horizons, standardization, substitution, and alternative sourcing strategies provide the strongest path toward increased resilience and reduced dependence. Ultimately, management effectiveness is defined by the ability to balance the immediate need to survive within a dependency with gradual efforts to reduce that dependence over time.

Based on these findings, the thesis develops a proactive governance framework for identifying vulnerable supplier relationships and selecting appropriate mitigation strategies throughout different stages of the supplier life cycle. The framework integrates dependence-related vulnerability mechanisms, supplier financial health, and relationship positioning to support systematic supply risk management in low volume, critical industrial settings.

Contribution: This thesis has been a complete collaboration between the two authors. Each author has been involved in every part of the process and contributed equally.

Key words: Buyer-supplier dependence, Supply chain resilience, Supply disruption risk, Asymmetric dependence, Resource dependence theory, Supplier relationship management, Strategic sourcing, Qualitative case study

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1 Introduction

This chapter provides the background, context and purpose of the thesis. First, a general background with relevant theory frames the problem and the gap in literature. The chapter proceeds with presenting the case company, problem formulation and purpose of the thesis. The research questions are presented, followed by focus & delimitations. Finally, the chapter concludes with the thesis' structure.

1.1 Background and Context

In contemporary supply-chain contexts, firms operate within interconnected networks in which performance depends on coordination across organizational boundaries (Lambert, Cooper, and Pagh 1998). As supply chains increase in complexity and firms specialize further, competitive advantage is increasingly achieved through coordination, collaboration, and relationship design with external actors rather than through isolated internal capabilities alone (Dyer and Singh 1998; Lambert, Cooper, and Pagh 1998). At the same time, this development has increased managerial attention toward supply chain resilience, as disruptions can rapidly propagate across interconnected networks and severely affect operational continuity. Supply chain resilience is commonly defined as the capability of a supply chain or supply network to prepare for disruptions, respond to unexpected events, and recover to a desired level of performance (Christopher and Peck 2004; Ponomarov and Holcomb 2009; Sheffi and Rice 2005).

Resilience is closely connected to supply risk. Supply risk refers to the focal firm's exposure to negative consequences caused by uncertain supply conditions and disruption events, commonly conceptualized through the combination of disruption probability and disruption impact (Tang 2006; Zsidisin 2003). As firms become increasingly reliant on external suppliers for critical products, technologies, and capabilities, disruptions related to supplier failure, bankruptcy, operational instability, or discontinued support may significantly threaten continuity of operations. Consequently, the management of supply risk has become a central aspect of achieving resilient supply chains. This has contributed to the development of supply chain risk management (SCRM), which aims to systematically identify, assess, mitigate, and monitor supply chain risks in order to reduce the probability and impact of disruptions (Jüttner 2005; Tang 2006; Zsidisin 2003). Research further emphasizes that effective SCRM requires organizational structures, governance mechanisms, and cross-functional coordination that support early warning, escalation, and proactive response capabilities, rather than reactive and ad hoc risk management practices (Norrman and Jansson 2004; Tang 2006).

Importantly, resilience is not a singular organizational property achieved through isolated opera-

tional measures such as redundancy or inventory buffers alone. Rather, resilience emerges from the interaction between organizational structures, governance mechanisms, decision-making processes, relational arrangements, and contextual conditions that collectively influence a firm's ability to prepare for, respond to, and recover from disruptions (Christopher and Peck 2004; Sheffi and Rice 2005). Governance therefore becomes central in supply relationships. In this context, governance refers to the mechanisms through which inter-organizational relationships are coordinated and controlled. This includes how decision-making powers are allocated, and how monitoring and adaptation are handled over time (Pilbeam, Alvarez, and Wilson 2012; Williamson 1979). Empirical research further suggests that formal contracts and relational governance mechanisms complement each other in managing inter-organizational exchanges and risks (Poppo and Zenger 2002). Recent research conceptualizes these mechanisms specifically as supply chain risk governance structures that align incentives, information flows, and coordinated action across organizational boundaries (Ahlqvist, Norrman, and Jahre 2020; Norrman and Eriksson Ahre 2024).

One important but insufficiently understood factor influencing resilience and supply risk is dependence between buyers and suppliers. As firms increasingly outsource activities and rely on specialized external actors, they simultaneously reduce direct control over critical resources and capabilities required for operations. Resource Dependence Theory (RDT) conceptualizes this as a structural condition in which organizations depend on external actors for resources necessary for organizational survival and performance, creating constraints, power asymmetries, and varying degrees of interdependence within relationships (Emerson 1962; Pfeffer and Salancik 2003). From an RDT perspective, dependence can therefore be interpreted as a fundamental driver of supplier vulnerability and supply disruption risk. As reliance on external actors increases, so does the potential operational impact in the event of supply disruption or relationship instability (Pfeffer and Salancik 2003). Furthermore, bargaining power and dependence are closely intertwined in buyer–supplier relationships and may influence the focal firm's ability to secure resources, negotiate favorable conditions, and implement mitigation strategies (Crook and Combs 2007).

In this thesis, supplier vulnerability is defined as the fundamental factors within the supplier and the buyer–supplier interface that make the supply situation susceptible to disruptions (Pettit, Fiksel, and Croxton 2010). Importantly, vulnerability is not treated solely as a supplier characteristic, but also as a relational condition shaped by dependence structures, power asymmetries, limited substitutability, switching barriers, and governance arrangements. While supply chain resilience and supply risk management have received extensive scholarly attention, there remains limited understanding of how asymmetric dependence specifically contributes to supplier vulnerability and supply disruption risk in industrial supply relationships characterized by low purchasing volumes and high operational criticality.

This challenge becomes particularly salient in industrial settings characterized by long-lived installed bases and highly customized technical systems. In such contexts, operational continuity depends not only on the availability of physical equipment, but also on the sustained availability of technically specific supplier capabilities required for maintenance, repair, upgrades, and long-term system support. Importantly, the service period of industrial equipment often substantially exceeds the production period, creating long-term dependence on suppliers for continuity of operations (Teunter and Fortuin 1999).

To establish consistent terminology, this thesis uses the term critical, low volume components to denote components and supplier capabilities that are highly consequential for operational continuity and installed-base performance, while simultaneously being sourced in low and irregular volumes. Although such components may represent a relatively small share of purchasing spend, they can create substantial operational risk in maintenance-driven industrial settings (Chekurov et al. 2018; Huiskonen 2001). In these contexts, mitigation options such as alternative sourcing or substitution are often constrained because technically equivalent alternatives may be difficult, costly, or time-consuming to develop and implement (Defense Standardization Program Office 2009). Consequently, the operational criticality of such supply situations is not necessarily reflected in purchasing volume. Instead, vulnerability emerges from the dependence created when technically specific products, knowledge, or supplier capabilities become unavailable.

1.2 Case Company and Problem Formulation

1.2.1 Organizational Context

Tetra Pak is a world-leading food processing and packaging company (Tetra Laval 2025). Their vision is to make food safe and available everywhere, while protecting the food, people and the planet. In 2024, the reported €12,82 billion in revenue, employed approximately 24 500 employees, and sold 178 billion packages. Tetra Pak delivers complete food solutions to a wide array of food and beverage categories, delivering packaging materials, process and packaging equipment, distribution equipment, digital solutions, and services.

This thesis is conducted within original equipment manufacturer (OEM) Supplier Management, who works with investments (CAPEX) and strategic considerations within packaging material factories globally. The equipment is referred to converting equipment, as the factories convert raw materials to packaging material.

The factories relevant in this context consist of large lines of machines dedicated to lamination and printing. Lamination refers to fusing multiple thin layers of different materials together to achieve one sheet of packaging material combining the beneficial properties of the constituent materials. Printing refers to adding dyes and colors to the packaging material to customize the packaging for the customer. Both steps are characterized by high speed operation, and Tetra Pak is world-leading in producing high quality packaging materials with these processes. Each factory requires a great deal of industrial equipment, and suppliers have often specifically engineered, designed or modified components or entire solutions to fit the increased demands of the cutting edge manufacturing system at Tetra Pak. Over time, iterations of equipment have evolved to fit new demands, increase performance and ensure consistent performance across factory. The pursuit of increased performance at the cost of specialization has increased the dependence on these suppliers, who possess the required knowledge and assets to manufacture, service and maintain the equipment. Should a supplier cease producing the equipment or offer service and maintenance due to profitability issues, bankruptcy, change of ownership, expansion or other factors, Tetra Pak would face severe operational, financial and reputational consequences.

Since 2020, growth in the customer base and demand for new complete packaging systems has slowed. As a result, the need for expansion through new factories has declined. Conse-

quently, the purchase of new equipment and machinery has decreased, and focus has shifted toward maintaining the existing installed base of machines.

1.2.2 Problem Formulation

The responsibility to ensure up-time for machines in the factories lies solely with Tetra Pak. For certain equipment, the up-time and the need for service, maintenance and spare parts spans decades. This lays the foundation for a difficult situation: the equipment and associated service is critical for Tetra Pak, but the low, irregular purchase volumes and high dependence causes exposure to risk. Should the supplier cease to produce or provide service, Tetra Pak's options are constrained by the high degree of specificity in the equipment. There are currently two suppliers of important, specialized or modified equipment that are at the risk of undergoing changes which would be detrimental to the supply of this equipment.

Supplier A produces a custom, industrial motor, with each unit costing approximately 1 million SEK. There are currently 59 motors installed worldwide, all of which require ongoing maintenance and repairs, including occasional shipment to the supplier's facilities for repairs. According to Tetra Pak, this motor is unmatched by anything on the market with its exceptional performance, reliability, size and energy efficiency. The supplier has custom equipment and dedicated space in their manufacturing facility for the production of these motors, of which Tetra Pak is one of few customers. However, the supplier recently issued a sudden announcement regarding the discontinuation of both the motor and the associated service offering. Tetra Pak suggests that this decision may be linked to the low ordering volumes observed in recent years, combined with Supplier A's desire to reallocate production capacity toward other expanding product lines.

Supplier B produces a complete line of printing machines, used to print on large industrial rolls. There has been a strategic partnership between Tetra Pak and the supplier for 30 years, and the machines have been developed in union with Tetra Pak. Tetra Pak employs Supplier B for 95-99% of their printing needs. The large firm has seen a severe decline in the revenue from other business areas, and has for several years been losing money. They are currently at the verge of bankruptcy.

These suppliers were specifically chosen for this thesis since they would allow two different perspectives of an unwanted supplier dissolution, one in which the supplier chose to end the relationship and one in which the supplier unwillingly ends the relationship. While the specifics are different, they represent a large supply chain risk, connecting asymmetric dependence with power imbalance and supply disruptions. When expensive equipment used for critical operations ceases to be produced, dependence on the suppliers cause uncertainty for the future of the installed equipment and new machine lines. The concentration of knowledge and co-engineering of equipment increases the barriers of switching to another supplier, as more standard equipment would result in large switching costs, down time of production and likely decreased performance.

1.3 Purpose

The purpose of this master's thesis is to analyze how asymmetric buyer–supplier dependence affects Tetra Pak's exposure to supplier vulnerability and supply disruption risk for low volume,

critical components and services, and to develop a decision framework that supports effective supply risk mitigation in such contexts.

1.4 Research Objectives

Dependence on actors within the supply chain is a natural and often unavoidable consequence of inter-organizational specialization and coordination. However, such dependence can also create conditions that increase supplier vulnerability and expose firms to supply chain risks. Understanding the implications of these dependence structures is therefore essential for developing more resilient supply chains. This leads to the first research question:

> **RQ1.** *What dependence-related factors cause supplier vulnerability and supply disruption risk for suppliers of critical equipment and service at Tetra Pak?*

Further, the literature on supply chain management and dependence resource theory aims at structuring processes and strategies to facilitate the function of the supply chain. However, the contextual conditions of the supply chain are equally important. In order to develop a framework that adequately addresses Tetra Pak's specific supply chain conditions and dependence-related challenges, the characteristics of the operational context must be incorporated into the analysis. This leads to the second research question:

> **RQ2.** *Which supply risk mitigation strategies are feasible and effective for managing vulnerable suppliers in this context, given Tetra Pak's operational and commercial constraints?*

Finally, in order to extract the essence of the findings and apply them for insights into how dependence affects resilience, application on the focus company must be centered. This results in the third research question:

> **RQ3.** *How can a governance framework be designed so that it can be used to identify, assess, and mitigate similar dependency-driven supply vulnerabilities and improve resilience in future sourcing decisions at Tetra Pak?*

The structure of these questions create a logical funnel, analyzing the current state and identifying underlying mechanisms that cause the issue, see Figure 1. Further, understanding the causes leads to a discussion on possible solutions, finalizing in a framework which Tetra Pak can employ in their organization. Consequently, the main research question of this thesis is RQ3, which uses RQ1 and RQ2 to compile and deliver insights into the current body of literature while supporting the development of the framework.

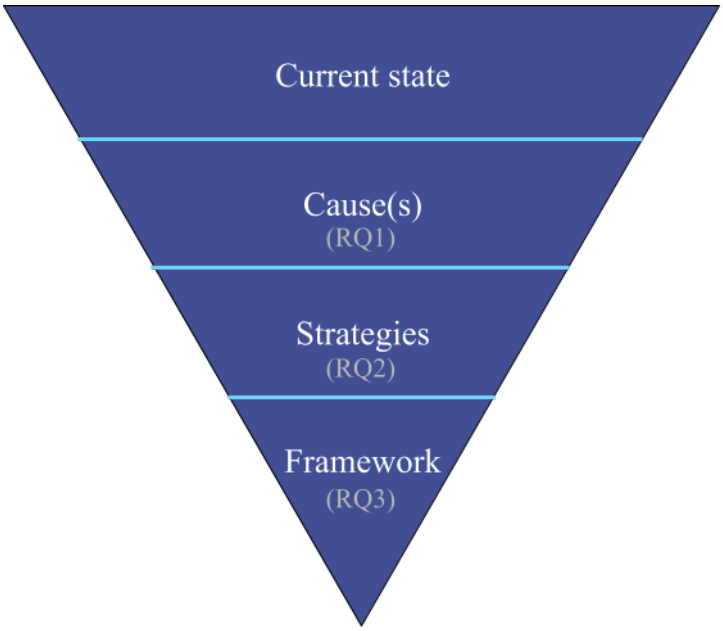

Figure 1: How the research question coalesce from the current state to a framework (Source: Authors)

1.5 Focus and Delimitations

The main focus of this thesis is Tetra Pak and its internal processes regarding relationships with low volume, critical suppliers. The analytical focus is on how asymmetric dependence between an industrial buyer and specialized suppliers can create supply risks, and how such risks can be mitigated and managed through proactive measures. The units of analysis are two supplier relationships that exhibit these characteristics. Data is collected primarily from internal stakeholders involved in sourcing, supplier management, engineering, and risk management. The study is conducted within the converting equipment supplier management team at Tetra Pak, which is responsible for supplier selection, evaluation, development, and contracting suppliers for Tetra Pak's internal production processes. The focus of this thesis can be seen in 2 below.

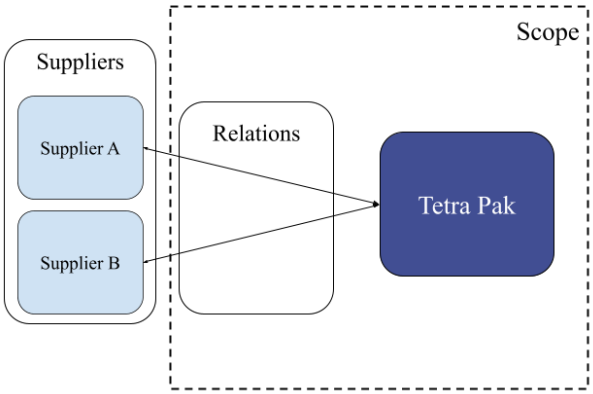

Figure 2: The scope in this study (Source: Authors)

The thesis is delimited to qualitative analysis, complemented by quantitative data used for contextualization. Advanced quantitative modeling, simulation, or optimization of sourcing and

inventory decisions fall outside the scope. Due to the time constraint of 20 weeks, the implementation and empirical evaluation of the proposed framework are not included; the study instead focuses on its design and the decision support it can provide. Furthermore, as the focus is on internal processes at Tetra Pak, the practices and strategies of suppliers are not examined in depth, and suppliers are considered only insofar as they respond to or are affected by Tetra Pak's governance and sourcing decisions.

The scope of the study is further limited by its focus on two case relationships within a single organizational context, which constrains the generalizability of the findings. The analysis is situated within a capital-intensive, highly customized industrial setting, specifically related to converting equipment, and the conclusions should therefore be interpreted with caution outside similar contexts. The study captures a snapshot in time and does not account for long-term or longitudinal developments in supplier relationships.

In addition, the reliance on internal stakeholders as the primary data source introduces potential bias, including limited visibility into supplier-side conditions and decision-making processes. The analysis is conducted at the relationship and process level, and does not extend to broader supply chain network effects or multi-tier dependencies. Key constructs such as dependence, vulnerability, and resilience are interpreted qualitatively, and no formalized measurement models or quantitative risk assessments are developed.

Finally, the study does not explicitly address legal, regulatory, or contractual complexities, nor does it evaluate the practical feasibility of implementing the proposed framework in terms of organizational change, system integration, or cost implications.

1.6 Structure

This chapter outlines the strucutre of the report. The left hand side displays the following chapters and their title. The right hand side briefly introduces the chapter by summarizing the contents.

2. Methodology	The chapter covers the research strategy and design. Further, the data collection principles and means of analysis is explained and discussed. Finally, the chapter contains a discussion regarding research quality
3. Theory	The chapter contains a narrative literature review of three major topics relevant to this thesis: (1) Risk & resilience, (2) Resource Dependence Theory (RDT) and (3) Supplier Relationship Management, including supply chain governance.
4. Empirical findings	The chapter presents the results of the conducted study. It presents the identified causes of supplier vulnerability and mitigation strategies currently relevant to Tetra Pak.
5. Analysis	The chapter analyzes the empirical findings from chapter four by applying the theoretical findings to the empirical findings. The two cases studied are first analyzed separately in a within-case analysis, and later together in a cross-case analysis in order to conclusively and rigorously answer the first two research questions. The chapter concludes with a discussion on the implications for the framework.
6. Development of Framework	This chapter utilizes the findings of previous chapters to assess the necessary capabilities of the framework and to answer research question 3. A discussion on limitations is included. Finally, the complete framework is presented.
7. Conclusion	This chapter summarizes the thesis by briefly describing the method, theory, empirical findings, analysis and the resulting framework.

2 Method

This section outlines the methodology used in the thesis. The focus is on research strategy, design and data collection. The section concludes by discussing research quality.

2.1 Research Strategy

When conducting studies within social sciences, there are several different research strategies to choose between. According to Yin (2003), the five most common strategies are experiment, survey, archival analysis, history and case study. The choice of which strategy to implement in a given study depends on (i) the type of research question, (ii) the extent of control an investigator has on actual events and (iii) the degree of focus on contemporary (or recent) events as opposed to historical events. See Table 1 for a breakdown of different research strategies.

Table 1: Relevant Situations for Different Research Strategies (Yin 2003), p. 5

Strategy	**Form of Research Question**	**Requires Control of Behavioral Events?**	**Focuses on Contemporary Events?**
Experiment	how, why?	Yes	Yes
Survey	who, what, where, how many, how much?	No	Yes
Archival analysis	who, what, where, how many, how much?	No	Yes/No
History	how, why?	No	No
Case study	how, why?	No	Yes

The research questions in this thesis have the prepositions ”what”, ”which”, and ”how”. We do not have control over behavioral events, and the focus is on current events. This results in survey and case study research being the most suitable, and archival analysis as an possible alternative for this thesis. As explained in 1.4, the first two research questions (”What” and ”which”) are seen as more supportive, and the ”main” research question (RQ3) has the preposition ”how”. The case study research approach has the advantage of allowing discussions and deeper explanations for processes and phenomenon as compared to a survey. Due to this, the case study

strategy was ultimately chosen, although another method could have been suited. A discussion on this can be found in section 2.2.1. However, the importance of a method is not what it is labeled as, but rather whether it enables the fulfillment of the research objectives (Saunders, Lewis, and Thornhill 2007).

The case study method follows a linear but iterative approach in six steps. They are: (i) Plan; (ii) Design; (iii) Prepare; (iv) Collect; (v) Analyze; and (vi) Share. The process is illustrated in Figure 3.

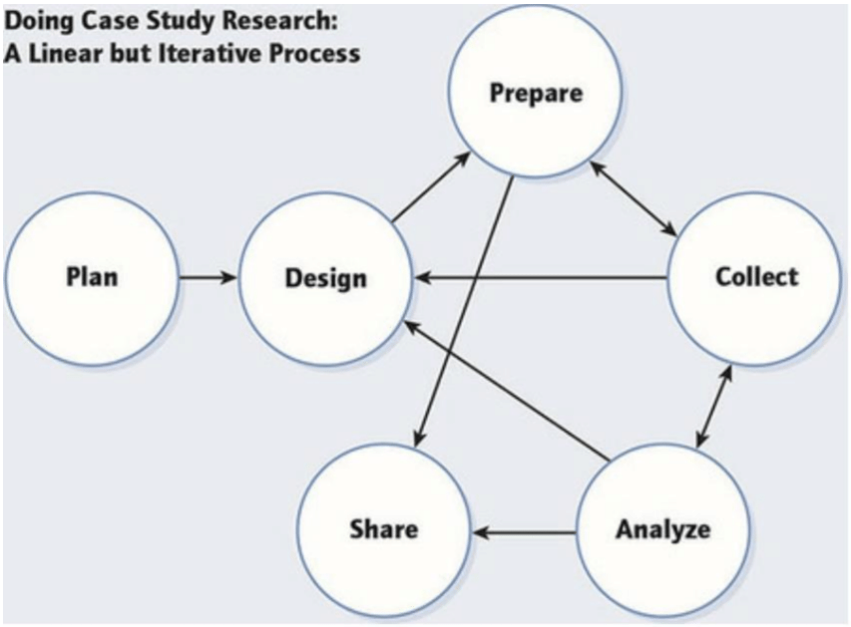

Figure 3: Case study Research Process (Yin 2018). p.1

In the first step, 'Plan', the goal is to establish the theoretical and methodological foundation of the study. This is done through

- Defining the research questions
- Determining the case study design
- Identifying theoretical framework

In constructing the goal document, a precursory document to the thesis, these topics were iteratively and laterally developed. The research questions have been presented and discussed earlier in the thesis. The case study design will be presented in the next section, 2.2, and a complete narration of the theoretical framework will be presented in chapter 3. The steps 'Prepare', 'Collect' and 'Analyze' all relate to the data collection and subsequent analysis of a case study. The data collection will be discussed in 2.3, and the data analysis in 2.4. The final step in the case study process is to 'Share' which is done through having a thorough, logical structure of the report, aimed at clearly generalizing the case, making it accessible and relevant to a number of practitioners, linking the findings to existing theory and doing it with rigor.

2.2 Research Design

Any research should aim to be robust and replicable, and the major tool to achieve this is through a planned and intentional research design. There are five components within research design

which is especially important for case studies (Yin 2003):

1. The study's questions
2. The study's propositions
3. The unit(s) of analysis
4. The logic linking the data to the propositions
5. The criteria for interpreting the findings

2.2.1 The study's questions

The devised research questions are not chosen randomly, but rather with an image of reality in mind which directs attention to something that should be examined within the scope of the study (Yin 2003). Within the research questions are assumptions that guide the search towards evidence and is an important part of the research design, as it is affected by the authors world view. The first question contains assumptions that suppliers of critical equipment and service are at risk for supply disruption as a result of supplier vulnerability, and that there are certain mechanisms which cause the vulnerability. The authors are aware of these assumptions and that confirmation biases are likely present, but are vigilant towards evidence that proves the opposite. Likewise, the second and third question contains similar assumptions, and should evidence that disputes these assumptions be uncovered, the authors will re-evaluate the purpose and questions of the thesis in order to maintain objectivity and ensure that the foundation is not built on any preconceived notions.

2.2.2 The study's propositions

The questions and especially the forms of the questions gives important clues as to the most relevant research strategy to be used (Yin 2003). The nature of the study questions need to be precisely clarified to verify that the case study method is the most relevant research strategy. The research questions have been presented and discussed in section 2.3, however without much perspective on the form.

The first two questions could be logically divided into two parts. The first question *"What dependence-related factors cause supplier vulnerability and supply disruption risk for suppliers of critical equipment and service at Tetra Pak?"* could be interpreted as *"**What** dependence-related financial and operational mechanisms create supplier vulnerability and supply disruption risk for suppliers of critical equipment and service, and **how** do they apply to Tetra Paks business"*. The second question *"Which supply risk mitigation strategies are feasible and effective for managing vulnerable suppliers in this context, given Tetra Pak's operational and commercial constraints?"* could become *"**Which** supply risk mitigation strategies are feasible and effective for managing vulnerable suppliers and **how** do they apply to Tetra Pak, given the operational and commercial constraints?"*. Altering the formulations of the questions in this way gives a clue as to how the case study strategy will be applied to these questions. The third question is logically in one part from this perspective and will remain as ***How** can a governance framework be designed so that it can be used to identify, assess, and mitigate similar dependency-driven supply risks in future sourcing decisions at Tetra Pak?*. The parts of the questions that follows after **what and which**, are, according to Table 1 on research strategies,

not generally studied using the case study strategy. The parts after **how**, are, however, well suited for analysis through a case study. The first parts could be answered in other ways, and since these topics are well studied and have theoretical ground in SCM, the aim in this thesis is to answer these questions through literature.

