Integrating Risk into Cost-based Sourcing Decisions

A Case Study at Volvo Buses

Master's thesis in Supply Chain Management

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Cover: Picture of a Volvo Buses BZR Electric (Volvo Group, 2025)

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SUMMARY

As competition intensifies in the automotive industry and uncertainties continue to grow, purchasing organizations face increasing pressure to balance cost efficiency with supply chain resilience. At Global Buses Purchasing (GBP) within Volvo buses, these two priorities have been identified as central strategic objectives. However, no practical tool currently exists that integrates supplier-related risks into cost-based sourcing decisions. Cost and risk are treated as parallel but separate dimensions where risk is discussed in governance forums without directly influencing the cost figures used to compare supplier quotations.

This thesis investigates how supplier-related risks can be more systematically incorporated into the sourcing process at GBP. The study was conducted as a qualitative case study, drawing primarily on semi-structured interviews with 34 respondents across GBP and Prevost, supported by analysis of internal assessment resources and documentation, and an Analytical Hierarchy Process-based (AHP) online survey distributed to internal stakeholders within GBP.

The empirical findings reveal a consistent pattern in which risk assessments serve primarily as screening mechanisms rather than integrated inputs to cost-based supplier comparisons. Building on these findings, the thesis develops a risk-adjusted Total Landed Cost (TLC) model that translates a pre-existing risk assessment tool into a risk index which is applied as a multiplier to the baseline TLC. This will allow sourcing alternatives to be compared on a consolidated economic basis within GBP's existing governance structure.

The thesis thereby contributes a structured empirical account of how risk is currently managed within GBP's sourcing process and proposes a pragmatic model for integrating risk directly into cost-based supplier comparisons in a way that is transparent, usable and compatible with GBP's existing resources and governance structures.

Keywords: Total Landed Cost, Total Cost of Ownership, Purchasing, Procurement, Risk, Supplier Selection, Supplier Evaluation

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Fredrik Thor & Joel Torberntsson
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Glossary

AHP – Analytical Hierarchy Process

APQP - Advanced Product Quality Planning

BA – Business Area

CI – Consistency Index

CR – Consistency Ratio

FMEA – Failure Mode and Effects Analysis

GBP – Global Bus Purchasing

GTP – Global Trucks Purchasing

PD – Purchasing Director

RFQ – Request for Quotation

RI – Random Index

SC – Sourcing Council

SNR – Supplier Network Resilience

SRET – Supplier Risk Evaluation Tool

SSA – Supplier Selection Approval

SVP – Senior Vice President

TCO – Total Cost of Ownership

TLC – Total Landed Cost

VBC – Volvo Bus Cooperation

VP – Vice President

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1 Introduction

This chapter introduces the case company and presents the background of this thesis. It then outlines the study's overall aim and purpose, offering context for the research approach. Finally, the scope and delimitations are defined to specify the boundaries within which the thesis is conducted.

1.1 Volvo Buses

Volvo was founded in 1927, with the release of their first bus the year after, in 1928 (Volvo Buses, n.d.-a). Since then, Volvo Group has grown into a world leading manufacturer of Trucks, Buses, Marine Systems and Construction equipment, with Volvo Buses being one of the business areas (BAs) and one of the world's leading providers of people transport solutions. However, the different BAs contribute differently to the Group's overall finances: Volvo Trucks accounts for 68% of yearly turnover, while Volvo Buses contributes 5% (Volvo Group, 2026). This illustrates a substantial difference in scale between the two BAs and highlights the comparatively smaller, yet strategically important, role of Volvo Buses within the Group. Today, Volvo buses operate in 85 countries, with a network of over 1500 dealerships and service centers (Volvo Buses, n.d.-b).

As part of its global operations, Volvo Bus Cooperation (VBC) also encompasses the North American brand Prevost, a Canadian bus manufacturer known for premium touring coaches and bus shells for high-end motorhomes and other conversions (Prevost Car, n.d.). Prevost was founded in 1924 and was fully integrated as a subsidiary of Volvo Group in 2004. They have an assembly plant in Sainte-Claire, Quebec and service centers across Canada and the US.

Given that Volvo Buses operate on a significantly smaller turnover compared to Volvo Trucks, coordinated purchasing becomes essential for achieving competitive cost levels. Purchasing activities are therefore strategically coordinated Between Volvo Buses and Prevost, something which allows them to leverage greater economies of scale, harmonize supplier relationships, and ensure consistent quality standards throughout the organization (Weele & Rozemeijer, 2022). A collaboration which allows Volvo Buses to access a wider market, and Prevost to benefit from shared technologies, platforms, and centralized procurement processes.

1.2 Thesis Background

As competition intensifies and expectations for sustained growth remain unchanged, increased pressure is placed on company's procurement function to reduce both sales and cost prices (Weele & Rozemeijer, 2022). GBP within Volvo Buses is no exception (Volvo Buses GBP, personal communication, January 22, 2026).

With growing competition from other manufacturers offering highly cost-competitive people-transport solutions (Suneson et al., 2025), VBC naturally faces mounting pressure to review and renegotiate their supplier-contracts. At the same time, heightened geopolitical tensions and a more volatile business environment create additional uncertainty. This combination puts Volvo along with many other companies in a precarious situation, where trade-offs must be made between cost savings and mitigating the risks of future supply chain disruption.

Unlike cars or even trucks, buses are highly customizable vehicles (R20). The ordering process often requires heavy involvement of engineers and design teams, who tailors the product to meet each customer's exact requirements and to ensure seamless integration into the customer's existing fleet and infrastructure. This high degree of customization results in a broad supplier base, often delivering lower volume and specialized components. Consequently, procurement decisions within Volvo Buses can be complex, with variability in specifications, limited economies of scale, and supplier dependency all playing a more significant role than in more standardized vehicle segments.