2.2.3 The unit(s) of analysis

The third component of research design relates to the unit(s) of analysis (UoA), which is related to the fundamental problem of defining what the case is. In the classic case study, the case could be an individual, but it could also be an event or entity that is less well defined (Yin 2003). For these cases, it is vital to understand that the UoA might not be well defined in terms of start and end or might have different definitions depending on the perspective of the author. It is therefore of utmost importance to clearly specify the unit of analysis and define (as well as possible) the extent of what it entails.

In this thesis, the UoA is defined as ”the two relationships that exhibit the following characteristic: asymmetric dependence between Tetra Pak and specialized suppliers that are vulnerable due to the dependence structure”. The important entity to be defined in this unit is ”the relationship” and its constituent components. The Cambridge dictionary define a relationship as ”the way in which two or more companies [...] behave towards each other”. This is the definition used in this thesis and entails the connection (such as partnerships or arms length relations), interaction (such as information sharing and meetings) and decision making (such as the strategic considerations in managing relations) regarding relationships. Relationships are not clearly outlined but require interpretation to understand. This supports the choice of a case study as a suitable method for analyzing the complexities of business relationships.

The choice of propositions and UoAs allows the thesis to be placed in the matrix for basic types of designs, which allows positioning as a single case study vs. a multiple case study, and a holistic or embedded approach, as seen in Figure 4 below. Since there are multiple units of analysis (relationships), and Tetra Pak is the main focus, isolating the context to be similar across all units, the thesis will be conducted as an embedded single-case study. This choice has implications for the analysis found in chapter 5. The analysis is done first by isolating each embedded unit of analysis separately as a within case analysis, to then be analyzed together in a cross case analysis.

2.2.4 The logic linking the data to the propositions

As explained in 2.2.2, the propositions directs attention to something that should be examined within the scope of the study. For the analysis of the collected data to be beneficial, it must be in line with the propositions of the research questions (Yin 2003). Due to this, there can not be too much data, too little data, or data that does not contain the evidence searched for. According to Yin (2018), it is very important to understand how the data will be analyzed in the early stages of the study, in order to facilitate questions and a method that allows for the correct data to be collected. The process of data collection is discussed in detail in chapter 2.3, and the analysis is discussed in chapter 2.4.

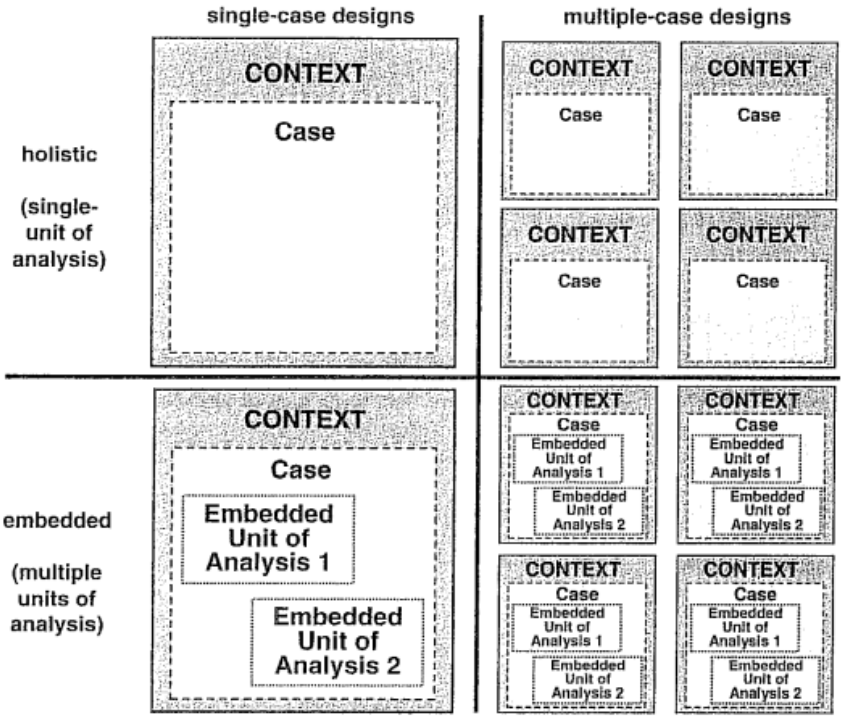

Figure 4: Basic Types of Designs for Case Studies (Yin 2003), p.41

2.2.5 The criteria for interpreting the findings

How can one be sure that the ”evidence” accrued from the data is indeed the correct explanation to the research questions? The criteria for interpreting the findings is a challenging task which shall not be undertaken without proper perspective on understanding biases and the effect of preconceived notions on ”objective” interpretation (Yin 2003). In a purely quantitative study, statistical analyses can be done in order to objectively, without hesitation, confirm the results of a study. However, no such tools exist in qualitative studies which can, without a shadow of a doubt, confirm a link between hypothesis and interpretation of data. The rigor of such a study lies in the construction of the study itself as well as qualitative tools with aim to increase the validity. The research quality will discussed at length in section 2.5 and the precise nature of data analysis will be covered in 2.4.

2.3 Data Collection

In case research, there are several different methods of collecting data, such as interviews, questionnaires, direct observations, content analysis of documents and archival research (Voss, Tsikriktsis, and Frohlich 2002). A foundational principle in case studies is triangulation, or using multiple data points to study the same phenomenon. Reliability of data will be increased if multiple data sources reveal aligning results.

There are two different types of data, qualitative and quantitative (Ellram 1996). Qualitative data is non-numeric information, such as interview transcripts, documents or images which is often descriptive in nature, and can offer in-depth insights into concepts, behaviors or phenomena. It is characterized by limited statistical analysis and relies instead on interpretation from the authors. This could be problematic as biases or preconceived notions could impact the de-

scription, explanation or the connections between data and the final analysis (Yin 2003). The authors remain attentive to any such biases in analysis and will, where appropriate, incorporate relevant qualitative data to allow an informed interpretation by the reader. On the other hand, quantitative data is numeric information such as KPIs, transaction history or simulation parameters which cannot be interpreted, and is well suited for statistical analysis. Quantitative data is less ambiguous than qualitative data and can be used to clearly compare data points. However, quantitative data is less suited for exploration or description of phenomenon, as data points display a result, but does not contribute to understanding the cause or implications of the result.

The main data source in this thesis is qualitative, in the form of interviews. These will be supported and complemented with internal documentation regarding process descriptions, tools and structures, and quantitative financial data regarding the supplier. The theoretical backbone of the thesis will be in the form of a literature review on relevant topics. These three aspects will be used in conjunction to triangulate the evidence to ensure the validity of the findings. See Figure 5. The following subsections will describe the processes and details of literature review, interviews and internal documentation.

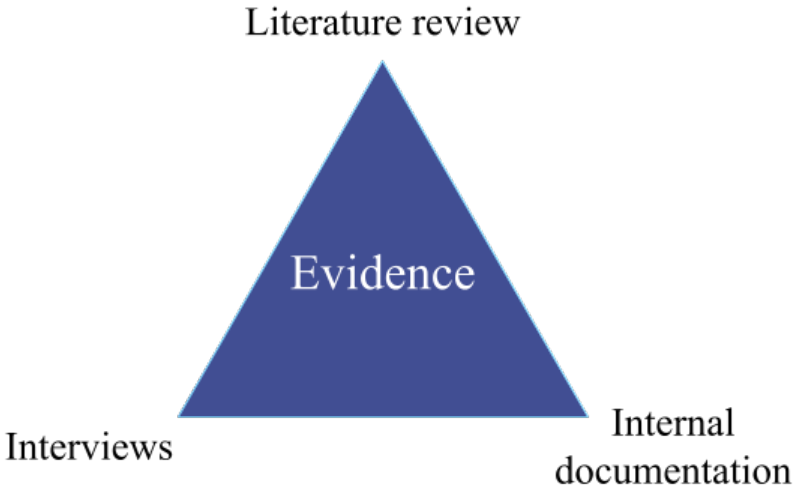

Figure 5: The three aspects of data, triangulating the evidence (Source: Authors)

2.3.1 Literature Review

Literature reviews can either be done as systematic or narrative reviews (Jesson 2011). The purpose of a systematic literature review is to systematically analyze all available material on a topic following clear structure, search strategies and inclusion criteria. It aims to summarize all literature on a topic in order to present definite conclusions, offering depth, but not breadth. The purpose of a narrative review is to ”summarize—and optimally critique—the literature on a particular topic” (Onwuegbuzie and Frels 2016). Jesson (2011) describes it as a broad, exploratory search with limited formal and predefined methodology. While not offering the same level of depth as a systematic analysis, it offers breadth on a topic or a range of topics and allows flexibility in source selection and synthesis. The risk with a narrative review lies in potential biases in the selection process.

The purpose of the literature review in this thesis is to synthesize the current knowledge, practices and frameworks in relevant areas to create a theoretical foundation as the basis of the research. For this purpose, the narrative approach is more relevant as it offers the required level of breadth. To perform this analysis, the authors will be attentive to any biases in the literature review and will attempt to minimize the risk of performing a one-sided review. On the contrary, Voss, Tsikriktsis, and Frohlich (2002) and Yin (2003) argue the importance of addressing literature that conflicts with findings or theories, to increase the confidence in the theory and the results.

The literature search process was conducted in two important phases. The first phase was exploratory, with the purpose of developing a knowledge base in order to create specific research questions and gaining a knowledge base for the preparation of the thesis, including identifying gaps in the literature and preparing for interviews. The second phase was conducted throughout the introduction phase to create the narrative review and ensure a strong foundation to support a thorough analysis.

The literature search was conducted in Scopus, and during the first phase, relevant key words were identified and relevant literature was read. The selection criteria during this phase was unstructured with the goal of exploration of the literature, as an initial literature search should be, according to Jesson (2011). Terms such as ”buyer-supplier relationship”, ”resource dependency theory”, ”supplier dependency”, ”supplier relationship management”, ”supply chain governance”, ”supply chain risk management” and ”supply chain resilience” were found to be of relevance and when possible, systematic literature of the topics were found. Through the studies, further exploration was done by snowballing, in order to find more specific and more recent studies on the topics.

The second phase of literature review was an iterative process with the purpose of creating the narrative review. Based on the relevant keywords and terms found in the first phase, three different overarching topics were chosen to be of utmost importance for the thesis: Supply chain risk management & resilience, resource dependence theory and supplier relationship management. The three topics were more deeply explored than in the first phase, in order to get the depth and breadth necessary. Utilizing systematic literature of the chosen topics were used whenever possible and complemented with articles found from snowballing as well as books on the topics.

2.3.2 Interviews

The largest part of the data contributing to the thesis is collected through interviews. The effectiveness of the interviews is, in large part, dependent on the skills of the interviewer (Yin 2003). According to Yin (2003), an interviewer should possess these skills:

- Be able to ask good questions - and interpret the answers
- Be a good listener - and not be trapped in preconceptions
- Be adaptive and flexible - and maneuver new situations
- Have a firm grasp of the issue at hand
- Be unbiased - and responsive to contradictory evidence

These aspects will be at the core of the interviews, and while neither of the authors have previous experiences with conducting interviews, great consideration is taken to these five skills in designing and conducting the interviews. To enable full transparency, the analysis will clearly state the emergence of contradictory evidence. Questions will be formulated to remain unbiased and not carry implications of direction or suggestive phrasing.

The goal of each interview is to create a rich dialogue with the interviewee in order to pose new information towards ideas from literature and to deal with discrepancies between expectations and responses. To facilitate rewarding interviews, interview guides was created; sets of questions specifically formulated for the different roles of the interviewees. This was to maximize the evidence which can be extracted from each interviewee and tailor the interview to their experience and expertise. The interview guide can be found in Appendix A. However, the interviews also contained questions which are not in the interview guides, depending on the answers and emerging questions during the interviews. This semi-structured approach combines the benefits of a structured format, namely specific questions that address the full scope of the interview topic, with those of an unstructured format, namely flexibility and adaptability in response to new perspectives or unexpected answers.

The duration of the interviews ranged between 30-60 minutes. Because of the semi-structured format, the amount of discussion and questions asked outside the interview guide relied solely on the interviewees themselves. The interviews were conducted both in person and online, depending on the availability and preference of the interviewees. Table 2 contains a summary of the interviewed roles along with the purpose of each interview.

Table 2: Interviewees & purpose of interviews

Role	Purpose	Length
Senior supply chain manager	Current practices & processes, specifics Supplier A	60 min
Global Category & Purchasing manager OEM & CAPEX	Current practices & processes	60 min
Manager, Global supplier management process	Current practices & processes	30 min
Supplier manager	Specifics Supplier B	60 min
Process manager supplier A	Technical specifics Supplier A	30 min
System manager supplier A	Technical specifics Supplier A	30 min
Process manager Supplier B	Technical specifics Supplier B	30 min
System integration manager Supplier B	Technical specifics Supplier B	30 min
Analytics, Compliance and Risk Officer	Supply chain risk management	30 min
Manager Asset Management	Obsolescence	30 min

2.3.3 Documentation

A vital part of the data, which is a cornerstone of the specific case studied in this thesis, is the contextual information. The specifics under which Tetra Pak operates, relating to supplier management, risk strategies and the details of the dependence between them and suppliers lies within internal documentation. The internal documents provided by Tetra Pak include process descriptions related to supplier selection; supplier-specific information such as product details, location, and size; information about tools used for risk management with examples of reports for the suppliers; annual spend and the proportion of components or services supplied. Due to the sensitive nature of these documents, they will not be presented in detail or appended. The general content of the relevant documents will be included with the permission of Tetra Pak, and figures are adjusted in such a way to retain the core message without presenting exact figures to retain sensitive information.

2.4 Data Analysis

The analysis primarily followed a deductive approach where the interview guide served as the foundation for grouping and understanding the findings. This approach was considered appropriate as the interview questions were developed based on the research questions and the theoretical concepts identified in the literature review. At the same time, the analysis remained open to new observations emerging from the empirical material, allowing for the identification of findings that were not anticipated during the study design.

All interviews were recorded and transcribed to ensure accuracy and completeness of the collected data. Following transcription, the interview material was subjected to a process of data condensation, as described by (Miles, Huberman, and Saldaña 1994). Data condensation refers to the process of selecting, focusing, simplifying, abstracting, and/or transforming the data of e.g interview transcripts in order to make the data stronger by sorting, focusing, discarding and organizing the data in such a way that conclusions can be drawn and verified. In this study, responses from each interview were reviewed and organized according to the themes represented by the interview guide. Statements, experiences, and observations relevant to a particular topic were grouped together under the corresponding interview question, enabling systematic comparison across respondents. Findings that did not fit within the predefined categories but were considered relevant to the research objectives were documented separately and incorporated into the analysis where appropriate.

The structured organization of interview data facilitated the identification of patterns, similarities, and differences across interviewees. Rather than focusing on individual opinions, the analysis sought to identify common perceptions, themes, and explanations related to the studied supplier relationships. Representative quotations were retained throughout the process to illustrate key findings and increase transparency by allowing readers to evaluate the connection between empirical observations and the resulting interpretations.

The primary units of analyses was the two supplier relationships selected for the case study. Consequently, the analysis extended beyond the individual interview level and focused on synthesizing evidence from multiple interviewees to develop an understanding of the dependence structures, vulnerabilities, and risk management practices characterizing each relationship. By comparing perspectives across different organizational functions, a more comprehensive view

of the relationships could be established.

The interview findings were analyzed in conjunction with internal documentation and quantitative supplier data. Internal documentation, including process descriptions, supplier information, and risk management reports, was used both to provide contextual understanding and to verify descriptions of existing practices. These documents offered an objective representation of formal processes, responsibilities, and tools used within Tetra Pak. Quantitative data, such as annual supplier spend, supplier size, and supply share information, were used to complement qualitative findings by providing objective indicators related to the structure and significance of the supplier relationships. Rather than being analyzed independently, the quantitative data primarily served to contextualize and support interpretations derived from the interviews.

The analysis relied on methodological triangulation by combining evidence from interviews, documentation, quantitative data, and the literature review. Triangulation strengthens the credibility of findings by reducing dependence on any single source of evidence and allowing observations to be examined from multiple perspectives. Findings were considered particularly robust when supported across several data sources, while discrepancies between sources were examined further to identify potential explanations.

The literature review served as an analytical framework through which empirical findings were interpreted and evaluated. Theoretical concepts related to risk and resilience, resource dependence theory and supplier relationship management informed the interpretation of the empirical material and provided a basis for assessing existing practices. The analysis therefore involved an iterative comparison between empirical observations and theoretical expectations, enabling both the validation of findings and the identification of areas where practice could potentially be improved. This process ensured that conclusions were not solely based on organizational perceptions but were also evaluated in relation to established research.

The final stage of the analysis involved synthesizing evidence from all data sources to answer the research questions. Through the integration of interview findings, documentary evidence, quantitative indicators, and theoretical insights, conclusions were developed regarding the characteristics of the studied supplier relationships, the vulnerabilities arising from asymmetric dependence, and the strategies available for managing the associated risks.

2.5 Research Quality

The quality of research is concerned with a number of different factors, and the literature covers many different terms, including validity, reliability, credibility, truth-value, traceability, transferability, trustworthiness, rigor, ethics and more. (Halldórsson and Aastrup 2003; Mota Pedrosa, Näslund, and Jasmand 2012). The traditional basis of research quality focuses on validity, reliability and rigor. Validity is the extent to which a study accurately identifies a real causal relationship and allows that relationship to hold beyond the specific study context (Halldórsson and Aastrup 2003). Reliability is a given study's consistency, predictability, dependability, stability and/or accuracy. Rigor refers to the quality of being thorough and following accepted standards and procedures. These are the building blocks which must permeate research studies regardless of type or method. However, Mota Pedrosa, Näslund, and Jasmand (2012) argue that the nature of qualitative case study research demands a more nuanced approach due to the interpretive aspect of the method. Additionally to validity, reliability and rigor, three main cri-

teria are well suited to cover the quality gap in the case study research method: Transferability, truth-value and traceability.

2.5.1 Transferability

Transferability refers to the extent to which a study allows its findings to hold beyond the specific study context (Mota Pedrosa, Näslund, and Jasmand 2012). Veering from traditional, quantitative research, which aims to do this through providing evidence that a chosen sample is representative of reality and is large enough, authors of case study research must be aware that time can change the context of people, which alters the applicability onto similar context. The similarity between context and general phenomenon is thus not up to the researchers to clearly describe, but rather to explain the context to such a degree that the reader can easily evaluate the transferability to another phenomenon. To facilitate this, documentation of the underlying theoretical aim, unit of analysis, justification of case selection and number of cases studied must clearly be described and explained. This thesis aims to be fully transparent and discuss these relevant factors exhaustively, to enable transferability.

2.5.2 Truth-value

Halldórsson and Aastrup (2003) discusses that ”reality” is subjective and that objective reality does not exist. Truth-value refers to the match between the authors reality and the informants reality and is a key component in the congruency of logic (Mota Pedrosa, Näslund, and Jasmand 2012). The main data of case research comes from interviewees, and if the ”realities” of these informants and the authors are misaligned, interpretations and inferences could be skewed. A large part of the truth-value lies in the inference aspect, related to drawing conclusions based on interpretations of reality. A major aspect of increased truth-value is attempting to find alternative explanations for the findings (Yin 2018; Ellram 1996). Finding patterns, addressing rival explanations and rigorously attempting to find problems in the patterns suggested greatly strengthens the findings. Additionally, truth-value is increased by providing a precise description of data analysis process, which allows the reader to assess the data processing in order to judge to truth-value. The data analysis process is discussed at length in section 2.4.

2.5.3 Traceability

Traceability refers to the consistency of documenting the research process and data sources to enable consistency and replicability in the studies findings (Mota Pedrosa, Näslund, and Jasmand 2012). It involves describing the what, why and how of research questions, data types and triangulation process to facilitate the assessment of the chosen methods suitability. This thesis aims to promote traceability by explaining and discussing these aspects in depth to avoid ambiguity and provide a clear, dependable result.

3 Theory

This section outlines the theoretical foundation and provides a narrative review of the topics deemed most relevant and important to allow a thorough, supported and accurate analysis of the data.

To structure the theoretical foundation and to make sense of how the various literature concepts connect to the research aim, Figure 6 presents an overview of theoretical areas in this chapter and what they bring analytically.

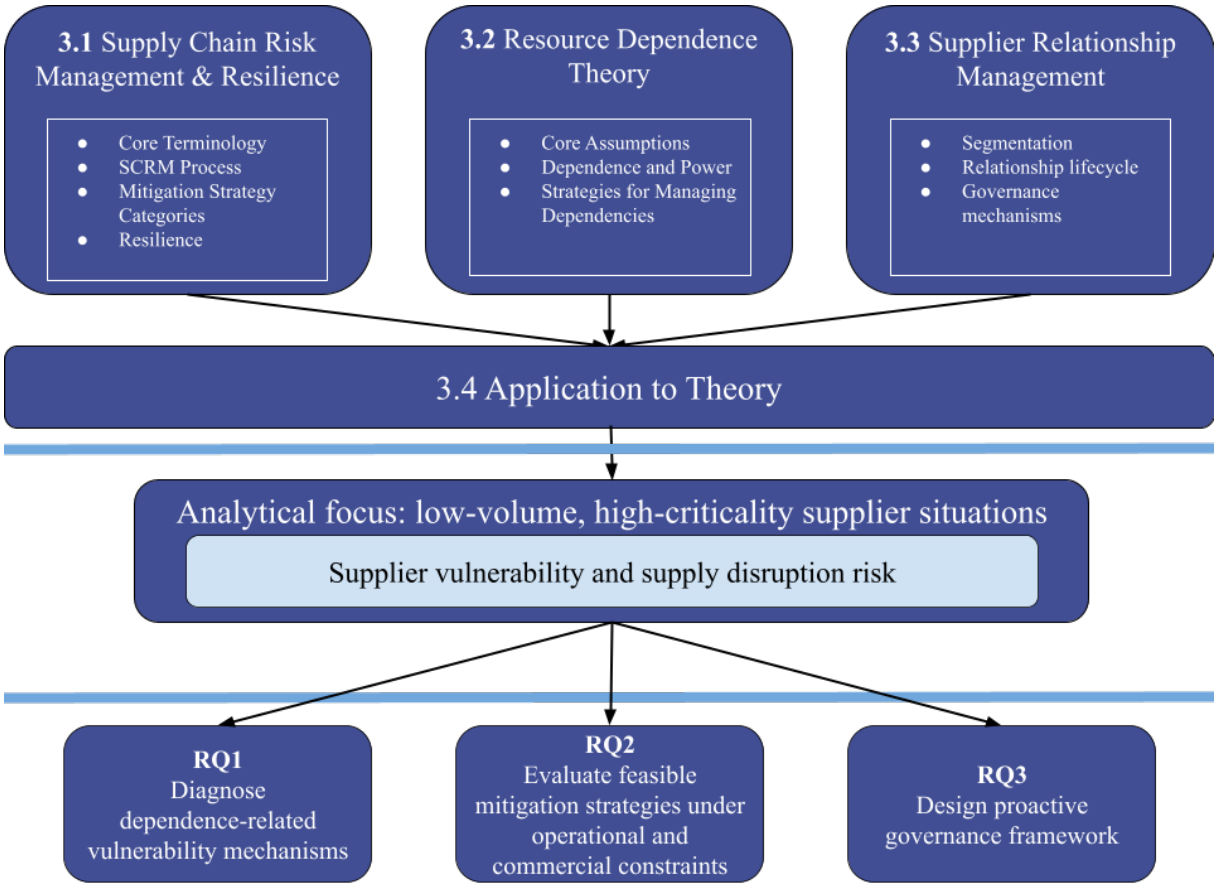

Figure 6: Overview of the theoretical foundation and analytical focus of the study. (Source: Authors)

Altogether these ideas merge and overlap to give solid support to analyze supplier vulnerability and disruption risk in low volume, critical supply settings forming the conceptual base for the research questions.

3.1 Supply Chain Risk Management and Resilience

Building on the problem framing introduced in chapter 1, this section consolidates risk- and resilience-related concepts that are used throughout the thesis into a consistent theoretical foundation. It first formalizes the working terminology applied in the study: supply disruption, supplier vulnerability, and supply risk, by specifying the conceptual boundaries of each construct and how they will be used in the analysis. It then positions these constructs within the broader logic of supply chain risk management (SCRM), synthesizing how SCRM is commonly operationalized through structured processes for identifying, assessing, mitigating and monitoring risks, and summarizing core categories of mitigation strategies discussed in the literature. Finally, the section establishes a link between SCRM and supply resilience, understood as the ability to prepare for, respond to, and recover from disruptions. It also explains why conventional mitigation strategies may be ineffective in situations involving low volume, critical supply.

3.1.1 Core Terminology and Construct Boundaries

3.1.1.1 Supply disruption

A *supply disruption* is defined as an unplanned event or condition that disrupts the normal flow of goods and materials in a supply chain, thereby exposing firms to operational and financial consequences (Kleindorfer and Saad 2005; Craighead et al. 2007). In this thesis, the construct is bounded to supplier-orientated disruptions where a critical supplier discontinues production of specialized equipment, spare parts or service due to strategic, financial, or operational changes, resulting in a loss of supply and/or maintenance availability for the local firm.

3.1.1.2 Supplier vulnerability

Vulnerability is treated as a structural property, describing the susceptibility of a supply setting to disruption effects, shaped by internal characteristics and interface conditions in the buyer-supplier relationship (Wagner and Bode 2006). In this study, vulnerability denotes structural and relational conditions that increase susceptibility to supplier-side *production discontinuation* and amplify the resulting operational and service consequences.

3.1.1.3 Supply risk

More generally, risk has been defined as the extent to which there is uncertainty about whether potentially significant outcomes will be realized (Sitkin and Pablo 1992, p. 10). Within purchasing and supply management, supply risk can be defined as the probability that an incident in inbound supply, arising from individual supplier failures or supply market conditions occurs and leads to outcomes such as an inability to meet customer demand and, in some contexts, threats to customer life and safety (Zsidisin 2003).

3.1.1.4 Supply chain resilience

Supply chain resilience refers to the adaptive capability of a supply chain to prepare for, respond to, and recover from disruption while maintaining (or restoring) desired performance levels (Ponomarov and Holcomb 2009). It is a multidimensional and multidisciplinary concept which can be applied on SCM with the purpose of managing flow-related risks in the supply chain. As

such, resilience is not one aspect or capability of a supply chain, but rather a set of dynamically integrated processes related to preparation/anticipation, efficient response and recovery that is supported by a structured risk management process, top management support, risk sharing, logistics capabilities etc. Ponomarov and Holcomb (2009) proposes that greater supply chain resilience is associated with faster recovery in disruptions, better control of logistics capabilities and overall greater sustainable competitive advantage.

3.1.1.5 Supply chain risk management (SCRM)

Supply chain risk management (SCRM) refers to the coordinated managerial approach through which companies identify and address supply risk sources, with the goal of reducing vulnerability and ensuring continuity throughout the supply chain (Jüttner 2005; Tang 2006). In this thesis, SCRM provides the managerial logic through which governance mechanisms (section 3.3) are selected, triggered, and applied in supplier relationships to proactively manage disruption exposure.

3.1.2 SCRM process

To make the concepts introduced in section 3.1.1 analytically useful, they must be embedded in a decision logic that explains how risks are systematically handled over time. A process view of SCRM provides this logic by structuring the activities and outputs through which risk information is generated, prioritized, acted upon and revisited in a continuous management cycle (Jüttner 2005; Tang 2006).

SCRM can be viewed as a continuous cycle of (1) risk identification, (2) risk assessment, (3) risk mitigation (treatment), and (4) risk monitoring and review (Tummala and Schoenherr 2011; Hallikas et al. 2004). The cycle is iterative: monitoring outcomes and new information feed back into renewed identification and reassessment, ensuring that the risk picture and corresponding actions remain aligned with changing conditions in the supply environment (Tummala and Schoenherr 2011).

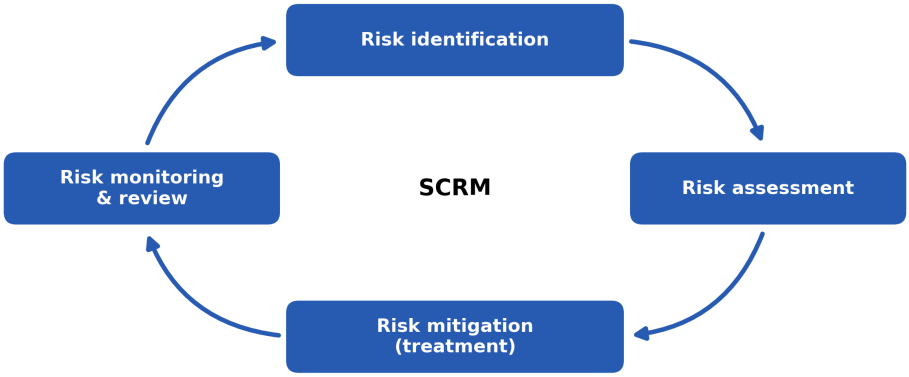

Figure 7: The SCRM cycle adapted by the authors based on Hallikas et al. (2004).

3.1.2.1 Risk identification

Risk identification involves the systematic recognition and documentation of relevant risk sources and potential disruption scenarios in inbound supply (Jüttner 2005; Tang 2006). Typical inputs include internal and external drivers and information sources, such as operational experience, supplier-related information, engineering and sourcing knowledge, and incident or performance records (Tummala and Schoenherr 2011). Empirically, proactive SCRM can involve dedicated organizational arrangements, processes and tools, as well as closer supplier interaction and formal supplier requirements (Norrman and Jansson 2004). The primary output of this step is a structured risk register that captures risk sources, plausible events, and affected components/suppliers, which provides the basis for subsequent assessment (Tummala and Schoenherr 2011).

3.1.2.2 Risk assessment

Risk assessment prioritizes and evaluates identified risks to inform managerial action. This stage focuses on the valuation of potential outcomes and the appraisal of uncertainty surrounding supplier failure (Sitkin and Pablo 1992). Within critical, low volume sourcing, a specific challenge arises: the rarity of historical failure events often makes standard probability reasoning distorted. While the low probability causes the assessment of identified risks to be perceived as a low priority, the potentially severe consequences outweighs the low probability. Therefore, risk assessment should not only utilize traditional frequency-based modeling, but also consider *consequence severity* and scenario-based reasoning in assessing risks. By emphasizing the catastrophic impact of a potential disruption, regardless of its perceived low probability, this approach provides the logic necessary to prioritize highly critical components in the subsequent design of a governance framework (Tummala and Schoenherr 2011).

A commonly used tool in risk assessment is the risk matrix, in where identified risks are evaluated according to probability and potential impact (*Risk management – Risk assessment techniques* 2019). In supply chain risks management, such tools are useful because risk assessment often involves both available data and managerial judgment, particularly when historical disruption data is limited (Hallikas et al. 2004). In this context, the matrix supports prioritization by making it possible to compare risks and determine which risks require managerial attention. The purpose of the risk matrix is therefore not to produce exact quantitative estimates, but to create a structured basis for comparing, communicating, and prioritizing risk.

Figure 8 illustrates this assessment logic through a generic risk matrix, where risks are categorized and prioritized according to their assessed Impact/Consequence and Likelihood/Probability.

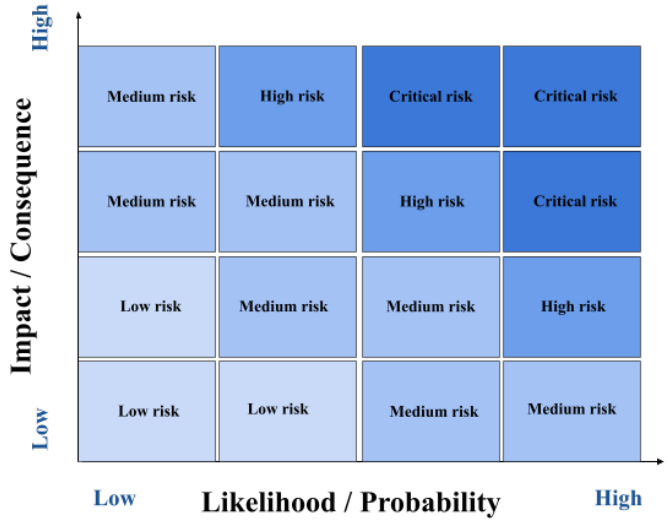

Figure 8: Generic risk matrix illustrating how risks can be assessed and prioritized based on probability and impact. (Source: Authors, based on IEC/ISO 31010)

3.1.2.3 Risk mitigation

Risk mitigation specifies and implements strategic actions aimed at reducing exposure or limiting the consequences of realized disruption (Tang 2006; Tummala and Schoenherr 2011). This involves selecting appropriate mitigation levers, such as buffering or bridging strategies (further developed in section 3.1.3).

3.1.2.4 Risk monitoring and review

Risk monitoring and review constitute ongoing supplier-focused activities that keeps risk registers and mitigation plans current as conditions and supplier information change (Tummala and Schoenherr 2011; Hallikas et al. 2004).

3.1.3 Mitigation strategy categories and feasibility constraints

To structure mitigation approaches, this thesis follows Tang's categorization of four broad intervention areas: *supply management*, *demand management*, *product management*, and *information management*. These categories represent different intervention points through which firms can reduce disruption probability, limit disruption impact, or improve the ability to respond when disruption occurs, although the boundaries between them may overlap (Tang 2006).

Supply management deals with the supplier base configuration and how it is arranged. Which sourcing choices are made, including single/multiple sourcing, supplier selection, quantity, and capacity allocation. *Demand management* focuses on influencing and stabilizing demand patterns, for example, through forecasting, demand shaping, or postponement. *Product management* addresses design-related interventions, such as standardization, modularization, or redesign, aimed at reducing dependence on specific components or suppliers. *Information management* is related to visibility and coordination across the supply chain, enabling earlier detection of risk and more effective responses (Tang 2006).

Although analytically distinct, these categories are intertwined in practice and mitigation strategies often combine elements from multiple categories. Their effectiveness depends on the structural characteristics of the supply context.

In the context of low volume, critical components, the applicability of these strategies is significantly constrained. Limited supplier availability, high qualification barriers, and weak commercial incentives reduce the feasibility of conventional mitigation approaches such as multi-sourcing. This leads to strategies typically applied through a portfolio of levers that balance the trade-off between *redundancy* and *flexibility* (Jüttner 2005; Christopher and Peck 2004). Redundancy-based strategies, such as maintaining safety stock or dual-sourcing, aim to provide immediate protection against disruptions but often have high holding costs and administrative complexity. On the other hand, flexibility-based strategies focus on the firm's agility, its ability to rapidly reconfigure supply flows or redesign components when a failure occurs (Tang 2006).

However, in the context of this thesis, both redundancy and flexibility are usually rather limited, sometimes even completely blocked. Redundancy may be economically infeasible due to low volumes, while flexibility may be technically constrained by qualification barriers and supplier-specific knowledge. Consequently, the evaluation of mitigation strategies shifts from a general focus on efficiency towards a focus on *implementation feasibility*. This implies that mitigation strategies must be assessed along two complementary dimensions: (i) expected risk reduction, in terms of probability and/or consequence, and (ii) feasibility of implementation given technical, operational, and relational constraints. This distinction forms the basis for the analytical evaluation of mitigation strategies in this thesis, where strategies are assessed not only by their risk-reduction potential, but also by whether they can realistically be implemented under the structural constraints of the supplier relationship.

This perspective aligns with Gelderman and Van Weele (2003), who argues that in what they refer to as "bottleneck" situations, where supply risk is high and purchasing volume is low, the strategic options available to the buyer are inherently limited. This will be further elaborated in section 3.3.1 (Segmentation). Under such conditions, conventional market-based mitigation strategies cannot be effectively applied. The buyer is instead constrained to either accept existing dependence or pursue long-term efforts to reduce it, for example through redesign, standardization, or gradual supplier base adjustment (Gelderman and Van Weele 2003). A more detailed discussion of how dependence shapes both risk exposure and feasible mitigation actions is provided in the following section.

Consequently, mitigation strategies cannot be evaluated in isolation from the structural and relational context in which they are implemented. The feasibility and effectiveness of approaches taken are shaped not only by economical and technical factors, but also by the underlying structure of power and dependence between buyer and supplier. This reinforces the need to analyze mitigation strategies through a relational lens, which is developed further in section 3.2.

3.1.4 Installed base and obsolescence constraints

In industrial settings with long-lived equipment, supply risk is not limited to the availability of new production units. It also concerns the continued availability of spare parts, maintenance capability, supplier support, and technical knowledge throughout the service life of the installed base. This becomes particularly important when equipment remains operational after new pro-

duction has slowed down or stopped. Teunter and Fortuin describe the end-of-life service period as the period that begins when a system is taken out of production and ends when all service obligations have expired, and emphasize that this service period can be considerably longer than the production period (Teunter and Fortuin 1999).

The mitigation problem therefore extends beyond future sourcing decisions. When supplier support declines or a component is discontinued, the buyer still has to keep the installed equipment operational. This makes spare-part availability, refurbishment, maintenance planning, and transition preparation central parts of risk mitigation. If discontinuation is announced in advance, a last-time-buy can secure remaining demand during the residual service period, but this is difficult because future demand and service needs are uncertain (Behfard et al. 2015). The installed base perspective therefore broadens mitigation from future sourcing decisions to the continued serviceability of equipment already in use.

3.1.5 Resilience

In contexts characterized by highly specialized components, long qualification lead times, and limited alternative sources, resilience depends less on the ability to quickly change suppliers and more on preparedness and early detection of supplier discontinuation risk (Christopher and Peck 2004; Pettit, Fiksel, and Croxton 2010). Under such constraints, resilience is strengthened by measures that increase visibility (e.g., monitoring capability and life-cycle signals), enable preventive responses (e.g., time-phased mitigation and contingency planning) and maintain continuity through coordinated inter-organizational action (Sheffi and Rice 2005; Ponomarov and Holcomb 2009). This shifts the interpretation of resilience from a reactive recovery metric to a proactive objective embedded in the design and governance of the supply relationship. Here, resilience is reflected in the extent to which the supply environment can anticipate, withstand, and recover from capability loss on the supplier side while maintaining the required installed base and service outcomes (Ponomarov and Holcomb 2009; Pettit, Fiksel, and Croxton 2010).

3.2 Resource Dependence Theory

While the last section defines the desired outcome of a resilient supply chain, this section introduces the primary theoretical lens of the thesis: Resource Dependence Theory (RDT). As suggested in the Research Objectives (section 1.4), the vulnerability observed in low volume, critical components is not merely a logistical challenge but a structural one rooted in power asymmetries. RDT argues that organizations rely on external actors for critical resources and that these dependencies create constraints and power differentials that firms seek to manage through various strategies and structural arrangements (Hillman, Withers, and Collins 2009).

3.2.1 Core assumptions

RDT starts from the assumption that organizational survival and performance depends on access to the resources that are often controlled by external actors. Because resources are distributed across organizational boundaries, companies face uncertainty and constraints that stem from interdependence with others; these conditions motivate managerial efforts to stabilize resource access and reduce environmental dependence (Pfeffer and Salancik 2003; Hillman, Withers, and Collins 2009). In this view, organizational behavior is shaped not only by internal efficiency considerations but also by the external control of critical resources and the relational context

through which those resources are obtained.

Another core assumption is that dependence relations have political and power-related implications. When one party controls resources that another party considers important and difficult to replace, the relationship becomes a potential source of influence and constraint (Pfeffer and Salancik 2003; Emerson 1962). RDT therefore treats power and dependence as relational properties, emphasizing how shifts in resources control and sustainability can alter the balance of influence between actors over time (Hillman, Withers, and Collins 2009).

3.2.2 Dependence and power

Power between actors within cross-organizational relations is commonly conceptualized through a power-dependence logic, where the power of one actor over another is a function of the dependence of the other actor (Emerson 1962; Pfeffer and Salancik 2003). From an RDT perspective, vulnerability can thus be interpreted as a structural consequence of dependence, in cases where critical resources are concentrated and substitutes are limited, disruption or strategic shifts at the resource-controlling actor can translate into disproportional operational exposure for the dependent actor (Pfeffer and Salancik 2003; Hillman, Withers, and Collins 2009).

Asymmetric dependence arises when one party relies substantially more on the relationship than the other. This increases the exposure of the more dependent party to constraints, as the less dependent party can more credibly withhold or reallocate resources elsewhere (Emerson 1962). In RDT terms, such asymmetry has significant consequences when the resource is critical and alternatives are limited, since the dependent actor's response options are constrained (e.g., switching, substitution, or rapid qualification of alternatives) (Pfeffer and Salancik 2003; Hillman, Withers, and Collins 2009).

Importantly, dependence structures cannot be fully characterized by 'who is more dependent' alone. Casciaro and Piskorski (2005) distinguish between power imbalance, the asymmetry in dependence between two parties and mutual dependence, the overall level of interdependence. They show that relationships with similar imbalances can differ significantly in terms of constraints and strategic options, depending on how much both parties rely on the relationship (Casciaro and Piskorski 2005).

3.2.3 Strategies for managing dependencies

While section 3.1.3 categorized the operational levers of mitigation, RDT provides the logic for the *strategic intent* behind their selection. Organizations are not passive; rather, they actively seek to manage dependencies by altering inter-organizational ties and the conditions under which critical resources are accessed (Pfeffer and Salancik 2003).

These strategies are interpreted along two general logics:

1. **Dependence Reduction:** Attempts to exit the dependency by expanding alternatives, internalizing activities (vertical integration), or redesigning products to eliminate unique requirements.

2. **Dependence Management:** Attempts to stabilize access to the resource by moderating power imbalances through relational or structural mechanisms, essentially "bridging" the

gap with the supplier rather than leaving the relationship (Hillman, Withers, and Collins 2009).

In their original formulation, Pfeffer and Salancik (2003) discuss several broad classes of dependence-management strategies, including vertical integration and mergers, joint ventures and other inter-organizational relationships, boards of directors (e.g. interlocks), political action, and executive succession (Pfeffer and Salancik 2003). Building on this, Hillman et al. (2009) synthesizes subsequent RDT research, emphasizing how organizations manage uncertainty and interdependence by reconfiguring relationships, structures, and boundary-spanning arrangements (Hillman, Withers, and Collins 2009).

While RDT provides a conceptual understanding of how firms manage dependence, empirical studies have identified more concrete strategies available to less powerful buyers in asymmetric relationships. Table 3 synthesizes such strategies and translates them into the context of low volume, critical supply situations.

Table 3: Dependency-management strategies for less powerful buyers in asymmetric supplier relationships, adapted to low volume, critical supply contexts.

Strategy	RDT Logic	Mechanism	Relevance in low volume, Critical Supply
Withdrawal	Dependence reduction	The buyer reduces its commitment to the relationship by limiting investments, reducing information sharing, scaling down the scope of collaboration, or exiting the relationship altogether.	Often difficult in this context due to high switching costs, technical specificity, and installed base obligations make exit infeasible even when dependence is undesirable.
Network expansion	Dependence reduction	The buyer broadens its supplier base by developing or qualifying alternative suppliers, thereby reducing reliance on a single resource-controlling actor.	Highly relevant in principle but often constrained by qualification lead times, limited supplier availability, and low commercial attractiveness due to irregular demand.
Status improvement	Dependence management	The buyer seeks to become a more attractive and prioritized customer through improved forecasting, enhanced information sharing, technological collaboration, or targeted investments.	Particularly relevant where the buyer is operationally dependent but commercially less important, as increased attractiveness may secure continuity despite low volumes.
Coalition formation	Dependence management	The buyer strengthens its position by aligning with other actors, such as customers, partner firms, or internal business units, to increase bargaining power and reduce isolation.	Potentially relevant when individual buyers lack leverage, although feasibility depends on the existence of actors with shared needs and aligned time horizons.
Socialization	Dependence management	The buyer strengthens relational ties through trust-building, repeated interaction, informal coordination, and cooperative norms that facilitate joint problem-solving.	Relevant in long-term service-dependent relationships where continuity depends on early communication, flexibility, and mutual commitment beyond contractual obligations.
Formalization	Dependence management	The buyer reduces uncertainty through formal governance mechanisms such as contracts, service-level agreements, defined responsibilities, escalation procedures, and agreed exit conditions.	Highly relevant in this thesis context, as formalization enables early risk recognition and clarifies responsibilities related to discontinuation, service obligations, and mitigation actions.

Source: Adapted from Pazirandeh (2014) p. 110, and grounded in Resource Dependence Theory (Pfeffer and Salancik 2003).

The strategies in Table 3 can be interpreted through the two core RDT logics: dependence reduction and dependence management. However, their applicability varies significantly in the studied context. Dependence reduction strategies, such as withdrawal and network expansion, are often theoretically desirable but in some cases practically constrained. In contrast, depen-

dence management strategies, including status improvement, socialization, and formalization, emerge as more feasible approaches for stabilizing supply under conditions of structural dependence. This distinction highlights that mitigation in such contexts is not primarily about eliminating dependence, but about governing it effectively.

Consequently, mitigation strategies in such contexts can be interpreted as either attempts to reduce dependence by expanding alternatives through qualification, redesign, or standardization, or attempts to manage dependence by influencing supplier behavior through coordination and governance mechanisms. This realization allows for a more nuanced perspective when evaluating mitigation strategies and supports the development of the governance framework in this thesis.

3.3 Supplier Relationship Management

Supplier Relationship Management (SRM) is the process of engaging in activities of setting up, developing, stabilizing and dissolving relationships with suppliers to create and enhance value (Moeller, Fassnacht, and Klose 2006). It is not a single linear process or series of steps. Rather, it is a philosophy that frames a collection of actions, approaches and mindsets, representing the purposeful management of relationships between buyers and suppliers (O'Brien 2022; Amoako-Gyampah et al. 2019). The roles of suppliers are multiple and diverse, encompassing a spectrum of engagements, and relations have to be managed accordingly (Wieland and Ivens 2025). Some key processes in SRM include supply base optimization, supplier performance management, supplier improvement & development, supplier segmentation and collaboration in day-to-day activities (O'Brien 2022). The goal of SRM is to add value beyond just lower prices, such as resilience, efficiency and sustainability (Jones 2024).

The internationalization of supply chains have deepened the interdependencies between businesses and their suppliers, making good SRM practices a vital strategic cornerstone in the supply side of supply chains. This has caused competition to shift from being between individual businesses to between entire supply chains (Jones 2024). SRM has forced to evolve from a transactional process ensuring the needed supplies are delivered in the right quantity and quality at the right time, to a strategic process aimed at seeking competitive advantages by increasing innovation, cementing good practices and limiting the exposure and impact of risks. This section will summarize the literature on SRM on three different aspects: segmentation, the stages of SRM and governance mechanisms.

3.3.1 Segmentation

Some suppliers are more important than others, and to increase the value from the supply base, it is crucial to identify which suppliers are important (O'Brien 2022). Segmentation is the process of determining which suppliers are important through the use of pre-determined criteria. One of the most common ways of segmenting the supply base is through the use of the Kraljic matrix, see Figure 9 on the next page. The Kraljic matrix is a tool to analyze either the individual suppliers or purchased items on two criteria: profit impact and supply risk (Kraljic 1983). The criteria used are not necessarily calculable, but rather a collective interpretation of the impact and risk of a given supplier, item and market. The profit impact is a combination of annual spend compared to total purchasing volume, contribution to profit margin or added value and so on (Kraljic 1983; Weele 2018). The supply risk is a combination of properties belonging

to the supplier, market or item that could impact supply continuity and supply disruptions. It could include concepts such as monopoly or open market, entry barriers, logistics costs and complexities, suppliers financial position, patents, availability of substitutes, political stability, supplier's share in buyer's purchasing volume etc. Depending on how suppliers or items are ranked along these axis, four different categories, or segments, are achieved. These categories often share similar market conditions and act as solid foundations for analysis of the supply situation. Along with each category, Kraljic presents associated supply strategies and suggests that the relationship and related SRM practices should differ between the quadrants.

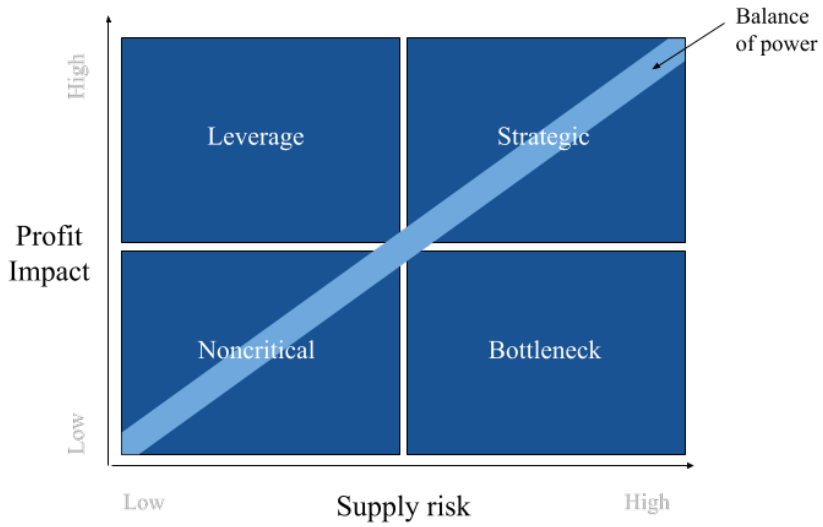

Figure 9: Kraljic Matrix. Adapted from Kraljic (1983), p.111 and Van Weele (2018), p.176.

Bottleneck items are high risk items, but have a low profit impact in comparison to the total spend. Because of this, there is an imbalance in the power between the buyer and supplier (Weele 2018). For the buyer, the items represent a relatively small value in terms of total spend, but high costs would incur if the supply is lost. The supplier might even have the buyer "locked in" due to a of a lack of alternatives, allowing little leeway for the buyer. As a result, the supplier holds great bargaining power in the relation. For bottleneck items/suppliers, it is vital to have a strategy aimed at securing supply and if possible, reducing the supply risk. This should include accurate medium term forecasts, good supply risk analysis, determine the ranking/importance in the suppliers client list, searching for alternative suppliers/solutions, volume insurance and preventative measures such as buffer stock or consigned stock (Van Weele 2018; Kraljic 1983).

Strategic items are the most influential to a business, as this is where long term value is acquired and generally make up a large portion of the turnover (Van Weele 2018). Usually, only one source of supply is available, and the product(s) are supplied at customer specification. These products represent a high share of cost price of the buyers end product, and as such, minor changes in price levels will have an immediate impact of the end product's cost. The power dynamics for strategic items could be either buyer-dominated or supplier-dominated, depending on the specifics of the relationship. Because of the power dynamics with strategic suppliers along with the large influence and impact the supplier could have on the total spend, collaboration or partnerships are preferred. The goal is to create mutual participation to achieve cost

reduction, quality improvement, process improvement and innovation.

Leverage items generally constitute readily available products that can be acquired from several suppliers at various quality levels (Van Weele 2018). They represent a large share of the purchasing volumes and spend, and are well suited for aggressive sourcing to achieve competitive prices. Because of this, the buyer holds great bargaining power over suppliers.

Noncritical items are standardized, low value items with a low supply risk. The goal with these products is to minimize the administrative and logistic complexity, as up to 80% of the total time in purchasing activities are used for these products (Van Weele 2018). The power balance between buyer and supplier are often equal, as the abundance of alternative suppliers and buyers allow both parties to switch to alternatives.