GBP's strategy for 2025–2026 centers on two major focus areas, namely optimizing total landed cost and strengthening supply chain resilience. While purchasers at GBP are aware that some suppliers carry greater risk than others, there is currently no practical and easy-to-use tool that integrates these two strategic priorities in the purchasing decision process. This gap illustrates a need for mechanisms that can help balance cost objectives with long-term supply chain resilience, an issue that becomes even more critical in the context of Volvo Buses' high-mix, low-volume purchasing environment.

1.3 Aim and Purpose

Strategic sourcing decisions often lack robust methods for quantifying and evaluating how supply chain related risks could be translated into financial exposure and how these risks can potentially affect total landed cost. At GBP, cost and risk are currently treated as parallel but separate dimensions in the sourcing process. While risk is explicitly discussed and assessed through various tools, these assessments do not directly influence the projected total landed cost figures when comparing supplier quotations. As a result, sourcing alternatives that may appear cost-efficient can expose Volvo Buses to substantial risk that may lead to increased costs over time.

The purpose of this thesis is to investigate how risk-related factors can be more systematically incorporated to support the evaluation of suppliers within Volvo Buses' sourcing process. The study aims to provide insights into the tradeoffs between risk and cost in sourcing decisions and to enable a more informed comparison between sourcing alternatives. Based on this purpose, the following research questions are formulated to guide the study:

RQ1 – Which cost- and risk factors are most relevant when evaluating a supplier within Volvo Buses' sourcing process?

This question focuses on identifying the cost and risk factors that stakeholders at GBP consider to be the most important when evaluating potential suppliers. This includes both the factors currently incorporated into the sourcing process and those that are recognized as relevant but not yet systematically used prior to final decision making and contract signing.

RQ2 – How can these cost and risk factors be integrated into a risk-adjusted cost model when evaluating suppliers?

This research question examines how the factors identified in research question 1 can be translated into a model that adjusts the baseline cost breakdown to reflect a supplier's overall risk exposure. Rather than treating risk as a parallel qualitative dimension alongside cost, the question seeks to explore how risk exposure can be incorporated directly into the cost figures used when comparing suppliers in sourcing decisions.

RQ3 – How can risk integration be designed to better align with existing sourcing tools and processes?

This research focuses on identifying which tools the identified risk factors should complement to be integrated into GBP's existing sourcing processes and infrastructure. The aim is to ensure that risk factors are integrated with current supplier evaluation tools and processes in a smooth manner that aligns with already established procedures, without adding unnecessary complexity.

Overall, these research questions are designed to progress logically from empirical grounding through analytical development to practical application. RQ1 establishes which factors matter most in GPB's sourcing context, RQ2 explores how these factors can be brought together into a coherent cost-and-risk evaluation framework, and RQ3 examines how that framework can be made actionable within GBP. Together, these research questions reflect the thesis's ambition to bridge the gap between theoretical models for risk-adjusted sourcing and the practical constraints of a low-volume, high customization purchasing environment.

1.4 Scope and Delimitations

As described in the 1.2, Volvo Buses operates with a broad and heterogeneous supplier base characterized by low purchasing volumes, high product customization, and many unique components. This results in an extensive parts catalogue and sourcing environment that differs from higher-volume BAs within the Volvo Group, such as Volvo Trucks. These structural characteristics make comprehensive data collection challenging and limits the feasibility of applying highly analytical or data-intensive sourcing models across the full supplier portfolio.

The first limitation concerns the targeted accuracy and ambition level of the proposed model. In alignment with guidance from the thesis supervisor at Volvo Buses (R9), the expected accuracy has been defined as "*fairly correct*" rather than exact or fully analytical. The intention is to provide actionable decision support that improves existing sourcing practices while remaining simple to use and requiring minimal additional data input. As a result, the model prioritizes usability, transparency, and ease of integration over numerical precision. To keep the added workload low, the model is designed to build on existing tools and data sources already approved and used within Global Bus Purchasing, which also constrains the level of detail and customization that can be achieved.

The applicability of the model is further limited to external supplier evaluation within GBP and is intended to be used only after the make-or-buy decision has already been made. Consequently, the model does not support strategic decisions regarding vertical integration or in-house production, nor does it address early design-phase decisions that influence sourcing alternatives. Its purpose is confined to comparing supplier quotations and sourcing recommendations in cases where external procurement has already been selected as the preferred solution. Another important limitation is that the thesis presents a conceptual and process-oriented model rather than a fully operationalized digital solution or spreadsheet tool. While the mathematical logic and integration points with existing tools are described in detail in later chapters, the implementation of a working version of the model falls outside the scope of the study. This means that practical considerations related to system development, automation, user interface design, and long-term maintenance are not addressed.

Due to time and data constraints, the proposed model has not been tested on real, ongoing sourcing cases. Instead, the analysis relies on documented sourcing tools, interview material, and retrospective evaluation of existing practices. As a result, the study does not empirically validate how the model would perform relative to current decision outcomes, nor does it quantify potential cost differences that might arise from its use in live sourcing situations. Furthermore, the thesis does not assess how the introduction of a risk-adjusted cost model would influence purchasing behavior, negotiation strategies, or final sourcing decisions in practice at GBP. The findings therefore address decision-support capability rather than decision outcomes. Behavioral aspects such as how buyers might adapt their recommendations, how suppliers might respond during negotiations, or how governance forums might interpret risk-adjusted figures are outside the scope of the analysis. The proposed framework also evaluates supplier risk at a specific point in time within the sourcing process and does not account for dynamic changes in risk exposure over the lifecycle of a contract. Risks related to supplier financial deterioration, technological obsolescence, regulatory change, or shifts in geopolitical conditions may evolve after supplier selection and are not continuously updated within the model. As such, the model should be seen as complementing, but not replacing, ongoing risk monitoring activities.

Finally, supplier-related risks are translated into cost implications through aggregated adjustments rather than through probabilistic expected-value calculations of individual risk events. This approach was chosen intentionally to balance analytical rigor with practical usability and data availability. However, it limits the ability to estimate the exact expected monetary value of specific disruptions or failures and instead provides a relative, comparative representation of supplier-related risk exposure. Taken together, these limitations reflect deliberate methodological choices aimed at ensuring relevance, feasibility, and acceptance within Volvo Buses' sourcing context. While they constrain the generalizability and analytical precision of the results, they also define the contribution of the thesis as a pragmatic step toward integrating risk considerations into cost-based sourcing decisions.