A critique on the traditional Kraljic matrix is that it only considers the buyers perspective on the relationship and strategy used, however Van Weele (2018) argues that effective purchasing strategies must reflect both the buyers and suppliers perspective. He proposes an additional dimension to the matrix, reflecting the suppliers view of the customer. More specifically, he proposes that every quadrant in the Kraljic matrix should be supplemented by a similar matrix, evaluating the buyer on customer attractiveness and accounting for the supplier's competitive position on the market. The resulting matrix is known as the Dutch windmill, as illustrated in Figure 10. Depending on both the suppliers position in the Kraljic matrix, and the buyers position in the Dutch windmill, four different strategies emerge: Core, development, exploitation and nuisance. The strategies are from the perspective of the buyer with the purpose of managing power asymmetries and improving bargaining power.

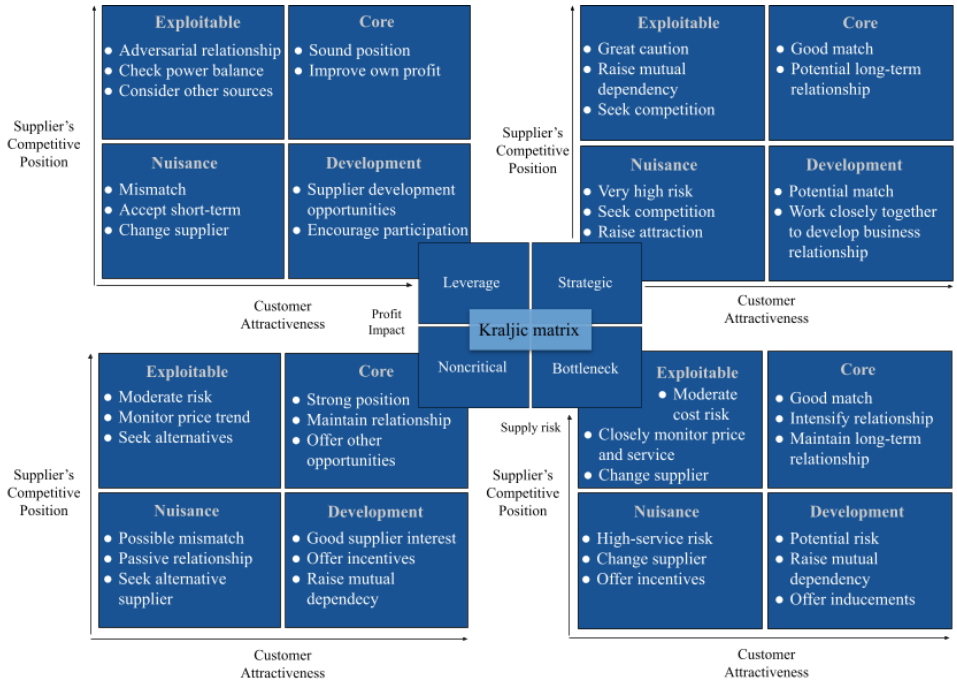

Figure 10: Dutch windmill: analyzing buyer-supplier interdependence. (Van Weele 2018, p.182)

Core segment indicates a good match between buyer and supplier and is suitable for long-term,

close suppler customer relations. In the case of a balanced relationship, both parties are willing to invest time and money into the relationship, which can lead to joint efforts to improve the supply chain efficiency. Due to the importance of the customer, they are often served with a dedicated account manager and experiences efforts from the supplier to increase customer satisfaction.

Development segment indicates that the supplier has a weak position, since they need to compete for the buyers business with other suppliers. A common strategy is for the supplier to offer additional value to the customer to increase the perceived competitiveness. The supplier is often willing to invest more into this type of relationship to obtain more business from the relationship.

Exploitation segment indicates that the supplier has a dominant position. Customers need to rely on the supplier since there are no alternatives. This is common for spare parts and investment goods. The supplier's power allows them to charge a high price and decide the specifics of the governance mechanisms. The supplier's strategy is to benefit from its strong position.

Nuisance segment indicates that there is a low interdependence between the buyer and supplier, and is possibly a mismatch. The buyer can easily switch suppliers, has many alternatives at varying quality levels, and is as such unwilling to invest in the relationship. From the supplier's perspective, the buyer represents a small share of the customer base, and is therefore also unwilling to invest. This type of relationship is not suited for long-term relationships and it is often beneficial to change supplier for a more favorable condition.

3.3.2 The Three Stages of SRM

SRM can be divided into three main phases (Moeller, Fassnacht, and Klose 2006):

1. Watching the market
2. Maintaining the relationship
3. Dissolution

3.3.2.1 Watching the market

The main aspect of watching the market is observing potential suppliers who do not yet have a relationship with the business (Moeller, Fassnacht, and Klose 2006). The intention is to be in business with the suppliers who would provide the best match, as the current state should never be considered permanent. This involves evaluating current and potential suppliers, and acquiring new suppliers, in order to optimize the supply base. Optimization refers to dissolving the relationship with suppliers that do not meet the needs of the company and instead acquiring alternative suppliers which can better meet the needs.

The acquisition of a potential supplier is usually a costly task, so switching suppliers needs to surpass the financial disadvantages (Moeller, Fassnacht, and Klose 2006). Additionally, comparing currently employed suppliers with potential suppliers is a difficult task, as many complexities exist. This can be attributed to information asymmetry between the supplier and buyer, differences in the offering, non monetary gains such as cultural differences etc. Thus,

direct comparisons might not be feasible, and potential evaluations could include personal preferences of properties that are difficult to accurately evaluate, or exclude ”soft” aspects such as organizational flexibility, which could reduce the reliability of the comparison. However, the process of watching the market to facilitate the acquisition of a potential supplier is more important in some situations than others (Kraljic 1983). When the supply risk is high, it is of great importance to have strategies to minimize the impact, such as risk mitigation strategies or contingency planning, as the impact could be severe. For strategic items/suppliers and bottleneck items/suppliers, being knowledgeable about the market and having replacement suppliers quickly in the case of unexpected events could be cheaper than initiating a search for a new supplier after the supply has been halted.

3.3.2.2 Maintaining the relationship

When a supplier has been selected, they enter the first stages of a relationship with the buyer. Moeller, Fassnacht, and Klose (2006) describes the four steps of a relationship with a supplier:

1. Set-up management
2. Development management
3. Contract management
4. Disturbance management

Set-up management occurs in the beginning of a relationship and entails eventual investments and processes that set the stage for the duration of the relationship. Investments can be a valuable and necessary part of an early relationship and can be specific or non-specific. Because of costs involved, companies should not build relationships with all suppliers (Halinen and Tähtinen 2002). Rather, the type and magnitude of investments should be guided by prioritization, a natural consequence of the segmentation progress. The categorization of suppliers allows the appropriate amount of resources to be allocated to ensure that the set-up management is aligned with the importance of the supplier (Gordon 2008).

Specific investments include setting up and developing social competencies, organizational conditions, trust and commitment. They can be variously intense, and great care should be taken to invest when a relationship is aimed to be close and cooperative, as otherwise the investment could be lost or suffer too low of a return. The aim of specific investments is to enhance joint value creation, economic performance and competitive advantage, and should involve the supplier and buyer firm as a safeguarding measure. Should a close relationship be desired, it should be characterized by exchanging information, allowing increased flexibility in activities from partners and at the highest level, blurring the boundaries of partners organizational boundaries.

Nonspecific investments are more likely to occur within arms-length relationships, which are relationships characterized by discrete transactions, minimal information exchange and low interdependence (Goilicic, Foggin, and Mentzer 2003; Moeller, Fassnacht, and Klose 2006). These types of relationships are incapable of realizing competitive advantages because nonspecific, standardized investments are either readily available to all competing firms or provide a value approximately equal to the cost of acquiring (Dyer and Singh 1998). Hence, specific supplier investment is a necessity for a strategic partnership.

After some time of socialization, the level of mutual trust can increase (especially in closer relationships), reducing control since the parties can act as if the future is more certain. The trust and associated commitment can be seen as a prerequisite for sharing ideas, information and clarifying the common goals and problems, i.e building and developing a longer term co-operative relationship.

Development management and *contract management* are two different strategies of maintaining and/or developing a relation with a supplier, and are dependent on the dynamics of the dyad. More specifically, the strategic importance and relationship contribution from the buyer perspective determine what strategy is most fruitful to achieve the goals of the relationship. Development management refers to identifying and evaluating problems or improvement areas and undertaking activities in union with the supplier to improve upon the situation and is more common for strategically important suppliers. Development activities are an especially useful tool with strategic suppliers because the suppliers can contribute to increased value and the buyers can engage in activities which facilitate the advancement of the supplier, which in turn creates a future tendency of development. On the other hand, contract management refers to managing through contractual agreements, which is more suitable for suppliers with less strategic importance, low specific investments and output-oriented tasks.

Disturbance management is the intentional efforts of a buyer to avoid breakdowns as a consequence of conflicts with a supplier. Conflicts may emerge regarding demand, price, relational frustrations, policy or ability constraints, time pressure or more (Moeller, Fassnacht, and Klose 2006; Newell and Ellegaard 2022). Moeller, Fassnacht, and Klose 2006 presents that 80% of disturbances are attributed to demand, such as sudden changes in demand quantity. However, not all conflict has negative consequences, and the outcome is largely dependent on how the disturbance is managed. Newell (2022) presents that conflict management can be functional or dysfunctional. Functional conflict management is a process where parties communicate and negotiate on different viewpoints of a disagreement for the purpose of improving the relationship. Conflicts handled functionally can stimulate inter-organizational knowledge sharing, inspire creativity and strengthen the relationship. Dysfunctional conflict management involves interpersonal disputes, one-way communication and hinders the decision making ability of the parties. Dysfunctional conflict management may hinder the parties from resolving the conflict, and may push either party towards choosing to end the relationship. Alternatively, the buyer might source from multiple suppliers to lower the dependence. This may very well harm the relation by lowering the trust and commitment, and signal a potential dissolution of the relationship.

3.3.2.3 Dissolution

There are three possible endings to a continuous business relationship: chosen, forced or natural (Halinen and Tähtinen 2002) (1) A chosen ending, in which one party makes the decision to purposefully end the relationship, (2) a forced ending, in which external circumstances cause the relationship to end, such as a bankruptcy, or (3) a natural ending, in which the need for business exchange has become obsolete (Moeller, Fassnacht, and Klose 2006).

There are several factors that can influence the ending of a relationship, and Halinen and Tähtinen (2002) divide these into three groups: Predisposing factors, precipitating events and

attenuating factors & events. Within these factors, there are task-related, actor-related, dyad-related and network-related aspects which influence the relationship. Predisposing factors are underlying and relatively static conditions that exist when companies enter a relationship. These may be task-related, such as providing a complex and abstract service; actor-related, such as poor company performance; dyad-related, such as conflicting goals; or network-related, such as the availability of several alternative partners. Precipitating events are occurrences that introduce change into a relationship and may trigger conflict or relationship breakdown. These events may be task-related, such as a failure to complete tasks according to specifications; actor-related, such as changes in personnel or bankruptcy; dyad-related, such as performance failures or unmet expectations; or network-related, such as a competitor making an attractive offer to one of the parties, potentially triggering a break-up. Attenuating factors & events have an important influence on the ending process, as they moderate the effect of predisposing factors and precipitating events. If the attenuating factors are high, managers are more likely to continue a relationship, rather than terminate it. Factors such as favorable company characteristics, relationship strength and quality, relational infrastructure, trust, commitment, personal relationships or strong resource ties may all act as attenuating factors, increasing the barriers of exiting the relation. Some attenuating factors, such as a lack of alternative partners or high switching costs, can cause the relationship to remain even when not preferred.

3.3.3 Governance Mechanisms

Broadly, governance refers to an institutionalized decision-making process among many independent actors (Ahlqvist, Norrman, and Jahre 2020). Governance itself is a higher level construct, which in the scope of SCM can be seen as structures that ensure that decisions are made for the long term, aimed at increasing collaboration, cooperation and sustainable value generating activities while reducing the threat of opportunism, risk and strategic misalignment (Pilbeam, Alvarez, and Wilson 2012; Ahlqvist, Norrman, and Jahre 2020; Norrman and Eriksson Ahre 2024). The operationalized tools of governance are referred to as governance mechanisms. These are the underlying, concrete instruments which describe in detail how the required behaviors will be motivated (Ahlqvist, Norrman, and Jahre 2020). In the context of inter-organizational relationships, such as those with suppliers, two common divisions of governance mechanisms are often studied: formal and informal governance mechanisms (Poppo and Zenger 2002).

Formal governance mechanisms generally include depersonalized exchanges, a reliance on financial parameters and formal contracts (Ahlqvist, Norrman, and Jahre 2020). They are e.g business plans, service level agreements, performance requirements, monitoring and reporting specifications, penalties for noncompliance etc. The more specific the promises, obligations, process descriptions and requirements are, the more complex the associated contract will be, and the higher the cost of governance will be (Poppo and Zenger 2002). New relationships tend to be governed more formally through contracts to achieve control over tangible exchanges, such as the supply of a physical product (Pilbeam, Alvarez, and Wilson 2012). The bargaining power of the companies undertaking formal governance mechanisms comes into play, as the more powerful entity in the relation holds the bargaining power over the specifics in the contract. Formal contracts can be a great tool in risky situations to narrow the domain of risk, but power dynamics can influence who holds the final control in determining the bearer of the risk (Poppo and Zenger 2002; Pilbeam, Alvarez, and Wilson 2012). As such, formal governance mechanisms are great at clearly specifying the demands of each party, allowing for negotiation

instead of conflict, but can be a double edged sword since the more powerful party can determine the demands.

Informal governance mechanisms (also referred to relational governance) on the other hand, generally include repeated interpersonal social exchanges that promotes norms of flexibility, solidarity, information sharing, trust and cooperation (Ahlqvist, Norrman, and Jahre 2020; Poppo and Zenger 2002). This could be through e.g establishing teams, task forces or committees; managerial contact through meetings or trips and mechanisms for shared decision making. As both parties commit to such norms, a mutual problem solving approach and cooperation becomes the natural resulting behavior. Poppo and Zenger (2002) suggest that relational governance promotes long-term cooperation and assumptions that short term inequalities will balance out in the future, which encourages cooperation in the short term. This means that the expectation of the long term relationship fosters short term flexibility, which is especially useful to counter potential hazards. However, the development and maintenance of relational governance required for continued trust and commitment is resource intensive. Informal governance mechanisms can as such be a useful tool to increase trust, cooperation and flexibility between parties. However, the large associated resource requirements of developing and maintaining the relationship demands a relationship where a long duration is wanted and when flexibility in the short term is seen as a competitive advantage.

3.4 Application of Theory

The theoretical perspectives provide a solid foundation for analyzing dependence-related aspects of risk and relationship management to achieve a resilient supply chain. However, in order to apply these perspectives more systematically within the thesis, this section will summarize the theoretical aspects based on the research questions. As outlined in section 2.2.2, one objective of the theoretical chapter was to answer the first part of the modified research questions: *"What dependence-related financial and operational mechanisms create supplier vulnerability and supply disruption risk for suppliers of critical equipment and service?"* and *"Which supply risk mitigation strategies are feasible and effective for managing vulnerable suppliers"*. By applying the theoretical concepts in a structured manner, this enables a clear identification of key findings from a dependence perspective. It also serves to delimit the following chapters on empirical findings and analysis by establishing a relevant and focused analytical framework.

3.4.1 Theoretical Application to RQ1

Among the theoretical concepts studied in chapter 3, several have the possibility of impacting supplier vulnerability. This section aims to compile the findings in order to answer the first modified research question, relating to which mechanisms cause supplier vulnerability and supply disruption risk.

Supplier vulnerability has been defined as structural and relational conditions that increase susceptibility to supplier-side production discontinuation and amplify the resulting operational and service consequences (Wagner and Bode 2006). Insights from supplier relationship management state that a continuous business relationship can end in three ways: chosen, forced or natural. Of these, a chosen or a forced ending are of particular interest, as these could result in abrupt, unforeseen supply disruptions with financial or operational consequences. A

central mechanism and the root of supplier vulnerability has been identified as power asymmetries. The constraints and power differentials are central to understanding supplier vulnerability (Weele 2018; Kraljic 1983). The key concepts driving the supplier vulnerability in this case is the knowledge/asset concentration and bargaining power and is well portrayed by the Dutch windmill.

Several factors further intensify supplier vulnerability. Some predisposing factors well understood to increase the risk are task-related, such as providing a complex and abstract service, actor-related, such as poor company/product performance, dyad-related, such as conflicting goals (Halinen and Tähtinen 2002). High switching barriers can act as an attenuating factor and limit flexibility, forcing a relationship with an actor due to lack of alternatives or high switching costs, which on its own can act as a contributor to supplier vulnerability(Pfeffer and Salancik 2003; Hillman, Withers, and Collins 2009). Other factors, such as low volume, irregular purchasing paired with uncertainty reduce the buyer's attractiveness as a core customer (Pazirandeh 2014; Weele 2018). Depending on the buyer's share of the supplier's revenue, this could decrease the financial stability the supplier experiences and increase the perceived risk associated with the buyer, especially in cases with prolonged duration of decreased and irregular purchasing. Several other predisposing factors exist which can further intensify supplier vulnerability, such as misaligned supplier selection relative to strategic segmentation, conflicting internal objectives and ineffective governance mechanisms, such as inadequate contractual specifications or misalignment between governance structures and relational goals. Precipitating events, especially repeated events with dysfunctional disturbance management can gradually erode the relationship and eventually lead to supply disruptions or a relationship dissolution (Halinen and Tähtinen 2002).

3.4.2 Theoretical Application to RQ2

The second research question addresses which supply risk mitigation strategies are appropriate for managing vulnerable suppliers under conditions of structural dependence. Based on the theoretical perspectives developed in this chapter, such strategies can be evaluated along two complementary dimensions: feasibility, referring to whether a strategy can be implemented given technical, commercial and relational constraints, and effectiveness, referring to its potential to reduce supply risk and/or improve resilience by lowering the likelihood or impact of disruption (Jüttner 2005; Christopher and Peck 2004; Gelderman and Van Weele 2003).

This evaluation logic combines insights from Supply Chain Risk Management (SCRM) and Resource Dependence Theory (RDT). While SCRM frames mitigation in terms of reducing risk exposure, RDT adds a relational perspective by explaining how the range of viable mitigation responses is conditioned by dependence structures and power asymmetries (Pfeffer and Salancik 2003). Mitigation cannot be evaluated solely by theoretical risk-reduction potential but also in relation to whether a strategy is actionable (Gelderman and Van Weele 2003). In highly dependent relationships, this often increases the relevance of strategies aimed at governing and stabilizing the existing supplier relationship, while more structural responses may be difficult to realize in the short term (Sheffi and Rice 2005; Ponomarov and Holcomb 2009; Poppo and Zenger 2002).

Table 3 translates these constraints into concrete strategic options by outlining dependency-management strategies available to less powerful buyers. In line with this, mitigation strategies

can be understood along two main dimensions: managing dependence and reducing dependence. Strategies aimed at managing dependence are generally more feasible, as they operate within existing constraints and focus on maintaining continuity. In contrast, strategies aimed at reducing dependence address the underlying sources of vulnerability but are often constrained by technical, economic, and temporal barriers.

In addition to these two dependence-oriented logics, some mitigation measures primarily function as continuity buffers, preserving operations in the short term when dependence cannot yet be reduced or fully governed.

Accordingly, the effectiveness of mitigation strategies cannot be assessed independently of their feasibility. In the short term, managing dependence is typically the dominant approach, while long-term risk reduction requires a gradual shift towards reducing dependence. This distinction provides the theoretical basis for evaluating mitigation strategies in contexts characterized by vulnerable suppliers and asymmetric dependence.

3.4.3 Analytical Framework

Figure 11 summarizes the theoretical synthesis guiding the empirical findings and analysis. It links dependence-related vulnerability mechanisms (RQ1) to the three mitigation logics used to evaluate feasible responses (RQ2). Together, these concepts provide the analytical basis for developing the governance framework in RQ3.

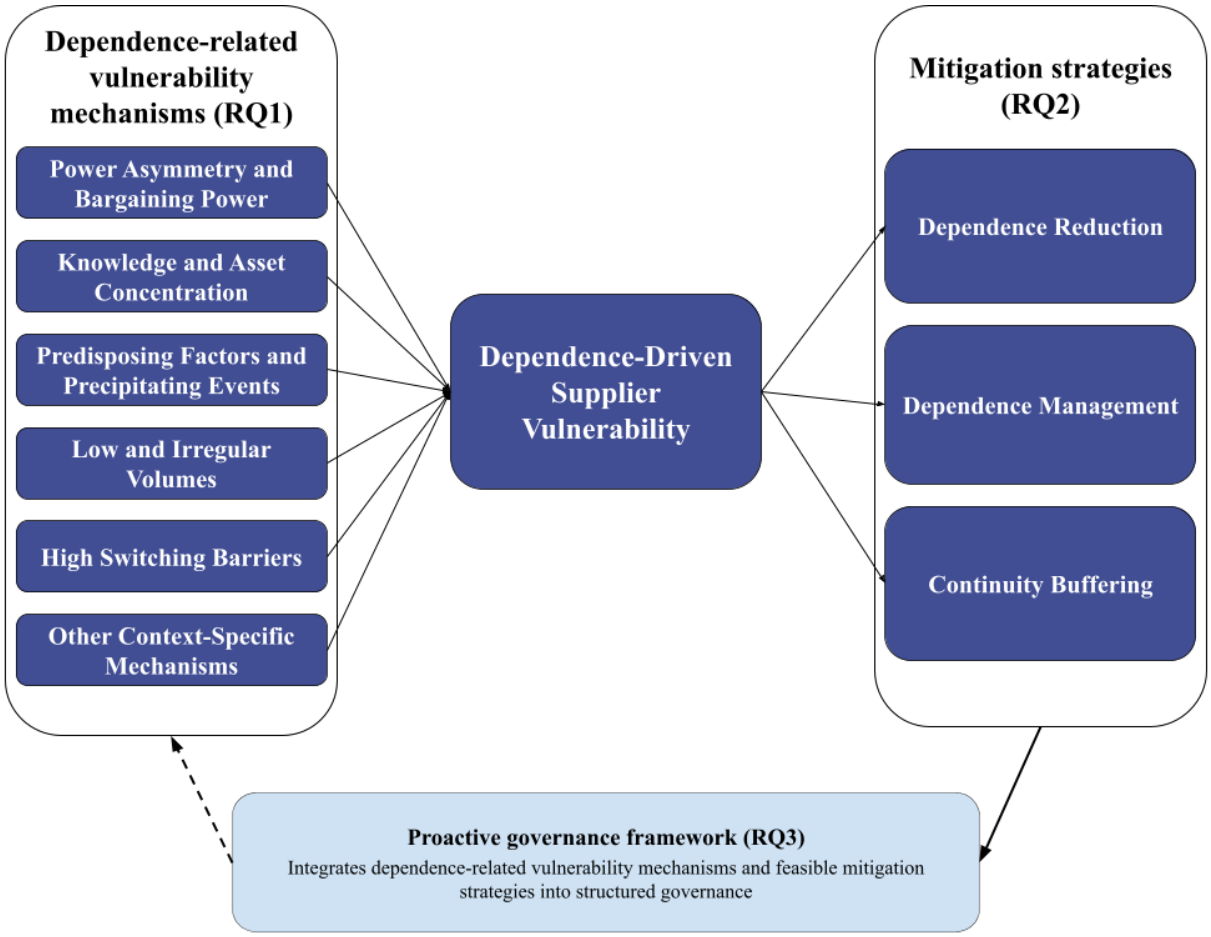

Figure 11: The analytical framework, showing the relationship between vulnerability mechanisms (RQ1), mitigation strategies (RQ2), and the development of a governance framework (RQ3). (Source: Authors)

4 Empirical Findings

This section describes the findings from the data gathered through interviews and documentation. The processes of determining the need, selecting suppliers, supplier relationship management, risk management and contractual aspects are described, to form a picture of what these processes look like today.

4.1 Current State

This section aims to explain in a general sense how the supplier-related processes occur at Tetra Pak within the converting equipment team. The main idea is to show how people define what is needed, how suppliers get chosen, how relationships are kept alive, and how risks are managed. It will also reflect how these processes are arranged and how different departments interact with each other when dealing with suppliers.

4.1.1 Determining the Need for new Equipment

The need for a new solution stems in most cases from the operational or technical departments, who often were refereed to by interviewees as ”the business”. These are the teams and people involved with day to day operations and middle level managers responsible for technical solutions. The need can also be initiated from top management, driving a need through strategic capacity planning. At times, the need can come from other teams, such as the obsolescence team in case of an informed obsolescence of a component or system, or from category managers who decide the needs for their categories.

4.1.2 Supplier Selection

Supplier selection is a joint effort between engineers, who design and develop solutions, and the supplier management team. Tetra Pak has a long history of solutions, and consequently suppliers, being driven by technical teams, who often decide on a solution primarily based on the best technical capabilities and performance available on the market. Engineers often take the lead in setting the specifications and deciding what kind of solution to proceed with. These specifications can get very detailed, down to the material properties of individual components, types of screws used and properties of components. As one senior supplier manager states: ”They want to use a silver bullet to shoot a sparrow”. This has historically led Tetra Pak to choose specialized, niche suppliers, capable of manufacturing the highest quality component, at the cost of increased supply risks. A supplier manager talks about instances where single person firms have been employed due to the specific technical performance and niche.

However, in the past 15 years, great progress has been made in allowing supplier management to play a larger role in the supplier selection process earlier, and today supplier management is involved from the start. As such, the supplier management team supports by qualifying and ranking suppliers on aspects covering many different perspectives and giving advice about sourcing. However, supplier management still has gripes regarding technical specifications, conveying that technical specifications are too detailed, focusing on input criteria regarding specifics of the solution, rather than the needed outcome the solution can offer, which limits them in the choice of supplier. Supplier management also has a responsibility to evaluate potential suppliers and create a list of preferred suppliers based on certain criteria, which include financial stability, maturity, company size, years of operation, compliance with ISO standards and sustainability rules etc.