2 Methodology

This chapter presents the research methodology used throughout this master thesis. It explains what scientific methods were used for data collection and how it was analyzed in accordance with the research questions, to arrive at the final conclusions. Presented lastly are the measures that were taken to ensure the validity and reliability of the study's findings.

2.1 Research Method

According to Bell et al. (2022), qualitative and quantitative research represent two overarching methodological approaches that differ in how empirical data is collected, analyzed, and interpreted. Quantitative research relies on numerical data collected through methods such as surveys, experiments, and statistical analysis, and typically follows a deductive logic aimed at testing hypotheses and identifying patterns or relationships between variables. Qualitative research, in contrast, focuses on non-numerical data and is suited to gaining deeper and more nuanced understanding of phenomena where existing knowledge is limited (Miles et al., 2014). This approach emphasizes flexible data collection methods such as open-ended interviews and document analysis, with analysis based on interpretative processes in which the researcher actively derives meaning from the material.

Although traditionally applied separately, qualitative and quantitative methods are increasingly combined to strengthen empirical inquiry and offset their respective limitations (Bell et al., 2022). This thesis primary methodological orientation is qualitative, reflected by the central role of semi structured interviews with employees at GBP. These interviews form the main empirical foundation of the study and are used to explore sourcing practices, decision support tools, and perceptions of supply chain risk. Alongside its qualitative core, the thesis also incorporates a minor quantitative component in the form of an AHP based online survey. This element adds a structured and numerical perspective to the analysis by examining how supply chain risk factors are prioritized within one of GBP's supplier evaluation tools. Rather than representing progression from one method to another, the qualitative and quantitative elements are treated as complementary. Together, the interviews and AHP analysis enable a richer understanding of both the contextual and evaluative dimensions of supply chain risk management within the sourcing process.

2.2 Research Design

How research data is analyzed and how evidence is generated can be categorized into five research design frameworks: experimental, cross-sectional, longitudinal, case study, and comparative design (Bell et al., 2022). Given the qualitative core of this thesis and the aim of developing an in-depth understanding of organizational sourcing practices, the research design is best described as a case study with the unit of analysis being GBP at Volvo Buses and to some extent Prevost. All activities beyond this functional and organizational boundary fall outside the scope of the study.

The case study design allows for an in-depth examination of a group or organization by drawing on multiple sources of evidence, including qualitative interviews and document analysis, to build a comprehensive understanding of the organizational context (Bell et al., 2022; Miles et al., 2014). Within this framework, the focus is on developing a holistic understanding of the Global Buying Process by examining patterns, relationships, and underlying mechanisms across the collected empirical material. This approach enabled the identification of cost and risk drivers most relevant to GBP, consistent with the view of case studies as a means of strengthening insights through the convergence of evidence within a clearly defined unit of analysis (Bell et al., 2022).

Data collection is conducted within an established theoretical framework, and the use of multiple data sources, enhancing the credibility of the findings. This approach was particularly suitable given that the phenomenon was difficult to investigate outside its natural context and cannot easily be quantified, as Volvo Buses operates within a unique purchasing environment characterized by complex sourcing conditions (R20). At the same time, the context-specific nature of the case study limits the extent to which the findings can be generalized and applied to dissimilar organizations. Despite this limitation, the depth and contextual richness provided by the case study design are considered appropriate for addressing the exploratory objectives of this thesis.

2.3 Research Process

What follows is an outline of the process followed for research and reaching the conclusion of this thesis. The steps are presented in broad strokes as the transition from each often was gradual without a definitive date existing for the ending or beginning of the steps. The research process can be seen in Figure 1, where the following text further describes each step of the research process in more detail.