The size of Tetra Pak and the profit impact of down time in the operations have played important roles in supplier selection, and more specifically the criteria which supplier management value for the converting equipment suppliers. The interviewees explain that any supplier of service should preferably be able to deliver this service globally, to minimize the supply base while delivering predictable, reliable service quality. In an internal document detailing the criteria to enable ranking of suppliers it can be seen that if it is a ”Professional Services supplier”, a co-employment risk assessment must be performed, and if the risk is ”MEDIUM” or ”HIGH”, a mitigation plan needs to be presented and approved by appropriate managers. As well as this, there are internal rules regarding supplier selection, such as avoiding suppliers with less than 10 employees, and not making up more than 40 percent of a supplier's total revenue.

4.1.3 Supplier Relationship Management

The suppliers of converting equipment at Tetra Pak provide industrial manufacturing equipment to the factories owned by Tetra Pak. Due to previous sourcing decisions led by engineers choosing niche, high performance solutions, the number of alternative suppliers capable of delivering solutions with similar performance are few. The supplier management team has been working with standardizing equipment and as such, has a narrow supply base with a concentrated spend on the employed suppliers. The demand for equipment for converting factories arises during expansion, such as building new factories, upgrading existing facilities or replacing broken equipment.

The first part of supplier relationship management, *watching the market*, is done conservatively. Throughout the years of business, Tetra Pak has built a list of preferred suppliers. With a long experience of conducting business with many suppliers, this list is a strength for Tetra Pak which aids in the *watching the market* phase. The cost of constantly looking for replacements or alternatives to the current supplier portfolio is too high and is not considered valuable enough to be a routine operation. Rather, Tetra Pak relies on the preferred suppliers and scout the market in the case of an actual business need which cannot be fulfilled by a preferred supplier.

The second part of supplier relationship management, *maintaining the relationship*, is managed in a number of ways at Tetra Pak. The way relationships are manged heavily depends on the strategic importance of a supplier. For the most strategic suppliers, quarterly meetings are held to go through service, potential issues or disturbances, development projects, machine improvements etc. A supplier manager describes this process as a good way to find new technical

solutions, improve upon problems and to foster great cooperation with the suppliers. With these strategic suppliers, there are also top management meetings, with a more long term strategic agenda. For less strategic suppliers, communication is described by several interviewees as ad hoc, difficult and poor due to the lack of time and importance.

Contract management matters greatly in determining and underlying the principles of how communication of the most important matters must be undertaken. Tetra Pak obliges suppliers, through contracts, to share obsolescence information at least 12 months in advance, but preferably 24 months in advance. One senior supplier manager explains that the contracts can be over 100 pages long, and potential changes or additions are difficult to enforce due to the extensive nature of the contract. The disturbance management and dissolution aspect of supplier relationship management will be presented more in depth for each supplier separately in section 4.2.1 and 4.2.2 respectively.

4.1.4 Risk Management

Tetra Pak works extensively with risk management, both on a proactive and reactive level. Proactively, Tetra Pak has several risk management systems, allowing for rapid and accurate risk identification, assessment and monitoring. The most prominent risk management system is capable of monitoring a large range of factors such as operational risks due to weather conditions, geopolitical issues, late deliveries, sustainability issues and financial issues such as late payments, business continuity risks, strikes etc. The system tracks risks in real-time and sends alerts the responsible supplier manager immediately in the case of an identified risk. This allows for near instant identification of risks. Additionally, the system complies the risks in a risk matrix and assigns each risk with a risk score, automating risk assessment and shortens the lead time from event to potential action by the supplier manager. Additional systems are used to more extensively track financial health and perform credit checks, providing extensive reports with relevant information.

On a high level, Tetra Laval, the owner of Tetra Pak has created a 50-page risk management protocol, referred to as the ”risk bible” by the risk and compliance officer. It details processes and procedures for the complete risk management process, including the process for implementing mitigation actions for identified risk. Identified risks are graded on a scale of 1-4, depending on the potential implications for Tetra Laval. In the case of an identified risk, with an intensity score of 2 or higher on a 4-level scale, a business continuity plan (BCP) must be developed, detailing a plan to mitigate the risks of business continuity from internal/external influences. The supplier manager develops this plan in accordance with the relevant factories and affected personnel, stating the worst case scenario and possible mitigation strategies. The interviewees state that an issue with this approach is the difficulty of translating a risk on a factory-level to a high level and accurately grading risks based on company impact. The complete production stop of one factory might be minimal in contrast with the total revenue figures, but severe for the factory. In the case of Supplier B, alerts have been raised that consequences could involve extended periods of complete production stop, but the difficulty of translating that into the bottom line for Tetra Laval has increased the difficulty of attaining resources for the risk management process.

A limitation identified with the risk management process is that the financial systems include extensive historical data, which reduces their sensitivity to sudden and significant changes in

risk. Additionally, the systems the lack of capability to monitor key personnel at suppliers, which is critical for the converting equipment department to ensure the retention of essential knowledge.

4.2 Mechanisms of Supplier Vulnerability and Supply Risks

This section presents the empirical findings on the mechanisms of supplier vulnerabilities and supply risks Tetra Pak experiences in the relations with Supplier A and B. Initially, an overview of the historical relation of the supplier is presented, including a description of the current situation. This is followed by information about the supplier, their offer and the properties of the dynamics in the relationship with Tetra Pak, including purchasing patterns and dependence. Then, based on the dependence-related vulnerability mechanisms found in the analytical framework, the indicators found in the interviews for each mechanism is presented. The aim is to exhaustively present the current situation and the background for the cases to allow an informed analysis.

4.2.1 Supplier A

4.2.1.1 Introduction to situation

The product relevant to this case originally came from a supplier other than Supplier A, a small motor manufacturing company. The relation with this supplier was initiated approximately 15 years ago to replace a prior solution. 12 years ago, the first industrial motor from this supplier was installed, and there are currently 59 installed and 11 on stock for breakdowns or major refurbishments. Approximately 10 years ago, the small motor manufacturer was acquired by Supplier A, a much larger company than Tetra Pak. From Tetra Pak's perspective, the acquisition was viewed positively, as the larger firm was perceived to entail lower risk due to its stronger financial resources.

In line with the reduced expansion of new factories and the resulting decline in demand for converting equipment, Tetra Pak has encountered increasing challenges with the supplier regarding communication and cooperation, which is discussed below. Recently, Supplier A announced the discontinuation of the motor with a final order date six months ahead of the announcement, with a 12 month lead time and an additional 12 months of service support. The announcement was sudden without clear indication from the supplier in advance, leaving Tetra Pak without a clear replacement or contingency plan. According to the supplier manager, the decision to discontinue the product was driven by its misalignment with Supplier A's core business, as well as the time, cost, and complexity involved in its production. However, the precise reasons for the termination of the relationship cannot be established with certainty.

4.2.1.2 Supplier and solution specifics

Supplier A is a large industrial manufacturing company with a broad product portfolio, primarily within motion and control technologies. The division responsible for the motor supplied to Tetra Pak produces an industrial motor, priced at approximately 1 million SEK per unit, which has been modified for Tetra Pak's application in converting equipment at its factories. Compared to the previous solution, the motor offers higher energy efficiency, improved reliability,

greater operating speed and superior overall performance, and is considered technologically unmatched compared to current market alternatives. These motors are critical for the production of laminated packaging material, a large part of Tetra Paks offering, with a supplier manager describing the situation as follows: ”Factories ... cannot run without those motors” Due to the size of Supplier A, Tetra Pak makes up a marginal share of their revenue, accounting for less than 1%.

In addition to purchasing new motors, Tetra Pak purchases refurbishment and regular maintenance services from Supplier A. Refurbishment involves replacing an installed motor for a stocked unit, transporting the used motor to the manufacturer's facility for repair and subsequently returning and reinstalling it at the factory. The cost of refurbishment amounts to approximately 50% of a new motor, but is returned in a condition comparable to new. According to the supplier manager, the supplier has shown reluctance to provide refurbishment services due to the low profit margin involved with this offering. The spend on new motors and services is estimated to be roughly 80% vs. 20%, respectively. Over the past 10 years, the spend has been as follows:

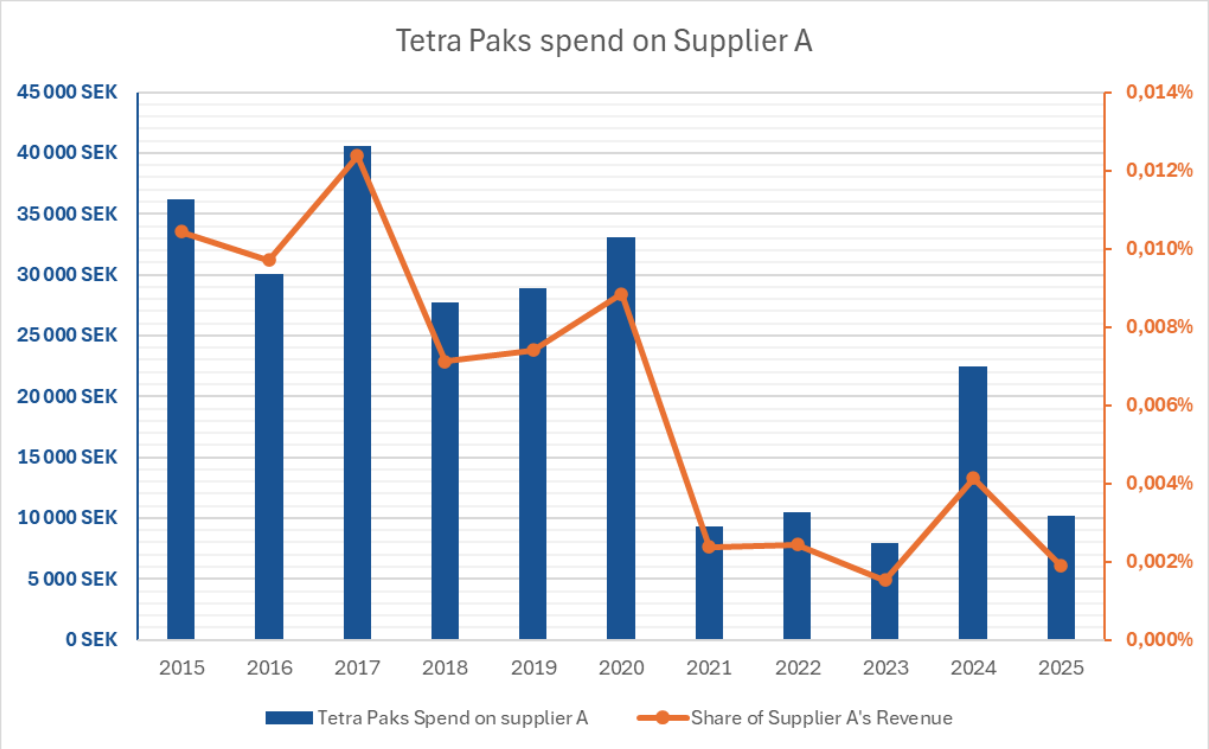

Figure 12: Tetra Paks spend on Supplier A, including the share of the suppliers revenue this constitutes (Numbers have been adjusted to maintain confidentiality while keeping relationships intact) (Source: Internal documentation and Supplier A's annual reports)

4.2.1.3 Dependence-related vulnerability mechanisms

Power Asymmetry and Bargaining Power

Prior to the acquisition, Tetra Pak accounted for a larger share of the supplier's revenue, and perceived the relationship as more favorable. Given the small size of the supplier, Tetra Pak could communicate directly with the factory and had no issues with maintenance or refurbishment.

Following the acquisition, communication had to go through a central service department, resulting in longer response times. As one supplier manager noted, this shift created a sense of reduced importance to the supplier. With Tetra Pak representing less than 0.01% of the revenue, its bargaining power was very limited, causing an increased power asymmetry in the relationship.

Knowledge and Asset Concentration

The asset concentration at Supplier A is currently high, since all products and services are provided by them. No alternative solutions are currently available that can replace the installed motors, and the cumulative investment in installed and stocked units is substantial, amounting to approximately 70 million SEK. Technical knowledge is also largely concentrated at Supplier A, given its role in providing maintenance and repair services. However, a significant portion of these services could, in principle, be outsourced to external motor maintenance providers and specialized engineers. A key constraint identified by interviewees is that the equipment has been modified for Tetra Pak's operations, and certain spare parts are exclusively available through Supplier A. As a result, outsourcing would require either the continued production of spare parts by Supplier A or its cooperation in providing blueprints and technical specifications, enabling third-party manufacturing.

Predisposing Factors and Precipitating Events

The initial relationship with the motor supplier showed no evident predisposing factors indicating potential relational issues. However, the acquisition of the smaller supplier by Supplier A altered the underlying conditions of the relationship, creating a fundamentally different context. New predisposing factors emerged as a result. From an actor-related perspective, the larger size of Supplier A implied greater financial stability and potential benefits such as global reach and an expanded service network. At the same time, the motor, previously a core product for the original supplier, became a minor component within Supplier A's broader portfolio. From a task-related perspective, misalignment in communication and operational priorities became evident. Due to the modification of the motor, Tetra Pak required close interaction and rapid service, as Supplier A retained exclusive technical knowledge. However, communication shifted to a more distant, formalized structure, limiting responsiveness. From a dyad-related perspective, the acquisition introduced a pronounced power imbalance and conflicting relational expectations, with Tetra Pak seeking close collaboration while Supplier A adopted a more arm's-length approach.

In addition to predisposing factors, there were several precipitating events before the dissolution of the relationship. From an actor-related perspective, Supplier A exhibited notable behavioral changes following the acquisition. According to the supplier manager, Tetra Pak was required to cease direct communication with the manufacturing facility and instead engage exclusively through a centralized service function. Efforts to schedule meetings concerning future maintenance needs and planning were repeatedly delayed, with one instance resulting in a meeting being scheduled a full year later than initially intended. The supplier was also reluctant to perform maintenance and wanted to limit contact with Tetra Pak to instances involving the purchase of new equipment. From a dyad-related perspective, the relationship was characterized by repeated communication failures and difficulties in cooperation. Rather than a two-sided disturbance management process, Supplier A changed the conditions for how the businesses interacted and did not show proclivity towards cooperation to find a joint solution.

Low and Irregular Volumes

With the background of reduced expansion of new factories, the demand structure for manufacturing equipment, including the motor purchased from Supplier A, has changed. Prior to 2020, around 10-15 motors were purchased each year and in total, 70 motors where purchased between 2014-2020. In contrast, only five motors have been purchased over the past three years, prior to the discontinuation announcement. The impact on spend on Supplier A, as seen in Figure 12, is evident and clearly illustrates the shift in the trend after 2020. The need of new motors primarily arises in the case of expansion, to replace broken motors or to upgrade older solutions. These events do not occur regularly and are therefore not forecasted, but rather depend on strategic investment plans and budget allocations.

High Switching Barriers

Several barriers have been identified that would limit the possibility of switching suppliers or adopting alternative solutions. First, the product is described as unique and niche with performance exceeding any direct substitutes on the market. As one process manager stated ”there is no other supplier with a motor in the size we need”. One potential alternative discussed in the an interview was to develop a motor with a similar performance with an alternative high end motor supplier. However, both the process manager and system integration manager emphasize that this would require substantial time and investment, with development cycles potentially extending several years before a viable solution could be operational. They also note that there are more standardized motors available on the market that could, in principle, be adapted to Tetra Paks production with modification. However, such alternatives would require significant integration efforts and would result in lower performance than the current solution.

Another aspect increasing the barriers to switching suppliers is the high cost associated with changing the current setup. The current installed base of 59 motors, plus the 11 motors on stock, represents a substantial sunk investment into equipment. Transitioning to an alternative supplier would require access to blueprints and technical specifications for spare parts from Supplier A to maintain ongoing repair and maintenance activities. If Supplier A were to discontinue the production of spare parts or refuse to provide the necessary technical documentation, motors could be forced out of operation before reaching their end-of-life, resulting in a large investment loss. The process manager noted that reverting to the previous solution is a potential fallback option, however this would involve lower energy efficiency, reduced reliability, and slower performance. It would also introduce costs related to lost production efficiency, increased downtime, and additional investment in replacement equipment.

4.2.2 Supplier B

4.2.2.1 Introduction to situation

Supplier B, a manufacturer of complete printing lines, has long been a strategic supplier for Tetra Pak. The machines supplied have been co-developed with the supplier, resulting in highly customized and specialized machines for Tetra Paks operations. Due to the reduced expansion of new factories, both the demand for new printing machines and the spend on Supplier B have declined sharply. The supplier was acquired by a private equity fund in 2017, but has not generated a profit since the acquisition (Source: Suppliers annual reports). In recent years, Tetra Pak’s risk management systems have repeatedly issued alerts that the supplier is at risk

of bankruptcy due to its financial position. This has been mitigated through continued financial support from the private equity owner, however interviewees describe uncertainty regarding how long such injections of capital can sustain Supplier B. Given the high degree of customization of the equipment, finding alternative suppliers for spare parts, maintenance or repair is very difficult, and a complete replacement of the installed base would involve very high costs.

4.2.2.2 Supplier and solution specifics

Supplier B is a manufacturer of specialized and customized printing machines, offering the complete machine line required for printing operations, priced at around 20 MSEK. In the 1970s, Tetra Pak designed, engineered and built their own line of printing machines, however, following a strategic decision to focus on core business activities, it was decided that the printing machines should be outsourced to a supplier. The relationship with Supplier B began in the 1980s, when technical specifications of Tetra Paks machine was transferred to Supplier B, who was instructed to manufacture it based on Tetra Paks design. While Supplier B assumed ownership of the solution, new initiatives and continuous improvements were still primarily driven by Tetra Pak. Tetra Pak led innovation for the printing lines and invested heavily into development initiatives. Over time, Supplier B became a strategic partner, representing a substantial share of the spend and providing high quality printing equipment with excellent performance.

The printing lines from Supplier B are, according to the responsible supplier manager for Supplier B, very important for Tetra Pak, as ”without it, we could not have any prints on the packaging”. The process manager noted that the equipment is critical and that ”If we don’t print, we don’t sell packages”, signifying that the current production hinges on the fact that Supplier B can continue supplying machines, spare parts and services. There are currently around 50 printing lines from Supplier B installed, comprising between 95-99% of the installed base for printing equipment.

In addition to purchasing machines, Tetra Pak also purchases regular maintenance and repairs. The spend on Supplier B does not have a forecast, as the primary need is driven by expansion, which is governed by company strategy and large investment decisions. During years with a larger spend, Tetra Pak makes up approximately a third of the company’s revenue, but in recent years the share has been reduced to around 10%. Over the past 10 years, the spend has been as follows:
In line with the decreased expansion of new factories, the demand for new printing lines and associated equipment has declined. Prior to 2020, approximately one machine was purchased annually. However, since 2020 only one machine has been purchased (in 2022). During the same period, Tetra Paks risk management systems have indicated a deterioration in Supplier B’s financial performance. One system reports a business continuity risk score of 80 on a scale of 0-100, indicating a high risk of insolvency and disruption to supply continuity. Another system assessing financial health on a scale of 0-100 consistently ranks Supplier B at low levels, and has most recently ranked Supplier B at a score of 16 out of 100, indicating very poor financial health and a very high risk of insolvency

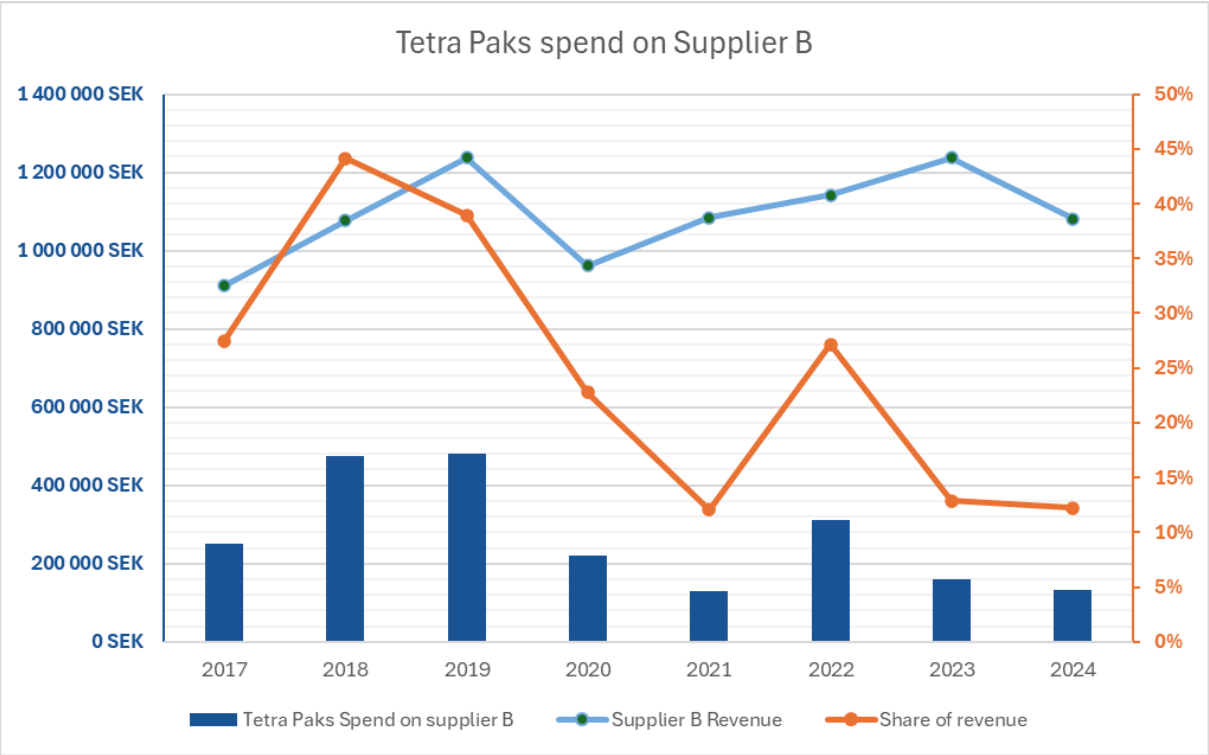

Figure 13: Tetra Paks spend on Supplier B, including the share of the suppliers revenue this constitutes (Numbers have been adjusted to maintain confidentiality while keeping relationships intact) (Source: Internal documentation and Supplier B's annual reports)

4.2.2.3 Dependence-related vulnerability mechanisms

Power Asymmetry and Bargaining Power

The relationship between Tetra Pak and Supplier B exhibits a degree of interdependence, however the bargaining power is skewed in favor of Supplier B. The high degree of customization effectively locks Tetra Pak into the supplier, as no other manufacturer is currently able to produce spare parts or provide maintenance and repair services for the equipment. The intellectual property rights, including blueprints and technical documentation required for manufacturing spare parts and servicing the equipment, are held by Supplier B. Although an escrow agreement is in place that would grant Tetra Pak access to this documentation in the event of Supplier B's bankruptcy, the completeness and usability of the materials are uncertain, and the ability to manufacture components based solely on this information is not guaranteed. As long as Supplier B remains operational, it retains significant bargaining power in the relationship with Tetra Pak.

Knowledge and Asset Concentration

Both knowledge and asset concentration are very high with Supplier B. The knowledge to manufacture spare parts or perform maintenance and repairs resides exclusively with Supplier B, and the customization prevents other suppliers from being able to perform these operations. From this perspective, knowledge is so concentrated that only a full replacement of the entire machine base would meaningfully reduce dependency. However, given the complexity and scale of the equipment, such a replacement would involve substantial costs and operational disruption. The asset concentration is likewise very high. The process manager noted that "Our installed base

is entirely theirs and our installed base is only available to Tetra Pak. So the product is unique for us and it's only built by them." At the same time, ongoing communication is taking place to assess which spare parts are critical and whether these could be sourced from alternative suppliers or upstream manufacturers within Supplier B's supply chain. In the case of bankruptcy, current stocks of spare parts could allow machines to run for a few months, before a complete production stop is inevitable.

Predisposing Factors and Precipitating Events

During the interviews, a few predisposing factors have been uncovered that later contributed to tension in the relationship. First, the complexities of ownership and the offering itself have created recurring issues. The supplier manager explains that the requirements communicated to Supplier B have been vague, which has led to issues in meeting Tetra Paks standards. The ambiguous allocation of responsibility for development and innovation has further strained the relationship. Although Tetra Pak has considered Supplier B a strategic supplier, they have not experienced innovation as could be expected from a strategic supplier. Interviewees note that Tetra Pak has frequently need to fund development activities in order to drive innovation, resulting in significant additional costs. In practice, Supplier B has been perceived as reactive rather than proactive, relying on Tetra Pak to define and initiate improvements. No clear precipitating events have been identified that would contribute to the dissolution of the relationship.

Low and Irregular Volumes

Since the primary need for new equipment from Supplier B stems from expansion, the demand is not immune to stagnation but rather prone to irregularity following company strategy. Prior to 2020, approximately one machine was purchased yearly, however, the lack of expansion has led to both less predictable and reduced demand. Maintenance requirements are comparatively more regular, however they represent a smaller share of total spend than the purchase of new equipment.

High Switching Barriers

Several significant switching barriers have been identified, however, the competitive landscape has shifted in favor of Tetra Pak in recent years. Since each installation costs 20 MSEK, replacing the whole installed base would require a very large investment. The financial barriers of switching suppliers are thus very high. An additional constraint is Supplier B's ownership of the intellectual property rights and technical documentation for the proprietary solution, which prevents the use of alternative suppliers for partial activities such as maintenance or repair. As a result, Tetra Pak remains effectively bound to Supplier B for this equipment, creating a strong structural switching barrier.

The supplier manager notes that many iterations of development activities and improvements has lead to the level of performance which has previously not been available on the market by any competitor. However, in the last 5-10 years, the market has evolved rapidly and there are currently eight or nine alternatives that could compete with the current solution. Tetra Pak is currently evaluating these alternatives and has identified two to three particularly attractive competitors that could potentially replace some or all of the offerings provided by Supplier B. In this context, the process manager comments that "we would almost improve our capabilities

in every way, with some exceptions, of course," indicating that switching barriers related to capability and performance have decreased significantly over the past decade.

4.3 Strategies for Managing Vulnerable Suppliers

This section presents the empirical findings related to mitigation practices used by Tetra Pak to manage supply risks associated with vulnerable suppliers. These findings include both long-term measures embedded in supplier relationships and actions initiated in response to emerging discontinuity threats, depending on where in the relationship or life cycle they are deployed. In line with the empirical purpose of this chapter, the section describes current mitigation practices and conditions affecting them, while evaluation of their theoretical suitability and analysis are reserved for chapter 5.

To provide clarity and structure, the identified strategies are organized in two layers. First, general mitigation practices applied across vulnerable supplier relationships are presented, reflecting proactive measures developed over time to prevent risk, reduce exposure and strengthen long-term continuity. Second, strategies that are tied more specifically to the analyzed cases are presented, including proactive practices linked to the individual supplier relationship and contingency-oriented responses triggered by elevated threats, such as financial instability, declining supplier performance, or the announced discontinuation of a component or service.

4.3.1 General Mitigation Practices Across Vulnerable Suppliers

Contractual and planning-related mechanisms contribute to mitigation. These provisions enable early planning and provide sufficient time to evaluate alternatives, which reduces the risk for unexpected discontinuity. Interviewees emphasized that the value of obsolescence notification provisions lies less in contractual protection itself than in enabling preparedness and response planning, while also noting that such clauses offer limited enforceability if suppliers fail to comply. As a result, contractual safeguards were described as dependent on complementary operational preparedness rather than sufficient as stand-alone protection.

A recurring preventive theme in the interviews concerns Tetra Pak's long-term effort to standardize equipment across its global operations. Interviewees described how the use of uniform technical solutions supports consistent product quality and performance across factories, simplifies maintenance, and supports efficient life-cycle management of the installed base. It was further described as facilitating the use of common spare parts and technical competence across factories, while reducing risks associated with fragmented technical solutions and supporting long-term supportability of equipment, with sourcing from a limited supplier base.

Proactive mitigation was also described as supported through broader governance and monitoring practices, including supplier risk monitoring processes discussed earlier in section 4.1.4, digital surveillance tools and cross-functional monitoring mechanisms. Interviewees described these practices as supporting visibility into supplier conditions, early identification of concerns and escalation when risks intensify. Periodic supplier evaluations were likewise described as complementing relationship-based monitoring through more formal oversight.

Lastly, another proactive practice that emerged was strong cross-functional coordination. Already from the initial phase of a business need, collaboration between supplier management,

engineering and sourcing functions allows supply risks to be addressed in conjunction with technical and commercial considerations.

4.3.2 Supplier A

4.3.2.1 Proactive Measures

A central long-term mitigation practice described by several interviewees concerns the refurbishment strategy used to extend the life of the installed motor base. Rather than depending solely on new production from the suppliers, spare motors are rotated through a refurbishment cycle in which removed motors are returned to service and overhauled to a state of a new motor. This refurbishment cycle was presented as an important mechanism for sustaining availability while reducing exposure to supply interruptions. Condition-based monitoring was described as supporting this strategy, with performance monitoring used to determine refurbishment timing and support more proactive life-cycle management.

Another proactive measure concerns supplier scouting aimed at identifying alternative suppliers and substitute technical solutions, which had been explored prior to the present discontinuity threat, although no fully qualified substitute had yet been implemented. These activities were described as precautionary efforts, intended to broaden awareness of potential alternatives and support future flexibility in sourcing.

4.3.2.2 Contingency-oriented measures

Following the supplier's decision to discontinue production and service support, mitigation activities shifted toward contingency-oriented responses.

One response has been inventory-related buffering. Spare motors serve as both operational backup and a means for continued production while longer-term alternatives are explored. Related stock-building alternatives were also discussed as part of ensuring continuity through a transition period.

Another possibility being explored concerns the use of external providers capable of servicing the motors and future refurbishment, given uncertainty surrounding long-term support from the original equipment manufacturer. Interviewees described this as part of a broader search for alternatives beyond the original supplier relationship.

Interviewees also discussed access to technical drawings, bills of material and related documentation, which was described as potentially important safeguards for future serviceability and sourcing outside of the original supplier relationship. Since not all spare parts are available on the market, such technical access was viewed as particularly important should substitution eventually be required, or if support would need to be secured through alternative providers.

Lastly, a fallback technical alternative was described as a possible, but less preferred option, if other mitigation measures were proven insufficient. They would have to use their previous drive solution, with a weaker motor, which would lead to significant reduction in performance output and qualification effort.

4.3.2.3 Constraints affecting mitigation feasibility

Despite these mitigation measures, interviewees repeatedly emphasized structural constraints limiting the range of feasible responses. Tetra Pak representing only a small share of the supplier's business was seen as a challenge that limits the influence in the relationship. Technical specificity and the internal high qualification requirements were further described as making substitution difficult and time consuming, while low and irregular demand volumes were viewed as reducing the practicality of maintaining supply agreements. Together, these conditions were described as constraining both the speed and scope of which available mitigation options could be deployed.

4.3.3 Supplier B

4.3.3.1 Proactive Measures

For Supplier B, proactive mitigation practices were described primarily in relational and collaborative terms. Given the co-developed and specialized nature of the equipment, interviewees emphasized escalation structures and strategic coordination mechanisms as particular important for maintaining visibility and addressing emerging issues before they escalate.

A central element of this approach was the use of top-to-top governance forums, described as supporting strategic alignment and addressing emerging concerns before they develop into disruption.

Complementing these relational mechanisms, an escrow arrangement was described as an important safeguard intended to secure access to critical intellectual property and technical documentation if supplier bankruptcy occur. The arrangement was further associated with efforts to verify that the information held under escrow would be sufficiently complete and usable if activated.

Interviewees also described proactive mitigation through active support of technology development. Tetra Pak was described as having assumed a leading role in funding and guiding development efforts, at times financing upgrades in order to drive innovation when the supplier had not advanced the platform proactively. As one interviewee noted, Supplier B had been considered a strategic supplier, but "they have not acted as a strategic supplier".

Selective inventory coverage for critical spare parts was further described as a preventive measure supporting operational continuity, where certain critical components are stocked specifically to reduce vulnerability in the installed base.

4.3.3.2 Contingency-oriented measures

As concerns regarding the supplier's financial health increased, mitigation efforts shifted toward contingency oriented responses. A first response described was intensified monitoring of the supplier's financial situation accompanied by escalation of contingency readiness.

A major mitigation strategy described as a parallel response has been the evaluation of alternative suppliers and technologies for future solutions. Although the installed base remains dependent on the current supplier, active preparation for future transition was described as a

method for reducing risks associated with future disruptions. This included strategic preparation to move away from the current proprietary platform over time, with future equipment purchases expected to shift toward alternative solutions associated with lower dependency exposure.

Lastly, interviewees described preparation of alternative service scenarios if the support capability from the supplier were to deteriorate or cease. This included consideration of how maintenance support could be secured under such severe disruption conditions, including seeking third-party providers with the relevant technical expertise.

4.3.3.3 Constraints affecting mitigation feasibility

Despite growing availability of alternatives, interviewees emphasized several constraints. Installed base lock-in and high switching costs associated with replacing current equipment were described as major barriers. Supplier-specific and intellectual property barriers were further emphasized as factors limiting substitution. At the same time, respondents noted that the improved competitive landscape reduced supplier availability barriers that historically reinforced dependence. Interviewees described this as widening the range of feasible mitigation alternatives, even though dependency constraints remain significant given that the installed base is expected to remain in operation for decades.

4.3.4 Cross-Case Summary

The comparison of Supplier A and Supplier B reveals that while root causes of vulnerability, namely technical specificity and high switching costs, are consistent, the applied mitigation strategies vary based on the nature of the equipment and the maturity of the relationship. A recurring pattern is the focus on managing the ”installed base lock-in,” where Tetra Pak is forced to balance the high performance of specialized solutions against the supply risks inherent in asymmetric dependence

Table 4 summarizes the key empirical patterns observed across both cases.

Table 4: Cross-case summary of mitigation patterns and constraints

Empirical Pattern	**Supplier A**	**Supplier B**
Installed base lock-in	High (59 units installed)	High ($\sim$ 50 units installed, 95–99% of installed base)
Primary safeguard mechanism	Inventory (11 units on stock)	Documentation (Escrow agreement)
Alternative sourcing evaluation	Fallback or new development	Competitive market exploration
Governance-based mitigation	Moderate (Transitioning to ad-hoc)	High (Top-to-top forums)
Immediate substitution feasibility	No (Years of development)	No (Decades of expected operation)
Relationship driver	Performance vs. availability	Co-development/Strategic alignment

5 Analysis

This chapter analyzes the findings from the previous chapter. Each supplier is studied separately to understand the causes for supplier vulnerability and to understand the applicability of different mitigation strategies. Then, a cross-case analysis is conducted to generalize the findings and separate isolated events from systematically important concepts. Finally, the suppliers are analyzed from a strategic perspective and the theoretical best practices are compared with those of Tetra Pak. Finally, we utilize the findings and analysis to answer the first two research questions.

5.1 Overview of Analysis

While chapter 4 presented the empirical findings, process descriptions, historical context, and key information on the relationships between Tetra Pak and the suppliers, this chapter links the findings to theory to contribute to the research field and deepen understanding of how the structure and management of an industrial buyer's processes have dependence-related implications. This will be achieved by continuing the structure of chapter 4 and analyzing the causes of supplier vulnerability separately from the mitigation strategies. Each section will contain a within-case analysis for each supplier followed by a cross-case analysis, with the purpose of rigorously answering research question 1 and 2. The chapter concludes with a discussion of the implications of the findings for the construction of the framework.

5.2 Causes of Supplier Vulnerability and Supply Risks

This section aims to answer research question 1: "What dependence-related factors cause supplier vulnerability and supply disruption risk for suppliers of critical equipment and service at Tetra Pak?". As explained in the method, this is done by dividing the question in two and answering the resulting questions separately. Recall that the resulting question is "What dependence-related financial and operational mechanisms create supplier vulnerability and supply disruption risk for suppliers of critical equipment and service, and how do they apply to Tetra Paks business". This section will analyze the findings presented in chapter 4, compare it with the theory in order to understand how the dependence-related mechanisms create supplier vulnerability and supply disruption risks.

5.2.1 Within-case Analysis Supplier A

5.2.1.1 Dependence-related vulnerability mechanisms

There is substantial alignment between the theoretical findings on vulnerability causes and the causes identified in the case of Supplier A. Multiple factors are active simultaneously, interacting in ways that reinforce one another and increase both the probability and potential impact of supply-related risks.

Power Asymmetry and Bargaining Power

Prior to the acquisition of Supplier A, the relationship was positioned in the bottleneck-core segment of Van Weele's Dutch windmill. This means that Supplier A had high supply risk due to the lack of alternatives and a low profit impact for Tetra Pak. From Supplier A's perspective, their offering was very competitive on the market and Tetra Pak was an attractive customer for them, given the alignment between Tetra Paks need and the supplier's core capabilities. This resulted in relatively balanced bargaining power. Tetra Pak acted in accordance with the strategy associated with this segment by intensifying the relationship and employing them for all of their factories. The relationship functioned effectively, with strong communication and efficient handling of issues and refurbishment activities. However, following the acquisition, Tetra Paks position in the Dutch windmill shifted, as illustrated by Figure 14. Although the supplier remained competitive on the market, Tetra Paks relative importance diminished due to the size of Supplier A. This shifted Tetra Pak towards the less favorable Exploitable segment. The shift was accompanied by noticeable behavioral changes which, including a termination of direct communication with the factory, reduced responsiveness to Tetra Paks inquires and a general lack of attention to Tetra Paks needs. These developments indicate an increase in power asymmetry and a widening gap in the bargaining power.

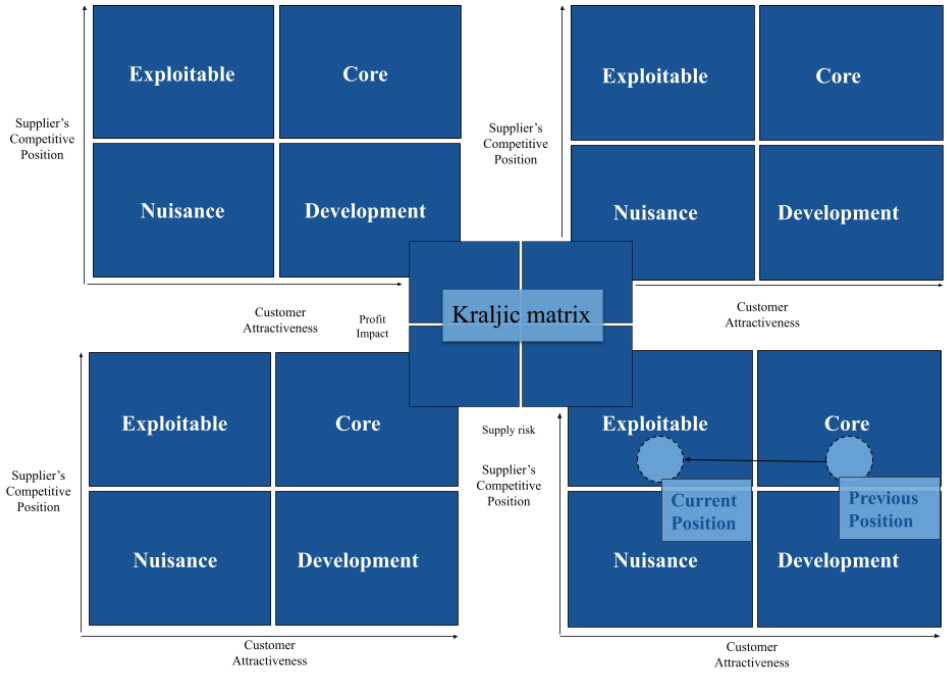

Figure 14: The change of Supplier A's position in the Dutch windmill (Source: Authors)

As a result, Tetra Pak was exposed to increased risk, as the relative importance of their busi-

ness had been drastically reduced. Eventually, Supplier A made an active decision to end the relationship with Tetra Pak by discontinuing the motor.

Knowledge and Asset Concentration

The current degree of knowledge and asset concentration severely limits flexibility. As Ponomarov and Holcomb (2009) suggests, this reduces the adaptive capability of the supply chain and as such negatively impacts resilience. The current knowledge concentration is high, as supplier A is the only supplier who can fully service and repair the equipment. The knowledge concentration of supplier A is also high, the possibility of outsourcing part of the services slightly reduces the concentration. While the concentration does not necessarily increase the probability of supply disruptions, it significantly constrains the range of available responses, thereby amplifying the potential operational and financial severity of impact. The sudden announcement of the dissolution left Tetra Pak exposed, as supplier A is the sole provider of both spare parts and services. The possibility of outsourcing services allows the reduced knowledge concentration to provide potential relief of some services. However, without a supplier of spare parts, the existing safety stock acts as a buffer and when depleted, Tetra Pak will need to rapidly find and implement an alternative solution to prevent significant operational disruptions.

A reduction in concentration is technically possible, with long-term planning. However, reducing concentration entails trade-offs as it generally would include choosing a standardized solution, of which there are several suppliers, or reducing dependence by means of network expansion (Pazirandeh 2014). The trade offs would include reduced performance, including increased administrative complexity, higher costs, and a more distant supplier relationship, which may in turn hinder innovation and weaken competitive advantage. Reducing knowledge and asset concentration could improve resilience for this supplier by increasing flexibility and enabling alternative response options. However, such a shift may also reduce customer attractiveness, potentially reinforcing an even more disadvantageous and exploitative relationship position in the Dutch windmill.

Predisposing Factors and Precipitating Events

While no clear predisposing factors were evident at the beginning of the relationship with Tetra Pak and the motor manufacturer, the acquisition fundamentally changed the structure of the relationship. The changes can be effectively illustrated through the Dutch windmill, highlighting that customer attractiveness is an actor-related predisposing factor which can influence the vulnerability of the relationship. Supplier A's acquisition of the motor manufacturer led to an unfavorable situation for Tetra Pak, clearly outlined by the reduced cooperation and increasing distance in the relationship. This, in turn, gave rise to multiple instances of precipitating events that were managed dysfunctionally and in an exploitative manner by Supplier A, further increasing the friction in the relationship and ultimately contributing to the dissolution of the relationship.

Supplier A's acquisition fundamentally changed the relationship between Tetra Pak and the supplier, reducing Tetra Paks attractiveness and as such increasing supplier vulnerability by increasing the probability for supply risks through reduced cooperation and heightened risk for chosen dissolution.

Low and Irregular Volumes

While volumes have declined significantly following Tetra Paks reduced expansion, the extent to which this contributed to the dissolution of the relationship remains uncertain. One plausible mechanism through which low and irregular volumes could contribute to supplier vulnerability is through reduced customer attractiveness, which would further shift Tetra Paks position towards exploitation in the Dutch windmill.

High Switching Barriers

Switching barriers are a central driver of supplier vulnerability, as they constrain the range of strategies available to Tetra Pak in the event of supply disruptions. The current installed base and stock can only be maintained and utilized until end-of-life through continued cooperation with Supplier A, as critical knowledge and assets required for operation are controlled by Supplier A. Without such cooperation, Tetra Pak cannot acquire the necessary spare parts needed to address potential failures. The substantial financial investment further increases this barrier by limiting flexibility. This reduces the feasibility to rapidly or repeatedly switch suppliers, acting as an attenuating factor in the relationship.

The selection of a niche and highly specialized product significantly constrains the ability to switch suppliers in this case, as more standardized solutions may have several suppliers of motors, spare parts and associated services. At the same time, the case indicates a trade-off between performance and supplier availability, suggesting an inherent tension between achieving high technical performance and maintaining supply chain resilience

5.2.2 Within-case Analysis Supplier B

During the initial years of the relationship with Supplier B, they were positioned as a strategic-core supplier in the Dutch windmill. Over time, however, the emergence of additional competitors shifted the supplier's position towards the development segment. This shift is also reflected in observed supplier behavior. In one instance, when Tetra Pak communicated that it was exploring alternative, more advanced technical solutions due to the increasing risk of bankruptcy, the supplier responded by stating that they had the capabilities of developing and delivering these types of solutions, indicating an attempt to reactively expand its offering and increase value provision. This type of response is characteristic of a development-oriented relationship, where the supplier seeks to strengthen its position through added value and capability expansion.

5.2.2.1 Dependence-related vulnerability mechanisms

Power Asymmetry and Bargaining Power

The relationship between Tetra Pak and Supplier B exhibits an apparent interdependence that, upon closer examination, appears weaker than it is perceived by either party. The supplier manager explains that Tetra Pak is heavily dependent on Supplier B for the continuation of production, and that Supplier B is heavily dependent on Tetra Paks business for survival, however, Figure 13 shows that while Tetra Pak's spend and revenue share of Supplier B fluctuates, the overall revenue of Supplier B is fairly consistent without a clear sign of dependence on Tetra Pak. This indicates that while Tetra Pak is heavily dependent on Supplier B to maintain their operations, Supplier B is not as dependent on Tetra Pak.

Tetra Pak treats Supplier B as critical for the continued production of their products while simultaneously acknowledging the existence of several alternative suppliers on the market that could replace Supplier B. The main driver of this perceived dependence appears to be the large investment into equipment. In contrast, Supplier B derives a substantial share of its revenue from Tetra Pak, creating a strong incentive to preserve the relationship. However, its overall continuity is not solely dependent on Tetra Pak, as it faces broader operational challenges. The company has not returned a profit over the past decade, including periods when Tetra Pak's spending was significantly higher than in recent years. This suggests that dependence on Tetra Pak is unlikely to be the primary driver of the supplier's financial distress. Instead, the emphasis on retaining Tetra Pak's business can be interpreted as an effort to secure and preserve an important revenue stream rather than a decisive factor determining the company's overall financial viability.

Prior to the emergence of qualified competitors, Supplier B occupied a strategic position in the Kraljic matrix. From the supplier's perspective, they were competitive and Tetra Pak represented an important customer. The relationship was positioned in the strategic-core segment in the Dutch windmill. With the emergence of additional suppliers capable of delivering comparable or superior solutions, supply risk for Tetra Pak decreased and the supplier's relative competitive position weakened. This shifted the relationship towards the leverage-development segment of the Dutch windmill, as illustrated by Figure 15. From Tetra Paks perspective, this development increased access to alternative solutions in the market and strengthened its bargaining power. Despite this increase in bargaining power, Supplier B retains control over critical intellectual property rights, including technical documentation and design specifications. This constrains Tetra Pak's ability to source spare parts or services from alternative providers while Supplier B remains operational. As a result, Tetra Pak is effectively locked into the relationship in the short term. A potential shift would occur only in the event of Supplier B's bankruptcy, at which point access to technical documentation will be transferred or become obtainable. Even in such a scenario, the completeness and usability of such documentation remain uncertain, potentially necessitating the rapid identification and qualification of new suppliers to ensure continuity of operations.

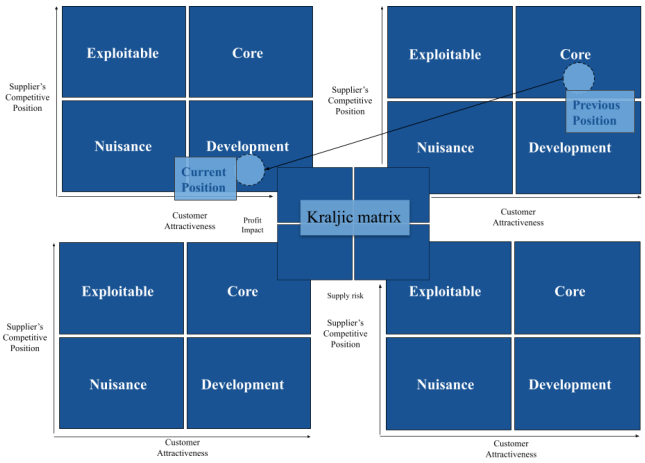

Figure 15: The change of Supplier B's position in the Dutch windmill (Source: Authors)

The increased bargaining power for Tetra Pak reduces the potential impact of supply risks, as alternative suppliers are capable of replacing Supplier B's equipment. However, the size, cost and complexity of the equipment means that a replacement would take significant effort, development time and cost. As a result, switching is not a purely administrative process but rather a large-scale development initiative, which still entails significant risk. The observed shift in bargaining power and power asymmetry does not appear to affect the probability of supply disruption events, but primarily influences their potential impact.

Knowledge and Asset Concentration

The customization of the equipment has caused knowledge to be concentrated exclusively to Supplier B, which prevents any other supplier from having the capabilities to deliver and install spare parts or perform maintenance and repairs. In the event of Supplier B's bankruptcy, this knowledge would be effectively lost, with continuity depending on whether the technical documentation provided through the escrow agreement is sufficiently detailed to enable the manufacture of required components. Knowledge concentration therefore increases the potential impact of supply disruption risks.

The asset concentration is also high, with Tetra Pak as the sole customer of the equipment and Supplier B as the only producer. This creates a situation where the performance of this solution from Supplier B's perspective is completely reliant on Tetra Pak. Changes in Tetra Pak's demand structure therefore directly impacts Supplier B and, over time, has the potential to increase the probability of supply disruption risks.

To summarize, knowledge concentration increases the potential risk impact, but without significant changes to risk probability. Asset concentration combined with a duration of low volumes, in contrast, appears to increase the probability of supply risks but has a limited effect on the risk impact. From a resilience perspective, increasing the share of concentration with a supplier can significantly impact supplier vulnerability and supply disruption risk.

Predisposing Factors and Precipitating Events

The identified predisposing factors, relating to weakly defined requirements for Supplier B, limited innovation and independent development appear to have functioned primarily as operational inefficiencies and financial burdens for Tetra Pak. However, there is no evidence that these factors have had a substantial effect on supplier vulnerability or triggered significant changes in the structure or stability of the relationship.

Low and Irregular Volumes

While lower volumes in recent years could contribute to weaker financial performance for Supplier B, the overall revenue trend does not support a direct causal link, as Supplier B reports broadly similar revenue levels prior to Tetra Pak's decline in demand. There is therefore no clear evidence that reduced or irregular volumes have increased the likelihood of Supplier B's bankruptcy. However, a more relevant mechanism which poses a larger risk to supplier vulnerability is the potential reduction in customer attractiveness associated with low, irregular, and non-forecasted purchasing patterns. If Tetra Pak continues to purchase at reduced and unpredictable volumes, Supplier B's perception of the relationship may deteriorate, potentially repositioning Tetra Pak into the nuisance segment of the Dutch windmill framework. Such a

misaligned relationship type could increase relational distance and reduce Supplier B's willingness to invest in the relationship. Given the high levels of asset and knowledge concentration, this would amplify the vulnerability and increase exposure to supply disruption risk.

High Switching Barriers

The barriers identified significantly constrain Tetra Pak's ability to switch suppliers, and effectively locks Tetra Pak in the relationship, despite the potential performance benefits of switching. The most significant barrier is the financial barrier, as each machine is very expensive and technically complex to replace. A second major barrier is the lack of ownership of the technical information required for maintenance and repair, which binds Tetra Pak to Supplier B for these activities. Had a more standardized solution been in place, multiple suppliers would likely have been capable of manufacturing spare parts and providing the necessary services.

As such, the knowledge and asset concentration as a result of choosing a customized, specialized solution increases the switching barriers which severely increases the potential supply chain risk impact in the case of bankruptcy. High switching barriers thus act as a major constrain in achieving supply chain resilience.