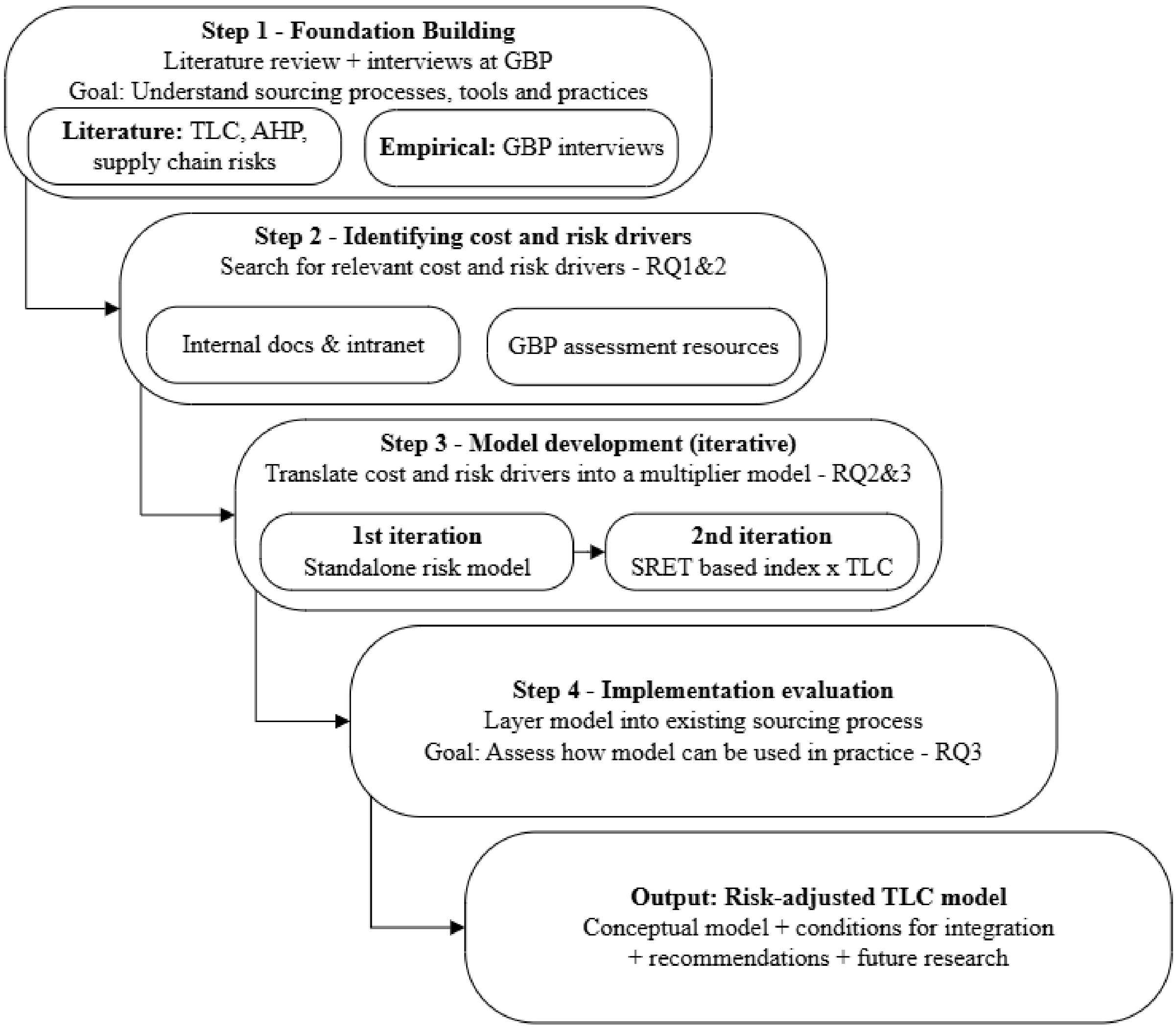

Figure 1: Outline of research process used for this thesis

The thesis was initiated by building an academic foundation of the subject through a literature review, a work that was ongoing for large parts of the study. Simultaneously as the early stages of the literature review, unstructured, semi-structed interviews and personal communications were held with individuals of interest to create an understanding of GBP's sourcing process, practices, and resources. This presented valuable insights into how supply chain considers risks when evaluating and selecting suppliers. The aim of this was to understand their current processes and tools that later were used to identify how and where the resulting model could best be implemented to support GBPs supplier evaluation process.

The second step of the thesis was to carry out a search, with a focus on identifying sourcing related cases with the purpose of determining which cost and risk drivers are most relevant (see RQ1), and how these drivers are considered when evaluating suppliers. This step was informed by insights gained during the qualitative interviews and personal communications conducted in Step 1. In line with established practices within management literature, where qualitative inquiry often proceeds and acts as preparation for the next quantitative phase (Azorin & Cameron, 2010), where the qualitative interview findings helped understanding GBP's processes and tools, how the users relate to them and to identify relevant sourcing cases to test the model on. This step's search was based on internal documents, recommendations received during interviews, and sourcing case materials identified through personal communications.

As for step 3, it was determined what level of data input and accuracy was needed, given the *"fairly correct"* accuracy target and the aim for simplicity as mentioned in 1.4. This step focused on developing a risk-adjusted model that translated the identified cost and risk factors into a cost multiplier (see RQ2). Drawing on literature related to TLC, Total Cost of Ownership (TCO), AHP, and supply chain risks, relevant metrics were identified based on GBP's existing practices and the availability of data from sourcing cases. In parallel, a risk profile was developed by identifying major risk categories such as supply risk, relationship risk, and environmental risk, and linking them to the TLC factors they were expected to influence, for instance supply risk affecting inventory-related costs. The development of the model in step 3 of the research process followed an iterative approach, in which the idea of the model was continuously reviewed and refined based on new findings from literature, empirical material, and model assumptions, rather than being fixed from the start. This iterative approach allowed insights from interviews, sourcing cases, and academic literature to influence one another as the model evolved, which is consistent with iterative research work commonly described in case-based and applied research settings (Mills et al., 2010). Throughout this step, considerations were also made regarding required data availability and accuracy, guided by the aim of achieving a *"fairly correct"* level of precision while keeping it simple and practical to use.

The last step was crucial for evaluating if the model could be implemented within the existing process infrastructure for selecting and evaluating suppliers, as well as for identifying potential changes needed in the current way of working to accommodate it (see RQ3). Using internal documents, sourcing case material, and interview insights, the model was layered into the current way of working to compare traditional cost assessments with risk-adjusted results and to observe how supplier rankings and perceived attractiveness changed, especially in cases with known risk exposure. Feedback from buyers and other stakeholders, together with insights from academic articles, was used to determine where in the sourcing process the model could best be utilized and how it could align with existing tools and resources.

2.4 Data Collection

The data collected during the duration of this thesis comes from both primary and secondary sources. Secondary data has been collected through a literature review of relevant books and articles. Moreover, access to internal documents via Volvo's intranet has also been used as a source of secondary data. Primary data has been gathered through qualitative interviews, described in more detail in Section 0.

2.4.1 Literature Review

In the early stages of the research process a literature review was conducted. The approach adopted was to perform a broad search at the outset of the thesis to gain a comprehensive understanding of the subject area and its relevance.

The main body of secondary information comes from course literature and academic journal articles. Some of these sources were identified through previously attended courses in the master's program in Supply Chain Management at Chalmers University of Technology, where literature from the 2024 course "*Purchasing and Supply Management*" was of relevance. Additionally, systematic literature searches were conducted using keywords such as "*Total Cost of Ownership*", "*Risk adjusted cost models*" and "*Risk multiplier in supplier selection*". Google Scholar was used as the primary search engine, alongside the Chalmers Library and Web of Science databases.

Identified sources were initially summarized using AI-tools to gauge their relevance to this thesis (see 2.5.3) and acted as a filter for collected articles. Once this filtering had been done, the most relevant sources were collected for more in-depth analysis.

2.4.2 Qualitative Interviews

Qualitative interviews were used as a primary method for data collection, with the term encompasses both unstructured and semi-structured interview formats (Bell et al., 2022). Qualitative interviewing is characterized by open ended, dialogic inquiry aimed at rich, contextualized accounts of participants' experiences, meanings, and practices rather than quantifying predefined variables. This approach allows interviewers to depart from strictly predetermined questionnaires, vary the order of questioning, and adjust research emphases in response to the interview situation.

An overview of all interviews conducted as part of this study is provided in Table 1. The overview summarizes interviewees' roles, organizational affiliation, and interview format. All but two interviews were conducted with individuals working at GBP. Interviewees external to GBP are marked with "(ext.)" next to their role titles. The interview format is indicated in the Format column, where S denotes a semi-structured interview and U denotes an unstructured interview.

Table 1: Overview of the interviews conducted as part of this thesis

Respondent(s)	Role(s)	Date	Topic	Format	Duration
R1, R2, R3	VP, PD, Commodity buyer	27/1	N/A	U	60 min
R4	VP & Site Manager	29/1	N/A	S	56 min

R5, R6, R7	Director Sustainability & Business Development, Sustainability Manager x2	30/1	N/A	S	50 min
R6	Sustainability Manager	2/2	Joined a presentation of a sourcing case	U	55 min
R8	Purchasing process & Systems Manager	10/2	SRET & purchasing process discussion	S	56 min
R9	PD & Thesis Supervisor	18/2	Feedback on first iteration of model	U	50 min
R10	SNR Coordinator	18/2	ORM Discussion	S	59 min
R2	PD	26/2	N/A	U	30 min
R11	Business Development Manager (ext.)	27/2	ORM walkthrough	S	20 min
R10	SNR Coordinator	5/3	General risk discussion	S	30 min
R12	Commodity Buyer	6/3	General risk discussion	S	30 min
R13	Commodity Buyer	6/3	General risk discussion	S	30 min
R14	Commodity Buyer	6/3	General risk discussion	S	30 min
R15	Purchasing Project Manager	6/3	General risk discussion	S	30 min
R16	Senior Commodity Buyer	10/3	General risk discussion	S	30 min
R17	Senior Commodity Buyer	10/3	General risk discussion	S	30 min
R18	Senior Commodity Buyer	10/3	General risk discussion	S	30 min
R16	Senior Commodity Buyer	12/3	General risk discussion	S	30 min
R9	PD & Supervisor	12/3	General risk discussion	S	30 min
R19	Commodity Buyer	12/3	General risk discussion	S	50 min
R20, R1, R9	SVP, VP, PD & Thesis Supervisor	16/3	Update meeting w/ internal stakeholders	S	60 min
R8	Purchasing Process & Systems Manager	16/3	SRET discussion	S	45 min
R21	Professional Buyer	17/3	General risk discussion	S	30 min
R22	Purchasing Project Manager	17/3	General risk discussion	S	30 min
R23	Professional Buyer	18/3	General risk discussion	S	30 min

R24	Global Supply Chain Development Manager (ext.)	19/3	Discussion regarding preferential origin	S	30 min
R25, R26	Digital Product Owner (ext.), Data Analyst (ext.)	25/3	General risk discussion	S	30 min
R27	Supplier Quality Specialist	20/4	General risk discussion	S	40 min
R28, R9	Professional Buyer, PD & Thesis Supervisor	20/4	General risk discussion	S	60 min
R29, R30, R31	PD, Procurement Manager, Procurement PM	21/4	Logistics' role in supplier evaluation	S	50 min
R32	Supplier Performance PM	21/4	General risk discussion	S	30 min
R33	Senior Uptime Buyer	22/4	Service market risks	S	30 min
R34	Professional Buyer	22/4	General risk discussion	S	30 min

2.4.2.1 Unstructured Interviews

Unstructured interviews were primarily used during the initial stages of the research process, when the relevant topics were still unclear and knowledge of internal processes within GBP at Volvo Buses was limited. In total, four unstructured interviews were conducted. These interviews typically began with a broad opening question, such as *"Tell us about what you do?"*, after which interviewees were encouraged to lead the conversation. Follow up questions were used mainly to enhance clarity or explore emerging topics (Bell et al., 2022). This format was particularly valuable in identifying themes that were not initially anticipated by the researchers which facilitated rapid immersion into roles, workflows, and organizational governance. Although flexible in structure, the interviews were conducted as part of the formal research process and informed the development of subsequent semi-structured interview guides.

2.4.2.2 Semi-Structured Interviews

Semi-structured interviews were conducted throughout the research process, with most taking place during the latter half of the interview period. In total, 29 semi-structured interviews were conducted. This format was used to gather in depth insights while maintaining a consistent thematic structure across participants (Bell et al., 2022). Interview guides with predefined topics and open-ended questions ensured that key areas relevant to the research were addressed. At the same time, the format allowed the interviewer to ask follow-up questions and explore unexpected but relevant themes as they emerge. This balance between structure and flexibility enabled the collection of rich data while remaining responsive to individual perspectives and experiences. The interview guide used to guide many of the semi-structured interviews can be seen in Table 1.

2.4.2.3 Documentation of interviews

All interviews in this study were documented through notes rather than audio recordings or transcripts. This approach was chosen due to practical and contextual constraints related to the research setting. While this limits the possibility of verification by the reader, the interviews are still treated as interviews due to their intentional design, alignment with the research questions, and systematic use in analysis. The focus of the interviews was on capturing key meanings, interpretations, and insights relevant to the study rather than producing exhaustive textual records. The implications of this documentation approach are considered part of the study's methodological limitations.

2.4.3 Informal Interactions

Informal interactions were used to gather insights and knowledge about day-to-day operations that were not easily accessible through formal or publicly available sources. The communication format is an informal, conversational interaction not initiated primarily as part of the interview-based data collection strategy (Bell et al., 2022). While these interactions at times resembled unstructured interviews conducted in informal settings but differed in that they were opportunistic and not guided by interview protocols. In other instances, the informal interactions took the form of confidential PowerPoint presentations delivered to an audience that included the researchers.