5.2.3 Cross-Case Analysis

The theoretical framework identifies several mechanisms of supplier vulnerability, providing a lens of dependence for analyzing the relationships between Tetra Pak and its suppliers. This enables a structured assessment of which mechanisms are applicable in each case, and the extent to which they contribute to supplier vulnerability and supply disruption risk. Throughout the individual analyses, the relationships have been analyzed from the viewpoints of power asymmetry & bargaining power, knowledge & asset concentration, predisposing factors & precipitation events, low & irregular volumes and high switching barriers. No additional mechanisms influencing dependence-related supplier vulnerability have been identified. The extent to which each mechanism contributes to supplier vulnerability is presented in the Table below.

Table 5: Cross-case summary of dependence-related supplier vulnerability mechanisms applicable to Supplier A and B

Dependence-related vulnerability mechanisms	**Supplier A**	**Supplier B**
Power Asymmetry & Bargaining Power	Increased supply risk probability and impact	Increased supply risk impact
Knowledge & Asset Concentration	Increased supply risk impact	Increased supply risk probability and impact
Predisposing Factors & Precipitating Events	Greatly increased supply risk probability	Low or no impact on supply risk
Low & Irregular Volumes	Low or no impact on supply risk	Low impact on supply risk probability
High Switching Barriers	Greatly increased supply risk impact	Greatly increased supply risk impact

The analyses reveals that different mechanisms impact the supplier vulnerability and supply disruption risk to varying degrees. However, in both cases, several vulnerability mechanisms are active simultaneously. In the case of Supplier A, increased power asymmetry contributed to reduced customer attractiveness, which in turn triggered precipitating events. For both suppliers, high switching barriers reinforced knowledge and asset concentration, while for Supplier B, prolonged asset and knowledge concentration further strengthened switching barriers through increased customization of the equipment. This indicates that supplier vulnerability is not driven by isolated instances of vulnerability mechanisms, but rather by the interaction of several mechanisms that reinforce each other, thereby increasing both supplier vulnerability and supply disruption risk and reducing overall supply chain resilience. Among these, high switching barriers appear to have the strongest impact on supply risk, which is consistent with the observed lock-in effects.

This leads to the answer to research question 1: ”What dependence-related factors cause supplier vulnerability and supply disruption risk for suppliers of critical equipment and service at Tetra Pak?”. Several identified dependence-related mechanisms can contribute to supplier vulnerability and supply disruption risk. At Tetra Pak, high switching barriers have the most pronounced impact, while the other mechanisms significantly influences both the probability and impact of risk. Consequently, isolated mechanisms tend to generate limited risk, whereas the combined effect of multiple interacting mechanisms substantially increases supply risk and supplier vulnerability, thereby negatively affecting supply chain resilience.

5.3 Strategies for Managing Vulnerable Suppliers

This section answers the second research question by analyzing the feasibility and effectiveness of mitigation strategies for managing vulnerable suppliers under conditions of dependency and disruption risk. The empirical finding shows that these two aspects do not necessarily coincide, as mentioned in 3.4.2. Some strategies that would be attractive from pure risk-reduction perspective are difficult to realize in practice, while more feasible strategies often reduce exposure

without materially reducing the underlying dependence.

Across both cases, the findings suggest that mitigation has largely focused on managing exposure within existing dependencies rather than enabling rapid exit from them. This reflects how previously mentioned causes of supplier vulnerability narrow the set of viable short-term responses. In practice, mitigation therefore becomes a layered activity in which continuity is protected in the short term, while longer-term efforts aim to reduce dependence. To clarify this logic, the section first outlines the common analytical conditions that shape mitigation in both cases before examining each supplier situation separately and finally synthesizing the findings across cases.

5.3.1 Mitigation Under Dependency Constraints

A central implication of the theoretical discussion in chapter 3 is that mitigation strategies cannot be assessed independently of the dependence structure in which they are applied. While SCRM often treats mitigation as the selection of responses that reduce disruption likelihood or impact, the findings in this thesis indicate that in low volume, critical supply situations, the range of viable responses is already narrowed. This reflects Pfeffer and Salancik's view that organizations are constrained when critical resources are controlled by external actors (Pfeffer and Salancik 2003).

This is consistent with the RDT perspective developed in chapter 3. When critical resources are controlled by the supplier and difficult to replace, short-term mitigation rarely revolves around eliminating dependence. Instead, firms tend to rely on strategies that primarily stabilize access and preserve continuity, creating time for prolonged adjustment. This corresponds closely to the distinction developed in section 3.2.3 and Table 3 between dependence management and dependence reduction. Dependence management strategies are generally more feasible in the short term because they operate within existing constraints and help protect continuity. On the other hand, dependence reduction strategies may offer more durable mitigation, but usually require longer time horizons, investment, and technical change before they can be realized.

A further condition shaping mitigation in both cases is the tension between technical performance and future substitutability. As shown in chapter 4, earlier engineering-oriented sourcing decisions favors highly specialized solutions that supported performance, but also contributed to vulnerability by increasing technical specificity, switching barriers, and dependence on supplier-controlled knowledge. This helps explain why mitigation often centers on managing dependence before reducing it. Questions related to standardization and future sourcing design are relevant in this regard, but are developed more fully in the cross-case analysis. Against this backdrop, the following within-case analysis examines how these broader conditions shape mitigation in relation to Supplier A and Supplier B.

5.3.2 Within-Case Analysis Supplier A

In the case of Supplier A, mitigation is shaped by a chosen ending of the relationship in which the supplier has announced discontinuation of the motor and limited future support. The vulnerability is therefore closely linked to the loss of supply and service capability for a highly specialized component that remains critical for Tetra Pak's installed base. In this context, the empirical findings indicate that mitigation is characterized primarily by continuity-preserving

measures combined with longer-term efforts to reduce and balance dependency.

A first observation is that the most immediately feasible strategies are buffer-oriented. The empirical findings show that spare motors and stock-building measures function as operational safeguarding during the transition period following the discontinuation announcement. In SCRM terms, this corresponds to redundancy mitigation aimed at reducing disruption impact rather than disruption probability. In the present case, such measures are effective precisely because the disruption threat has already become concrete. Once the supplier has chosen to discontinue production and support, the main issue is no longer to prevent withdrawal, but how to preserve operations while alternative responses are explored. Buffering is therefore highly effective in the short term as it protects continuity directly. However, its limitation is equally evident. Inventory does not reduce the dependence on supplier-specific knowledge, supplier-controlled spare parts, or future technical support. Instead, it extends the time available for future actions. This makes buffering a continuity-preserving response rather than a dependence-reducing strategy, since it limits the impact of immediate disruption without changing the underlying supplier-specific dependence (Tang 2006).

The extra time gained is particularly important given the dependence created by the long-lived installed base, where substitution is constrained by technical and operational requirements. The current installed base and stock motors represent a substantial sunk investment and remain critical to factory operations. Safety stock does not function merely as ordinary inventory coverage, but also as a way of preserving operational flexibility in a situation where redesign and qualification of alternatives take considerable time. The strategy is therefore feasible because it can be implemented within the current technical structure, but it remains a temporary accommodation of dependence, not a durable solution.

A second important mitigation pattern concerns life-cycle extension through refurbishment and condition management. Refurbishment is a central mechanism for sustaining availability over time. Rather than relying solely on new production, Tetra Pak has sought to preserve the usefulness of already installed or stocked units through repair cycles. Analytically, this shifts the continuity logic from acquiring new resources towards extending the service life of existing ones. From a resilience perspective, this supports the ability to absorb disruptions by prolonging the usability of the installed base. From an RDT perspective, this is better understood as dependence management response under constrained conditions rather than a means of reducing dependence.

At the same time, the feasibility of this strategy is inherently limited. Since Supplier A's discontinuity affects both new production and continued full refurbishment support, refurbishment functions primarily as a temporary means of sustaining continuity within a deteriorating support structure. Refurbishment depends on continued access to repair capability, technical knowledge, and critical spare parts, all of which remain closely tied to the supplier. While interviews suggested that certain maintenance activities could potentially be supported by external providers, these options do not substitute the supplier's full refurbishment capability. They are therefore better understood as partial contingency measures that may widen the set of available responses while leaving the broader dependence structure largely intact. At the same time, if service and refurbishment capabilities are successfully developed outside the supplier, this represents a possible but limited pathway towards reducing aspects of that dependence.

A third mitigation pattern concerns access to technical drawings, bills of material, and related documentation. in line with the formalization in Table 3, this can be interpenetrated as a dependence management mechanism because it seeks to reduce uncertainty by clarifying access conditions and securing information needed for future response options. In this case, documentation serves a similar role by potentially supporting alternative repair routes, future redesign, or partial transfer of service capability. Although such access does not eliminate dependence, it may improve preparedness and widen future response options. Its value depends on whether the documentation can be obtained and whether it is sufficiently complete to support those alternatives, suggesting that it functions primarily as an enabling mechanism rather than a stand-alone mitigation measure.

A fourth mitigation direction concerns alternative solution development and future standardization. Supplier scouting and alternative technical solutions are precautionary efforts that had already been explored before the present discontinuity threat, even though no fully qualified substitute had yet been implemented. In the short term, these efforts are heavily constrained by the uniqueness of the current motor, the extensive development cycle required for a replacement, the internal qualification effort, and the fact that more standardized alternatives may imply lower performance. This supports the argument in section 3.4.2 that dependence-reducing strategies are often desirable in principle but difficult to realize under structural dependence. In this case, a switch to a different motor or to a more standardized, off-the-shelf solution appears to be only strategy that directly addresses the root cause of vulnerability, namely the lack of substitutions and the concentration of technical capacity at the supplier. Yet it is also the least feasible short-term response, because of the time consuming process of technical validation, redesign, internal qualification, and potential decreased performance. Therefore, alternative solution development should primarily be considered as a long-term dependence-reduction strategy rather than an immediate mitigation against the present discontinuity.

This distinction between managing current disruption and reducing future vulnerability is central to interpreting the case. Buffer stock is effective since it protects continuity, standardization and redesign are important because they lower dependency in future sourcing. The broader preventative orientation towards more standardized and off-the-shelf solutions in future investments is therefore analytically significant. In SCRM terms, this corresponds to product management strategies reducing risk by changing the design basis of the supply situation. In RDT terms, it corresponds to dependence reduction.

Taken together, the case of Supplier A shows how limited the room for action becomes once a highly specific solution is already installed across factories. The motors are expensive, important for production, currently difficult to match with another solution and replacing them immediately is not be a reasonable option. The priority is instead to keep the operations running smoothly and preserve the value and performance, while alternatives are scouted. Spare motors and refurbishment help extend the useful life of the installed base, and technical documentation could make it easier to use external support, which help manage a transition. Still, these measures are constrained by dependence structure that had already developed around the supplier-specific solution. When Tetra Pak became a less attractive customer after the acquisition and volumes declined, its ability to secure long-term support also became weaker. For future sourcing decisions, this case shows why critical equipment should be judged not only by performance, but also serviceability, documentation access, supplier vulnerability, and the risk of supplier support disappearing over time.

5.3.3 Within-Case Analysis Supplier B

In the case of Supplier B, the primary vulnerability stems from supplier fragility rather than product discontinuation, which shifts mitigation towards governance-based stabilization, visibility, contingency preparedness, and gradual transition planning.

A first key pattern is relational governance and intensified coordination. The findings show that senior management dialogue, strategic interaction, and close ongoing communication have been used to maintain visibility into the relationship and address emerging concerns early. In line with the socialization-based dependence management strategies discussed in section 3.2.3, and the informal governance mechanisms discussed in section 3.3.3, these mechanisms function by stabilizing access, improving early warning signaling, and supporting coordination response under uncertainty (Poppo and Zenger 2002; Pazirandeh 2014). Their effectiveness lies in improving preparedness. While their limits are clear, they do not alter the supplier's financial position directly or resolve the underlying vulnerability.

A second major mitigation pattern concerns formal governance and contingency safeguard, most notably through the escrow arrangement and efforts to secure access to technical documentation. These measures reduce the exposure if the supplier becomes unavailable. By securing access to drawings, specifications, and other critical documentation, the buyer improves its adaptability to involve third-party actors or evaluates alternative repair and maintenance options, which is an important contingency mechanism and strengthens preparedness.

A third mitigation pattern concerns monitoring, visibility, and escalation mechanisms. Digital surveillance tools and financial risk alerts are important because they strengthen the ability to detect deterioration early enough to activate response measures. Although monitoring is not mitigation in a narrow sense, the case suggests that it functions as a critical enabling condition for mitigation, particularly where vulnerability unfolds gradually rather than through immediate disruption.

A fourth set of strategies concern continuity-preserving measures around service and spare-part capability. Selective spare-part stocking, preparation of alternative service scenarios, and exploration of third-part expertise act as ways of preserving support capability if the supplier's service function weakens. Rather than constituting a full substitution for the supplier relationship, these contingency-oriented forms of functional redundancy improve preparedness but remain limited by supplier-specific constraints such as intellectual property, machine customization, and documentation limitations.

A fifth mitigation direction concerns gradual dependence reduction for future investments. For future equipment purchases, the competitive landscape appears more favorable, with improving alternative supplier options and ongoing evaluation of substitution solutions. This suggests that dependence reduction may be more feasible at the point of future Tetra Pak's decisions than for the current installed base. In theoretical terms, this corresponds to network expansion and market-oriented dependence reduction. At the same time, the findings show that such measures address future exposure rather than the immediate vulnerability of the existing installed base, whose long operational life continues to bind Tetra Pak to the existing relationship.

The case of Supplier B suggest that effective mitigation under financially driven supplier vulnerability relies on combining governance-based stabilization and preparedness measures in

the short term with gradual dependence reduction over longer time horizons. Rather than relying on any single response, mitigation effectiveness depend on layering relational governance, contingency safeguarding, monitoring, and future transition planning.

5.3.4 Cross-Case Analysis

A comparison of Supplier A and Supplier B reveals a common pattern. Dependency conditions narrow the set of viable response options and creates enduring commitments tied to future operations. These bring mitigation towards managing exposure within the relationship, not enabling a rapid exit. At the same time, both cases show that precautions have been taken to reduce dependence to the extent to where it is feasible, suggesting that dependence management and dependence reduction are not alternative responses, but complementary elements of mitigation.

This extends the distinction developed in Table 3 by suggesting that effective mitigation often depends on combining these strategy types over different time horizons. The cases exhibit common structural constraints while requiring distinct tactical approaches, as summarized in Table 6.

Table 6: Cross-case synthesis of mitigation patterns

Dimension	**Supplier A**	**Supplier B**
Dominant vulnerability	Product discontinuation	Financial fragility
Primary short-term mitigation	Buffering and refurbishment	Governance and monitoring
Formal safeguards	Documentation access	Escrow and contractual safeguards
Contingency-oriented measures	Third-party maintenance exploration	Alternative service scenarios
Dependence reduction path	Standardization and redesign	Future sourcing shifts
Main feasibility constraint	Technical specificity	Installed base and IPR lock-in

A first cross-case insight is that the underlying reason for perceived threat dictates the dominant mitigation logic. Technological obsolescence necessitates a material logic, namely buffering to decouple from life-cycles, while organizational fragility requires a relational logic, namely organizational monitoring and preparation. This demonstrates that resilience in high-dependence settings, is having the capabilities to activate the right responses to the specific threat.

A second insight concerns the synergy between formal and informal governance in managing these dependencies. Across both cases, the findings indicate that formal safeguards such as escrow or documentation access provides a safety net, but they are often too rigid or slow to act as the primary risk management tool. Instead, it is the relational mechanisms, intensive management dialogue and collaborative monitoring that provide the early warning signals needed to activate the safeguards. This reflects the argument that formal contracts and relational governance can function as complements rather than substitutes in inter-organizational relationships

(Poppo and Zenger 2002). In settings where the buyer has low commercial leverage due to small volumes, relational capital can act as a substitute for market power. Therefore, effective mitigation depends on a hybrid governance approach, using relational trust to gain transparency and visibility, while using formal contracts to secure critical resources for a potential exit.

A third and broader insight involves the structural tension between performance-driven specialization and resilience-oriented sourcing. Both cases demonstrate that the current vulnerabilities were not accidental but ”designed-in” through earlier choices that favored highly customized, supplier-specific solutions to achieve superior technical performance. From a resource dependence perspective, this created the very ”lock-in” that now limits mitigation feasibility. This makes the preventive orientation towards standardization analytically significant. However, this should not be viewed merely as a technical goal, but also a strategic move to lower future switching barriers and break a cycle of strong dependency. It represents the only true *ex-ante* mitigation strategy that addresses the root cause of vulnerability rather than just managing symptoms.

This leads to the answer to research question two: the most feasible and effective strategies for managing vulnerable suppliers in a low volume, critical context are not singular tools but a synchronized combination of dependence management and dependence reduction measures. In the short term, buffering, governance, and other continuity-preserving measures are most feasible path to manage exposure. Over longer time horizons, standardization, substitution, and alternative sourcing offer the strongest path to regain strategic independence. Ultimately, management effectiveness is defined by the ability to balance the immediate need to survive within a dependency with gradual efforts to reduce that dependence over time.

5.4 Implications for Framework

The findings in this chapter show that there are several mechanisms of vulnerability and many mitigation strategies for dealing with vulnerabilities. The combination of vulnerabilities, or the specifics of the situation ultimately limits the pathways of mitigation. However, the findings indicate that the strategic sourcing decisions have a major impact on which mitigation strategies are feasible and is therefore the key consideration for resilience. The current high-dependence situations were, to a large part, initiated by the need of an advanced, specific or custom technical solution. Customization and high-performance solutions without clear alternatives create a lock-in effect that drives dependence, creates supplier vulnerability and increases the probability and impact of risk.

A framework aimed at proactively dealing with dependency-driven supplier vulnerability situations similar to the cases illustrated in this thesis should ultimately be a tool to identify, assess and mitigate these situations in order to increase the resilience. This leads to the tool needing to do three things:

1. Identify supplier-relations where supplier vulnerability is likely to emerge.
2. Assess the situations to construct an appropriate response.
3. Choose and implement feasible and viable mitigation strategies, given the context.

The findings of the analysis provides a solid foundation for creating a framework for identifying, assessing and mitigating dependency driven risks with the aim of improving resilience. The

following chapter will utilize the findings from the theory and the analysis to create a structured governance framework that will act as a guide in future sourcing decisions.

6 Development of Framework

This chapter utilizes the findings from theory and the previous chapter to create a structured framework. The three capabilities of the framework identified in the previous section are discussed separately to understand how each capability constitutes a part of the resulting framework. A discussion of the limitation of the framework is included. Finally, the complete framework is presented.

6.1 Introduction

This chapter aims to combine the theory, findings and analysis of the cases in order to build an understanding of how a framework should be structured in order to analyze dependency-driven vulnerabilities within the supply base in order to improve resilience. As mentioned in the previous chapter, the process for proactively managing such vulnerabilities is three fold; identification, assessment and applying strategies. Identification is required to be aware of potential vulnerabilities and resilience concerns within the supply chain, and adequately assess the supply base. Assessment is required to focus efforts and investments and to contruct an appropriate response. Mitigation strategies serve to fulfill two objectives. Firstly, to be proactive with resilience and align the supply chain with resilience goals. Secondly, the strategies should be able to mitigate ongoing dependency-driven risks and provide necessary insights to manage supply continuity. The chapter includes a discussion of limitations of the framework, and the generalization to other contexts.

This leads to the answer to RQ3, *How can a governance framework be designed so that it can be used to identify, assess, and mitigate similar dependency-driven supply vulnerabilities in future sourcing decisions at Tetra Pak?*. The resulting framework will be able to manage similar sourcing decisions at Tetra Pak, and provides a basis for managing similar sourcing decisions at other companies.

6.2 Proactive foundation

The most effective way of managing dependence related risk is not to mitigate dependence after it has emerged, but to prevent unnecessary dependence from being created in the first place. As described earlier, supplier vulnerability is not just a property of a supplier but a structural property, shaped by internal characteristics and interface conditions in the buyer-supplier relationship. From this perspective, resilience is strongly influenced by proactive decisions made during sourcing, design, supplier selection, and relationship governance. As such, the foundation of resilient supply chains lies not only in reactive mitigation capabilities, but also in

proactively limiting unnecessary exposure to dependence related vulnerabilities.

The studied cases illustrate how high levels of customization and modification towards technically superior solutions can create substantial long-term risks. While such solutions may provide advantages in the short term, they may simultaneously increase switching barriers, knowledge and asset concentration and dependence on individual suppliers. As such, there is an important trade-off between short-term performance optimization and long-term strategic flexibility. From a dependence perspective, firms must therefore evaluate whether the performance benefits generated by a highly specialized solution justify the increased vulnerability and potentially reduced flexibility associated with the relationship. If a solution creates strategic advantage, higher dependence-related risks may be acceptable. However, the level of dependence and associated vulnerability should be in line with the strategic value generated by the solution relative to available alternatives.

For this reason, the framework introduces a step before the identification step: *Step 0 - Proactive Foundation*. This step focuses on proactively reducing unnecessary dependence exposure before vulnerabilities become embedded within the supply chain structure. The most important proactive measure is to avoid unnecessary dependence during initial sourcing and design activities. As observed in the empirical findings, excessive specification and over-customization can unnecessarily reduce the amount of potential suppliers without significantly improving the performance outcome. For example, specifying highly detailed technical requirements with limited strategic importance may drastically reduce the number of feasible suppliers while contributing little to overall competitive advantage.

Another important proactive principle is to preserve future substitutability through standardization, modularity, and redesign. Standardized and modular solutions widen the future set of potential suppliers, facilitate substitution, and reduce switching barriers if disruptions occur. While complete standardization may not always be feasible in highly specialized industrial settings, increasing the degree of modularity and reducing unnecessary customization can significantly improve future flexibility and resilience.

The proactive foundation further emphasizes the importance of preserving visibility, documentation access, and ownership clarity throughout the supplier relationship. Access to technical documentation, intellectual property rights, engineering specifications, and maintenance-related knowledge can significantly reduce vulnerability in the event of supplier disruption, bankruptcy, or relationship dissolution. Clear ownership structures and maintained access to critical information therefore act as safeguards against future operational discontinuity and reduce uncertainty during disruption events.

Finally, the proactive foundation includes continuous assessment of substitutability, alternative supplier availability, and requalification effort. Maintaining awareness of market alternatives, supplier capabilities and the resources required for switching suppliers increases preparedness. Even when immediate substitution is not feasible, understanding the feasibility, cost, and lead time associated with potential alternatives reduces uncertainty and improves preparedness in the event of disruption.

6.3 Identification

The first capability of the framework is ability to identify situations where supplier vulnerability is likely to emerge. The cases of Supplier A and Supplier B demonstrate that such vulnerability can be sudden or develop gradually, and that there are a range of mechanisms that can influence supplier vulnerability.

The first step in identifying situations is to understand the current relationships and the associated offerings within the supply base. Each supplier should be assessed individually, with the objective of mapping the underlying dependence structure and identifying potential misalignments in the relationship. This assessment begins by evaluating the relationship using the Dutch windmill, first placing the supplier in the Kraljic matrix and then shifting the perspective to the supplier and placing the relationship in the Dutch windmill.

The initial Kraljic matrix placement offers insights into how to treat the supplier, along with the importance on strategy and risk. The Kraljic matrix and the strategies presented in section 3.1.1 offer the recommended strategies and the power balance for each segment. The placement in the Dutch windmill is arguably more important to understand the expected relationship dynamics, as the perspective of the supplier will ultimately guide their behavior towards Tetra Pak. A core supplier will be a good match, provide opportunities and often long-time success. Development suppliers can be potential matches, but dependency structures and relationship specifics can impact risk and interest. Nuisance suppliers can be very risky and possibly mismatches and great caution should be taken with engaging in long-term relationships. Exploitable suppliers can easily gain bargaining power over Tetra Pak and control the relationship due to the power imbalance, and competition should be sought to lower risk and improve flexibility. Figure 10 and the accompanying strategies in section 3.1.1 offers insight into the different segment along with different strategies.

As seen in the cases of Supplier A and B, the position in the Dutch windmill are not static and can shift depending on external factors, such as an acquisition of the supplier or changes in the competitive landscape. Accordingly, this assessment should be conducted at regular intervals and in responses to changes in either the supplier or the relationship.

The second step in analyzing relationships is to evaluate the presence of the dependence-related vulnerability mechanisms identified through research question 1. Assessing the power asymmetry & bargaining power, knowledge & asset concentration, predisposing factors & precipitating events, low & irregular volumes and high switching barriers provides a comprehensive view into the risk mechanisms associated with the relationship. While an objective view of the mechanisms might be feasible, a qualitative evaluation conducted by a supplier manager familiar with the supplier and the context is likely sufficient. The precise method for weighing these mechanisms has not been addressed in this thesis and requires further research. The supplier managers should also be attentive to changes in the mechanisms, such as the change in behavioral patterns seen in the case of Supplier A. This analysis should be performed at regular intervals to understand the change of vulnerability mechanisms in the relationship.

The third and last step in identifying vulnerabilities is to monitor the suppliers financial health. As in the case of Supplier B, this capability provided the earliest indication of distress. Continuous monitoring of the financial performance enables an assessment of the actual impact of the

dependence.

These three aspects, relationship positioning, vulnerability mechanisms and financial health are the three core elements for identifying dependence-related supplier vulnerability in this thesis. Together, these aspects form an understanding of the risk level with a solution or supplier and provides a basis for further assessment. The aspects should not be viewed in isolation but considered altogether, as they impact each other and may reinforce or mitigate each other's effects.

6.4 Assessment

Once suppliers have been analyzed and potential risks have been identified, an appropriate response must be formulated in order to allocate resources where they generate the greatest value and to adequately address identified risks. This is achieved by considering relevant characteristics of both the risk and the buyer–supplier relationship. More specifically, the identified risk level, the urgency of the risk, and the nature of the relationship collectively determine the most appropriate course of action.