Distinctive to this form of data collection is the absence of transcripts, note-taking and publicly available source material (Karolinska Institutet, 2024). Informal interactions were therefore not treated as primary analytical data in the same way as interviews. Instead, they were used to support understanding, further clarify complex processes, and supplement insights from interviews and other data sources. Notably, several valuable insights emerged through in-office informal interactions, as these settings enabled open dialogue and the sharing of knowledge. While such interactions contributed meaningfully to the researchers' understanding of the empirical context, they are presented as complementary rather than central to the study's analytical claims.

2.4.4 Online Survey

As part of the research, an online survey was distributed to individuals within GBP holding procurement related roles. The purpose of the survey was to collect data on perceptions related to the Supplier Risk Evaluation Tool (SRET) Risk Analysis sheet. The complete survey instrument is provided in Appendix B. The survey was distributed via email and by Microsoft Teams on 8 April 2026, with a reminder sent five days later. In total, 66 individuals were invited to participate. Data collection closed after 20 days, at which point 16 responses were received. Previous research by Bell et al. (2022), which reviewed over 1,000 articles, indicates that a median survey response rate of 40% and a mean response rate just below 45% are generally considered acceptable for credibility in organizational research. The response rate achieved in this study was 24%, which falls below this benchmark. The implications of this limitation are discussed in Section 2.5.

2.5 Quality of Methodology

To evaluate research in business and management, the criteria of validity and reliability need to be addressed. These two concepts address the quality of the thesis and whether the result from research is repeatable or not (Bell et al., 2022). Hence, the following Section addresses these two concepts in more detail, together with an important note regarding AI usage in this thesis.

2.5.1 Validation

Validity refers to the extent to which a research method accurately measures the constructs it is intended to capture and whether meaningful conclusions can be drawn from the collected data. In the context of this study, validity considerations primarily relate to survey design, respondent selection, and response rate (Bell et al., 2022).

From a validity perspective, all respondents that participated in interviews help purchasing-related roles within GBP or were external stakeholders directly involved in GBP's sourcing process. This ensured that the empirical material collected reflected accurate organizational knowledge and experience rather than second-hand accounts. Moreover, the use of multiple data sources including interviews, internal documents, assessment resources and informal interactions allowed for triangulation across different types of sources. The iterative research process described in 2.3 is another strengthening factor to validity. By having an iterative process, the thesis reduced the risk of drawing premature interpretations and conclusions.

The potential implication concerning validity concerns the case-specific nature of this thesis. As a single case study conducted within GBP, the findings of this thesis are deeply embedded in the organization's purchasing context as previously described in 2.2. This limits the extent to which the conclusions can be generalized to other organizations or purchasing environments.

The online survey mentioned in Section 2.4.4 was distributed exclusively to individuals holding purchasing-related roles within GBP, ensuring that respondents possessed relevant experience and contextual knowledge of SRET. This targeted sampling approach supports content validity, as the questions were assessed by individuals assumed to be familiar with the concepts being investigated. In addition, the survey questions were closely aligned with the research objectives and theoretical framework, further strengthening construct validity.

However, the response rate achieved represents a limitation to the overall validity of the survey findings. Of the 66 individuals invited to participate, 16 responses were received, corresponding to a response rate of 24%. Previous research by Bell et al. (2022) suggests that response rates of approximately 40 to 45 percent are commonly regarded as acceptable. As the response rate in this study fell below this benchmark, the risk of non-response bias cannot be excluded. A lower response rate may affect validity, as it limits the extent to which the findings can be generalized to the wider population of purchasing professionals within GBP. It is possible that individuals who chose to respond have different perspectives on risk analysis practices than those who did not participate. As a result, the survey findings should be interpreted as indicative rather than representative of the entire population.

Despite this limitation, the survey results can still be considered suitable for exploring patterns and supporting qualitative interpretation, particularly when combined with other data sources used in this study. The implications of these validity limitations are considered when interpreting the empirical findings presented in.

2.5.2 Reliability

Reliability refers to the degree to which a study's results are consistent and could be reproduced if the study were conducted again under similar circumstances (Bell et al., 2022). in qualitative research, such as this thesis, reliability is closely linked to how data is collected, interpreted and documented rather than to strict replicability in a statistical sense.

Given the qualitative and case-based nature of this thesis, full replicability may be difficult to achieve. The thesis is embedded in a specific organizational and temporal context at Volvo buses and Prevost, where social interactions, decision processes and organizational structures are dynamic. For instance, insights derived from interviews, informal interactions and observations within purchasing and sourcing contexts are influenced by the roles, experiences and perspectives of individual respondents at the time of data collection and may change substantially over time. In order to counteract this issue, transparency in the research design and data collection processes has been provided (see 2.2 & 2.3), allowing readers to understand how the thesis was conducted and how conclusions were drawn.

Reliability has been strengthened through a structured and collaborative research process. After each interview, notes were jointly reviewed and discussed to reduce the risk of individual bias, misinterpretation, or selective attention. This approach facilitated in ensuring consistency in how empirical material was captured and interpreted in the thesis. Additionally, the use of semi-structured interview formats provided a common structure across interviews while still allowing flexibility for respondents to elaborate on issues they considered important. Key insights from interviews were to some degree triangulated with internal documents, sourcing tools and feedback from informal communication at Volvo buses which further increased the consistency and credibility of interpretations. The breadth of interview samples is also an important factor in strengthening the reliability of this thesis. A total of 34 respondents were interviews across a wide range of roles within GBP, including commodity buyers, senior buyers, members of senior management, and more. This cross-functional coverage reduces the risk that the empirical findings reflect the perspective of a single function or seniority level and increases the likelihood that recurring themes represent accurate organizational patterns rather than individual viewpoints.

As described in 2.4.2.3, all interviews were documented through notes rather than audio recordings or transcripts. While notes were reviewed collaboratively after each session and on an ongoing basis, the absence of recordings means that exact formulations cannot be verified and that some nuance may have been lost in the documentation process. As such, this may have an implication on whether the reader can independently assess whether the interpretations drawn from collected interview material are accurate with what was said. This can potentially limit the auditability of the empirical foundation. A related concern to this is that informal interactions as described in more detail in 2.4.3, which cannot be traced and verified because of confidentiality and lack of notes taken during these interactions. Although these interactions were treated as complementary rather than primary analytical data, it may be difficult for the reader to assess the influence these interactions had on the result and conclusions drawn from this thesis.

2.5.3 Use of AI

Generative AI and AI-assisted tools, including Microsoft Copilot, ChatGPT by OpenAI, Google's NotebookLM, and Lovable, have been used during the research and writing phases of this thesis. These tools were employed to support grammar refinement, sentence formulation, and the preliminary summarization of scientific articles to efficiently assess the potential relevance of sources. Lovable was used during the development of an early iteration of a risk-adjusted total landed cost model. All information processed through these tools has been reviewed for accuracy and validity by at least one of the thesis authors. Both authors confirm that all information included in the thesis has been retrieved from credible sources, and that all interpretations, analyses, models, and conclusions presented are entirely their own.

3 Theoretical Framework

This chapter established the theoretical foundation for the thesis by reviewing literature on supplier selection, total cost approaches, and supply chain risk. Supplier selection was framed as a multi-criteria decision process in which cost, quality, delivery, and risk must be assessed beyond unit price alone. Total Landed Cost was positioned as a supply-chain-focused subset of Total Cost of Ownership, and different TCO model types were discussed to highlight the trade-off between analytical accuracy and practical applicability. The chapter also introduced the Analytic Hierarchy Process as a method for structuring and weighting decision criteria and reviewed supply chain risk theory to classify key sourcing risks. Together, these perspectives motivate the integration of risk considerations into cost evaluation and provide the basis for the subsequent empirical analysis and model development.

3.1 Supplier Selection & Evaluation

Supplier selection plays a significant role within the procurement process and can be regarded as one of the most important decision points (Weele & Rozemeijer, 2022). The main objective of the supplier selection phase is to reduce risks associated with the purchase by actively considering, evaluating and analyzing potential suppliers (Tahriri et al., 2008). As purchasing becomes more strategic to an organization, the choice of suppliers has a direct impact on the effectiveness of the company’s supply chain, the organization’s competitiveness and ultimately, their bottom line. According to Beil & Ross (2009), it is important for organizations competing in an intensive global business context to not only develop existing suppliers, but also to discover potential new suppliers. This is supported by Giunipero & Monczka (1997) who argue that multinational firms require an effective strategy regarding sourcing for parts to achieve the lowest possible sourcing cost. The importance of effective sourcing is highlighted by the fact that around 60-80% of a company’s revenue can be traced back to supplier for purchased items (Giunipero & Monczka, 1997) (Weele & Rozemeijer, 2022).

Thus, supplier selection methods have often been generated following a multi-criteria approach where criteria such as cost, quality, delivery performance and supplier capacity are evaluated alongside less tangible aspects such as environmental performance, trust and supplier’s potential for developing together with the buying company (Tahriri et al., 2008). Hence, over time, several supplier selection methods have been developed to structure and support this decision within the procurement process. Traditional methods include linear weighing models where suppliers are rated on several criteria and then the ratings are aggregated into a single score. Moreover, there are total cost approaches where all relevant aspects of supplier performance are expressed in monetary terms. However, there may be difficulties in deciding what the best way is to evaluate and select suitable suppliers. Additionally, this is even more complicated by the wide availability of approaches and methods. But, regardless of what the chosen approach is, the overall objective of the evaluation process should be to reduce the purchase risk and maximize the overall value to the purchaser (Monczka et al., 2009).

On a more general basis, the supplier selection is primarily done by the procurement function of a company. This means that the procurement functions responsibility is to source and select suitable suppliers to ensure supply continuity of goods and services to be used in manufacturing of a final product (Weele & Rozemeijer, 2022).

As described by Weele & Rozemeijer (2022), the procurement function has traditionally been to decide the procurement needs, supplier selection, arriving at proper price, specifying terms and conditions, issuing the contract, and ensuring proper payment and delivery. The emphasis on the procurement function was to ensure that the right materials and services were obtained of the right quality, right quantity, at the right place, at the right price, and from the right source. Shown in Figure 2.

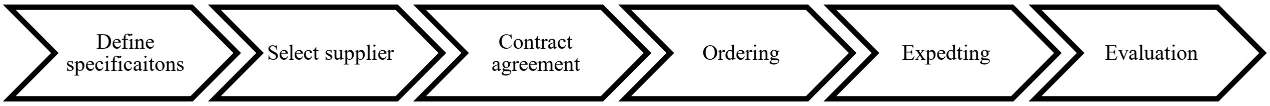

Figure 2: Procurement Process Approach. Adopted from Weele & Rozemeijer (2022)

3.1.1 Supplier Evaluation Criteria

When evaluating potential suppliers, it is common to compare suppliers across multiple categories (Monczka et al., 2009; Weele & Rozemeijer, 2022). However, it may be difficult to know exactly what kinds of category to use in specific sourcing cases. For instance, there may be greater emphasis on ensuring that the supplier has constant delivery performance with short lead times to support a just-in-time production system, or more emphasis on a supplier's process a technological capability for new product development. Regardless of the sourcing case, there are three primary criteria's that suppliers are evaluated on, namely cost or price, quality and delivery (Weele & Rozemeijer, 2022). These three criteria are generally the most obvious and most critical areas that affect the purchaser. But, for critical items, or where the expenditure is projected to be significant, a more detailed suppler evaluation study is required. As such, there are additional criteria to support the evaluation process, which are summarized in Table 2.

Table 2: Supplier evaluation criteria and description. Adopted from Monczka et al. (2009).