Firstly, the overall risk level should be assessed. If the identified risk within the relationship is low, no further action is required. However, if there is a perceived risk with the supplier, further assessment is facilitated. Secondly, the time until the potential impact of the risk materializes determines the feasibility of possible dependence management and reduction strategies. If the anticipated impact lies more than three years in the future, there is sufficient time to implement long-term strategic measures. If the impact is expected within a shorter time, the focus of the strategies must shift towards measures capable of generating results more rapidly. Within the framework, this characteristic is referred to as urgency, and responses are categorized into strategic, tactical, and operational levels depending on the available time horizon. Thirdly, the nature of the relationship influences the degree of collaboration and coordination that cna realistically be achieved. In strategic and close relationships, more collaborative and informal governance mechanisms may be feasible, whereas such measures are less applicable in transactional or distant supplier relationships.

6.5 Mitigation strategies

The third capability of the framework is the ability to select and sequence mitigation strategies that strengthen resilience across the supplier relationship life-cycle. This capability builds on the proactive foundation in Section 6.2, the identification logic in Section 6.3, and the assessment logic in Section 6.4. The purpose of *Step 3 - Mitigation Strategies* is to both define possible mitigation actions and to clarify when different actions become most relevant.

The mitigation logic therefore distinguishes between strategic, tactical, and operational responses based on the time available before the risk is expected to materialize. While the proactive foundation in Section 6.2 addresses how unnecessary dependence can be avoided before it becomes embedded, the mitigation capability focuses on how identified supplier vulnerabilities should be handled once a risk has been recognized and assessed. In this way, the framework connects the assessment output from Section 6.4 to the selection of mitigation strategies: low urgency allows strategic dependence reduction, medium urgency calls for tactical prepared-

ness, and high urgency requires operational measures that protect continuity under existing constraints.

The first mitigation level, 3A, concerns strategic long-term actions. This level is relevant when the assessed urgency is low and the organization still has sufficient time to address the underlying dependence before disruption becomes imminent. The focus is therefore not immediate continuity protection, but reducing structural vulnerability over time. This may include defining a long-term exit or transition roadmap, shifting future demand to alternative platforms, qualifying replacement suppliers or technologies, reducing installed-base lock-in over the life cycle, and gradually redesigning or standardizing solutions where technically and economically reasonable.

These strategic actions are most relevant when the firm has time to influence the future structure of the supply situation. They are therefore closely connected to dependence reduction. In the studied context and cases, such measures are constrained by high switching barriers, concentrated technical knowledge, installed base obligations, and extensive re-qualification requirements. As a result, they require engineering effort, validation, and time-consuming organizational coordination. However, they are also the measures that most directly address the root causes of dependence-related vulnerability, since they reduce reliance on supplier-specific products, knowledge, or service capabilities over time.

The second mitigation level, 3B, concerns tactical mid-term actions. When identification reveals a heightened risk of supplier vulnerability, or when a shifted company strategy motivates an escalated risk profile, the strategic focus shifts towards targeted anticipation and preparedness. At this stage, firms should intensify monitoring, conduct structured risk reviews, stress-test continuity assumptions, verify the completeness and usability of technical documentation, prepare bridge-buy or last-time-buy scenarios where relevant, assess third-party service options, and accelerate qualification or redesign work that may later become necessary. The objective at this stage is not full substitution, but to increase readiness before the firm is forced into reactive decisions under time pressure.

Tactical mitigation therefore functions as a bridge between long-term dependence reduction and short-term continuity protection. These measures do not necessarily remove the underlying dependence, but they improve the firm's ability to respond if the risk threat develops further. This is particularly important in supplier relationships where technical knowledge, spare parts, documentation, or service capability remain concentrated at the supplier. By preparing alternative response paths before disruption occurs, the firm reduces uncertainty and increases the number of feasible options available if the situation escalates.

The third mitigation level, 3C, concerns operational short-term actions. If vulnerability develops into a concrete continuity threat, or if there are indicators that a disruption will occur, the strategic task shifts from anticipation to continuity protection under existing constraints. The most feasible near-term responses are typically those that preserve access to the existing supply arrangement or protect the installed base. Such actions include activating continuity and escalation plans, securing critical spare parts and buffer stock, using refurbishment and condition monitoring, increasing the frequency of supplier follow-up, securing urgent technical support, and systematically collecting drawings, specifications, service procedures, and other forms of technical documentation.

These operational measures do not remove the underlying dependence, but they can reduce immediate exposure and provide time for more structural responses to be developed. In situations where continued access still depends on the focal supplier, continuity protection should also be complemented by actions that reinforce the relationship. This may include intensified managerial dialogue, recurring review meetings, continuity discussions, negotiated support for legacy requirements, and clearer allocation of technical support responsibilities. The main objective is to prevent existing dependence from escalating into supply disruption while alternatives are being developed.

For suppliers classified as strategic, or suppliers with particularly high operational impact, the mitigation response may require additional managerial attention beyond the standard 3A–3C actions. This may include senior management involvement, dedicated cross-functional teams, long-term support agreements, joint roadmaps, or targeted investments to secure capacity, technical support, or continuity. Such governance-intensive measures are not relevant for all supplier relationships, but may be justified when the potential disruption impact is high and the supplier remains difficult to replace. In this way, the strategic supplier box complements the urgency-based mitigation levels by ensuring that critical relationships receive sufficient organizational attention and escalation.

The main implication of this strategic logic is that resilience is strongest when vulnerability is addressed before it becomes urgent, already in *Step 0 - Proactive Foundation*. A simple but important principle is that the earlier dependence-related vulnerability is addressed, the wider the available strategy space becomes. Early design, sourcing, and governance choices cannot remove all dependence, but they can preserve options that are otherwise lost once technical specificity, supplier-specific knowledge, and switching barriers have become embedded in the supply situation. Acting early therefore reduces the need for high-urgency responses later, while also making such responses easier to execute if warning signals or disruption threats still emerge. In this sense, the purpose of the strategy capability is not only to guide firms once supplier vulnerability has become visible, but also to show how constrained mitigation becomes when dependence has already been built into the supply situation. The more proactively dependence is limited, documented, and governed, the less the firm has to rely on reactive continuity protection under time pressure. However, where dependence has already become established, firms still need to manage access to the existing supplier before long-term dependence reduction through redesign, standardization, or substitution becomes realistic.

6.6 Limitations

This framework is subject to several important limitations and considerations. First, the framework is primarily derived from internal buyer-side interviews, documentation, and perspectives. As a result, the motives, intentions, and actual capabilities of the suppliers were not independently validated. The analysis therefore reflects Tetra Pak's interpretation of the relationships and associated risks, rather than a fully two-sided assessment.

Second, while the framework is based on empirical findings and theoretical concepts, practical implementation have not been fully addressed. The framework identifies mechanisms of vulnerability and proposes mitigation strategies, but it does not account for organizational constraints related to implementation, such as resource availability, cost-benefit trade-offs, time

requirements or resistance to operational change. As such, the practical feasibility and effectiveness of individual strategies may vary depending on organizational context.

Another limitation concerns the identification step of the framework. Several vulnerability mechanisms, such as power asymmetry, knowledge concentration and predisposing factors are qualitative and difficult to objectively quantify. This makes it challenging to consistently measure the severity of individual mechanisms or evaluate the interaction effects between them. In practice, supplier vulnerability emerges through the combined influence of multiple interrelated mechanisms, whose effects are often dynamic and context dependent.

As a result, the framework should be viewed as analytically generalizable to similar critical, low volume sourcing contexts, rather than universally applicable across all types of supplier relationships.

6.7 Framework

Combining the findings and contributions of the thesis results in the framework presented in Figure 16. The framework clearly outlines the three steps, tools and methods used to identify, assess and develop strategies aimed at improving resilience and mitigating supply risks arising from dependence. Resilience is defined as the capability of a supply chain (or supply network) to prepare for disruption, respond to unexpected events, and recover to a desired level of performance. Using this framework, firms can prepare for disruption by identifying similar situations and act proactively and respond to unexpected events by using the reactive strategies in order to recover to a desired level of performance.

The applicability of the framework extends beyond the specific case of Tetra Pak, and should be an imperative tool for all firms seeking to understand the implications of dependence on the supply chain. The proactive foundation serves as an important reminder that high levels of dependence are not required, but must be chosen carefully when the benefits outweigh the potential risks. The Dutch windmill, in combination with the supplier vulnerability mechanisms create a detailed picture of the strength, distance and risk in a relationship. Together with the suppliers financial health, these aspects give a good indication of risk of an unwanted dissolution with a supplier, both chosen and forced. The assessment logic concentrates efforts to suppliers who create value and pose an actual risk, and ensures responses are of appropriate nature considering the time horizon and relation characteristics. By dividing the mitigating strategies into three separate levels based on the time horizon firms can always revert to the framework in any step of the life cycle with a supplier to gain an understanding of the implications of how asymmetric dependence can cause supplier vulnerability in a supply chain under low volume, critical context.

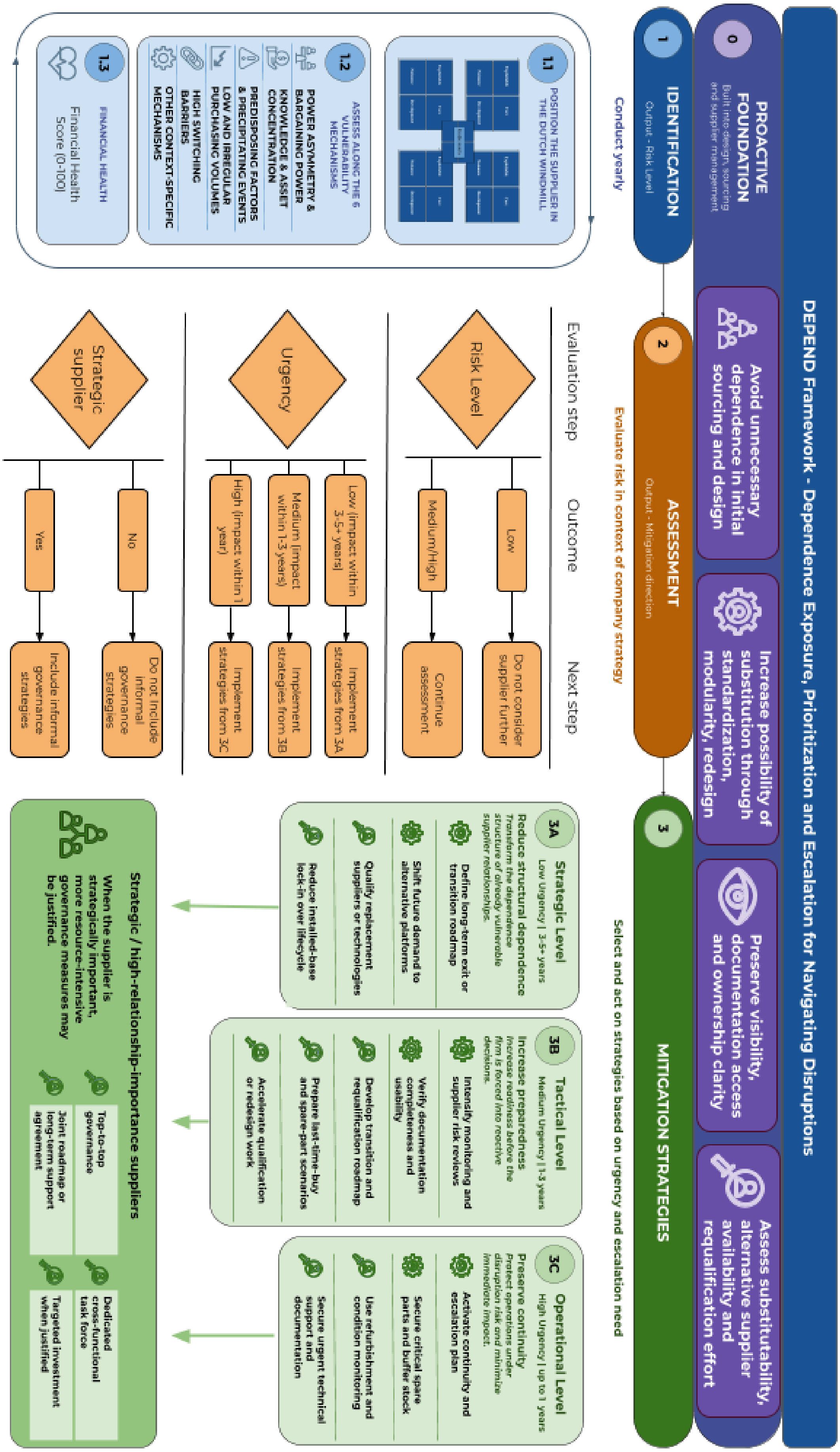

Figure 16: DEPEND Framework - Dependence Exposure, Prioritization, and Escalation for Navigating Disruptions (Source: Authors)

7 Conclusion

This chapter summarizes the thesis by presenting the findings connected to the purpose and research questions. This is followed by a discussion of the contributions to theory and practitioners. Finally, limitations and future research is presented and discussed.

To conclude the thesis, the following chapter explains and discusses the findings, based on the purpose and research questions. Thereafter, the contributions to the theory as well as to practitioners is discussed. Lastly, a discussion on identified limitations and possible directions for future research is held.

7.1 The Research Questions

The purpose of this thesis was to analyze how asymmetric buyer–supplier dependence affects Tetra Pak's exposure to supplier vulnerability and supply disruption risk for low volume, critical components, and to develop a decision framework that supports effective supply risk mitigation in such contexts. The intention has been to understand the implications of being intertwined in a supply chain network, and how the dependence on external actors can have an impact on Tetra Paks operations. This was achieved by applying the case study method and studying two ongoing supplier relationships within the converting equipment team at Tetra Pak. The design of the case study was planned to be well documented and rigorous to allow the findings to hold beyond the specific study context, exhibit a high degree of truth-value and be traceable.

To begin, the purpose and research questions were iteratively developed with the supplier management team at Tetra Pak, to facilitate a rewarding thesis for both parties. This concluded in the final purpose presented above with research questions aimed at finding actionable insights to achieve greater resilience in the supply chain regarding critical, low volume sourcing. The first step was a thorough narrative literature analysis, finding and summarizing the available research on risk management & resilience, resource dependency theory and supplier relationship management. This resulted in an analytical framework, serving as the foundation for analysis.

The gathered data consisted of interviews with key personnel to understand current practices & processes, specifics regarding suppliers and the relations, current risk management tools and obsolescence. This qualitative data was supported by quantitative documentation regarding process descriptions, supplier-specific information, relationship specifics and currently used software and tools. Once the data from these sources had been analyzed, insights provided the necessary information to construct the DEPEND framework, detailing how to identify, assess and apply proactive and reactive mitigation strategies to improve resilience in a critical, low volume sourcing context. To achieve this, three research questions were posed.

RQ1. *What dependence-related factors cause supplier vulnerability and supply disruption risk for suppliers of critical equipment and service at Tetra Pak?*

This research question was divided into two parts. To answer the question conclusively, insights from both current theory and new findings from Tetra Pak was required. Current research on resource dependency theory and supplier relationship management was studied to find six vulnerability mechanisms that have the potential to cause supplier vulnerability and supply disruption risk. Theses were power asymmetry & bargaining power, knowledge & asset concentration, predisposing factors & precipitating events, low & irregular volumes, high switching barriers and other context specific mechanisms. Of these, both studied supplier relationships showed signs of the first five vulnerability mechanisms. To varying degrees, the mechanisms impacted the probability and impact of potential supply chain disruptions, with high switching barriers consistently presenting the greatest potential impact for supply risks. These dependence-related vulnerability mechanisms were shown to generate limited risk in isolation, but substantially increasing the supply risk and supplier vulnerability when combined, negatively impacting supply chain resilience.

RQ2. *Which supply risk mitigation strategies are feasible and effective for managing vulnerable suppliers in this context, given Tetra Pak's operational and commercial constraints?*

The second research question was similarly divided into two parts to allow for a theoretical and practical viewpoint. Insights from theory revealed two broad paths of mitigation in situations of dependence: dependence reduction and dependence management. Within these paths, several mitigation strategies exist, summarized in Table 3. In addition to these, certain mitigation strategies focusing on short term continuity buffering to preserve operations were also identified which are feasible when dependence cannot be reduced or fully governed. The analysis of the studied cases found that the most feasible and effective strategies for managing vulnerable suppliers in a low volume, critical context are not singular tools but a synchronized combination of different measures. In the short term, buffering, governance, and other continuity-preserving measures are most feasible path to manage exposure. Over longer time horizons, standardization, substitution, and alternative sourcing offer the strongest path to regain strategic independence. Ultimately, management effectiveness is defined by the ability to balance the immediate need to survive within a dependency with gradual efforts to reduce that dependence over time.

RQ3. *How can a governance framework be designed so that it can be used to identify, assess, and mitigate similar dependency-driven supply vulnerabilities and improve resilience in future sourcing decisions at Tetra Pak?*

To extract the essence of the findings and apply them for insights into an actionable governance framework, the third question summarized the findings of the prior research questions to converge into a framework. The discussion of the findings related to the first two research questions led to the conclusion that an effective framework must be capable of analyzing dependence exposure and associated risks throughout all stages of the supplier relationship, from supplier selection and relationship development to potential dissolution. As such, the framework must be able to identify risky suppliers, assess these and apply mitigation strategies in a proactive and reactive manner. The resulting framework, found in Figure 16, sections these three capabilities into discrete steps with actionable analysis and mitigation strategies. In the identification step, the relationship is analyzed using the Dutch windmill. Then, the relationship is assessed along the vulnerability mechanisms. Finally, the financial health of the supplier must

be taken into consideration. Combining these three elements reveal a foundational analysis of the risk in the buyer-supplier relationship. Next, assessment of the vulnerable supplier relations must be conducted by accounting for the overall dependence-related supplier risk, the urgency of the identified risks and the possibility of collaboration and coordination within the relationship. This allows mitigation strategies to be applied where they have the most effect and to where there are most strategically sound. Based on the analysis and identification, appropriate mitigation strategies can be applied to manage and reduce the risk systematically, and as such increase the resilience of the supply chain in a critical, low volume sourcing context.

7.2 Contributions

The contribution of this thesis is within two distinct areas: (1) Advancing the theoretical link between dependence and resilience within a critical, low volume sourcing context, and (2) a practical framework for understanding and analyzing dependence-related risk withing critical, low volume sourcing.

In line with Pfeffer and Salancik (2003), this study has shown that no firm can exist in isolation but rather is dependent on external actors for organizational survival and to achieve high performance. A vital property of supply chains, often studied in other disciplines, is resilience. This thesis analyzes the intersection of these concepts, studying the resilience implications in high dependence situations, where purchasing volumes are low, but the purchased offers are critical for Tetra Pak. It expands upon segmentation by showcasing the usefulness of the Dutch windmill by Van Weele (2018) and how it is especially important in the studied context. The thesis also performs an analysis of dependence strategies under critical, low volume sourcing and contributes to the ongoing research on resource dependence theory by Hillman, Withers, and Collins (2009).

The main contribution of the thesis is however to Tetra Pak and practitioners within similar industries, where the actionable governance framework presents a structured way of working with improving resilience under dependence constraints within low volume sourcing in real contexts.

7.3 Limitations and Future Research

This thesis is subject to several important limitations that should be considered when interpreting the findings and conclusions. As outlined in the introduction, the study is conducted within a single organizational context and focuses on two supplier relationships at Tetra Pak. While this narrow scope has enabled in-depth analysis and detailed understanding of the studied relationships, it limits the generalizability of the findings to other firms, industries, and supply chain settings. The conclusions are therefore context dependent and should be interpreted cautiously outside similar industrial environments or product types.

The studied supplier relationships are specifically characterized by low volume, irregular purchasing patterns combined with high operational criticality. The analytical framework and identified vulnerability mechanisms are therefore developed within this particular relationship structure. Consequently, the applicability of the findings to supplier relationships with different demand structures, competitive dynamics, or operational characteristics remains uncertain. The

industrial setting also constitutes a limitation. The analysis is situated within a capital-intensive and highly customized converting equipment environment, where technical specialization, long equipment life cycles, and high switching barriers strongly influence supplier dependence and vulnerability. These conditions may differ substantially from less customized or more standardized supply chain contexts.

The study is also limited to relationship- and process-level analysis and does not examine broader supply chain network effects or multi-tier dependencies. Similarly, legal, contractual, and regulatory complexities are not analyzed in depth.

Finally, due to the 20-week time constraint of the thesis, the practical implementation and evaluation of the proposed framework were not included. The study instead focuses on framework design and conceptual decision support. As such, the organizational feasibility, implementation complexity, system integration requirements, cost implications, and long-term effectiveness of the framework have not been validated.

Future studies should seek to build upon this thesis' findings. Importantly, expansion to other organizations, industries, countries, settings, tiers and relationship types is required to understand the frameworks boundaries of application. The proposed model is based on the scope of this study and does not allow for alterations of the supplier's action, but rather only internal processes and actions within the relationship. Future research could analyze the capabilities of firms to impact suppliers actions to improve resilience and manage or reduce dependencies.

Further, the framework currently relies on qualitative analysis of suppliers and relationship attributes within the vulnerability mechanisms. This requires a dedicated supplier manager with a good understanding of the competitive market, supplier capabilities and insights into the history of the relation. Future studies should attempt to quantify the identification step of the framework, to allow a quicker, more accurate and consistent evaluation of supplier risk. Further understanding of the vulnerability mechanisms is required to understand each aspects contribution to risk and the interactive effects of several present mechanisms.

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Interview Guide - Master's thesis "Managing Supplier Vulnerability in Low-Volume Critical Supply: Designing Resilient Sourcing and Governance Mechanisms"

Date:
Respondents name:
Respondents email:

Participation in this study is voluntary. You may decline to answer any question and may withdraw from the interview at any time without providing a reason.

Due to the limited number of interviews and the organizational roles represented, full anonymity in relation to the company cannot be guaranteed. Although names will not be disclosed, individuals may potentially be identifiable internally based on their position or perspectives.

All information shared during the interview will be treated confidentially, and only shared with permission from Tetra Pak. Any identifying details, such as names and suppliers will be omitted or adjusted to avoid traceability. The data collected will only be used for this master thesis and will be deleted after the completion of the assignment.

The interview will be recorded solely for transcription and analysis purposes. Recordings and transcripts will be stored securely and accessed only by the researchers. All data will be handled in accordance with applicable data protection regulations and used exclusively for academic purposes within this thesis project.

By proceeding with the interview, you confirm that you have been informed about the purpose of the study and consent to participate under these conditions.

Introduction

1. Shortly describe your role and responsibilities.

Risk & Resilience

2. How do you currently identify & assess supply risks in your supply chain?
3. Are there formal risk assessment protocols in place?
4. Are there formal risk mitigation protocols in place?
5. Which position is responsible for initiating and implementing risk management tools for supply risks?
6. Are there any risk sharing agreements with the suppliers?
7. Which position owns the decision to financially support or stabilize a supplier?
8. Which position monitors risk exposure?

Supplier selection & determining the need

9. Which position(s) initiates a business need?
10. Which positions are involved in determining the need and weighing alternative solutions?
11. What does the supplier selection process look like?
12. Are there risk assessment practices during the supplier selection process?
13. How are different aspects regarding the need weighed?

Supplier relations & mechanisms of vulnerability

14. How does information sharing take place between Tetra Pak and the suppliers?
15. What kind of information is shared?
16. Have there been any conflicts, problems or events of misalignment in the relationships?
17. Has there been cooperation with the suppliers on any level?
18. Looking back at the last 10 years of dealing with the suppliers, could anything have been done to avoid the problems occurring now?

Supplier specific

19. What offerings do you purchase from the supplier (products, service, others) and how large is the spend on each offering?
20. How long has business been ongoing with the supplier?
21. How important is the equipment for your business?
22. How predictable are order volumes for the different offerings?
23. If the supplier could not deliver spare parts or service from today, what would the consequences be?
24. Are there minimum value commitments?
25. What minimum volume would make this relationship stable?
26. What share of the supplier's revenue comes from Tetra Pak?
27. How dependent is Tetra Pak on the supplier?
28. Who is more dependent in practical terms, and why?
29. How and when did you realize that there were issues with the supplier?
30. What makes switching suppliers difficult?
31. What technical knowledge is unique to this supplier?
32. Are there patents, proprietary tools or other barriers preventing alternative solutions?
33. Do you currently have multiple suppliers or contracts with another supplier who can (temporarily or permanently) fulfill the needs of the distressed supplier, should their operations cease today?
34. How many qualified alternative suppliers exist?
35. What other alternative solutions are you currently considering?
36. How are you working to prevent a similar situation from happening in the future?
37. How do you see this project contributing to long-term supply resilience?

Legal & contracts

38. Are there any contractual obligations that exist towards customers or internal owners that would prevent switching suppliers or exploring alternative solutions?
39. Are there any contractual obligations that exist towards the supplier that would prevent switching suppliers or exploring alternative solutions?

Obsolescence

40. How do you identify suppliers where the need will no longer exist?
41. How do you identify suppliers that might cease their business operations?

42. What potential actions are taken to decrease the impact or probability of risks associated with unwanted endings of supplier relations?
43. How is obsolescence contractually implemented? Are there contractual agreements regarding the dissolution of a relationship, conflicts, bankruptcy or other reasons for obsolescence?
44. Are there safeguarding measures in place to prevent supply disruptions?
45. Where in your current process do you think obsolescence is actually created, not just detected?
46. If you could change one decision upstream (design, sourcing, contracting), what would reduce obsolescence the most?
47. What are you currently doing too late in the process?

Other

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48. Is there anything we haven't asked that would be important to get the full picture?