Criteria	**Description**
Management Capability	• Management practice long term planning • Company vision • Historic investments made
Employee Capability	• Workforce turnover rate • Overall skills and abilities of the workforce • Morale • Employee-management relations
Supplier cost structure	• Labor costs • Material costs • Manufacturing costs • Process operating costs • General overhead costs
Quality management & processes	• Statistical process control • ISO 9001 (quality management) • Safety • Training • Maintenance
Process and technological capability	• Process design

	• Product design activities • Current equipment used in processes
Environmental regulation compliance	• ISO 14001 (environmental management) • Recycling management • Hazardous and toxic waste management
Financial stability	• Solvency status • Debts & assets • Liquidity status • Profits
Longer-term relationship potential	• Supplier relationship commitment • Sharing of data and information

3.1.2 Supplier Evaluation Methods

In terms of how to evaluate suppliers in the criteria, several analytical approaches are available. Failure Mode and Effects Analysis (FMEA) is one such method that has been adapted from engineering and reliability contexts to be used in supplier evaluation and selection. Within supply chain and purchasing research, FMEA is primarily used as a structed way to identify, assess and prioritize supplier-related risks by decomposing them into discrete risk dimensions and scoring their potential impact. One way of using FMEA is in a sourcing contest is to conceptualize different aspects of supplier performance such as cost, quality, delivery, technological capability, and service as potential "failure modes" that may disrupt operations or increase total cost over time (Chen & Wu, 2013).

However, traditional FMEA logic is often insufficient and hence, modifications have been made to the existing traditional safety-oriented focus to better capture business and operational consequences. One of these are the modified FMEA model developed by Chen & Wu (2013) who combined AHP (described in more detail in chapter 3.4) together with the scoring from the FMEA. By combining both FMEA and AHP, the weights of risk categories are adjusted to better reflect that all risk dimensions are not of equal importance. For instance, quality related supplier risks are more important than supplier sustainability risks. This allows the risks to exert a stronger influence on the final supplier ranking of the final supplier ranking. Similarly, Feller (2008) used a FMEA-based framework to derive relative importance weights for supplier-related risks factors in global sourcing decisions. Rather than using FMEA to rank suppliers directly, the framework structures the risk landscape and identify which factors contribute the most to the overall exposure. These factors are then normalized into weights that remain fixed across supplier evaluations, reflecting the focal firm's general risk profile rather than supplier-specific characteristics. Moreover, AHP is another multi-criteria method for evaluating suppliers. This method is described in more detail in chapter 3.4.

3.1.3 Integrating Risk and Cost

Supplier evaluation methods that rely solely on price or unadjusted total cost measures risk underestimating the long-term financial exposure associated with sourcing decisions. Literature on supplier selection and Total Cost of Ownership (TCO) increasingly emphasizes that supply chain risks, such as quality failures, capacity constraints, financial instability, and network vulnerability often materialize as additional costs that are not visible at the time of quotation (Degraeve & Roodhooft, 1999; Ellram, 1993). Despite this recognition, many organizations still assess risk and cost as parallel but separate dimensions, making it difficult to compare sourcing alternatives on a consolidated economic basis.

To address this gap, prior research has proposed models that integrate risk considerations directly into cost evaluation by translating qualitative or semi-quantitative risk assessments into financial adjustments. A representative example is the risk-adjusted cost framework proposed by (Sharma, 2016), which conceptualizes supplier risk as a modifier of cost rather than as an independent decision criterion. Instead of viewing risk as an abstract score alongside cost, the model positions risk as a driver of expected cost escalation, thereby enabling a more direct comparison between sourcing alternatives.

The original model in which this model was developed is based on the methodology employed by Sharma (2016). The same kind of calculation is what the original model is built upon. The model is illustrated in Figure 3 to show the flow and steps involved.

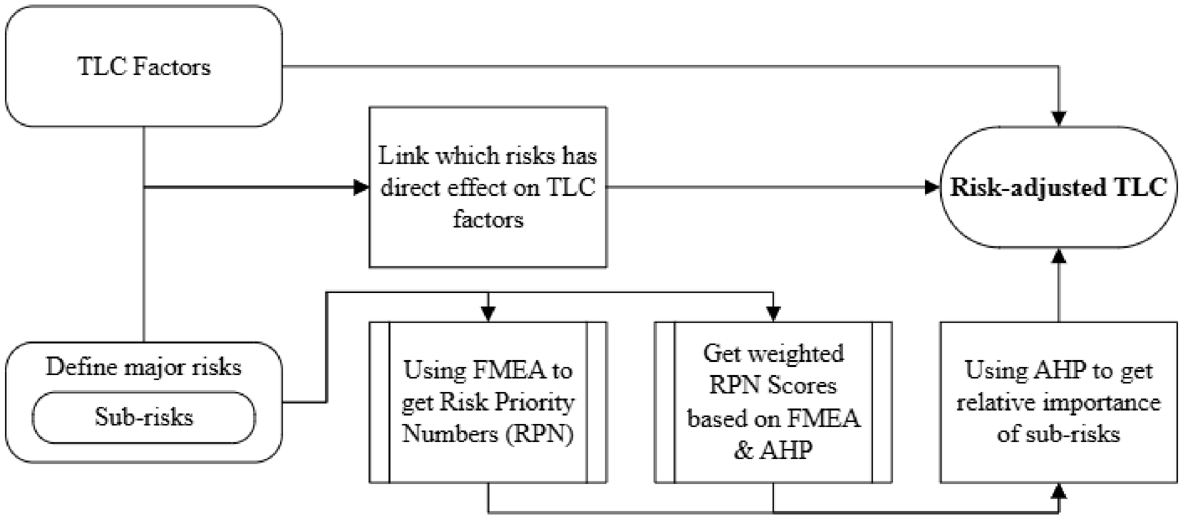

Figure 3: Schematic overview of model by Sharma (2016)

As seen in Figure 3, the model developed by Sharma (2016) is built around three core ideas. First, the model assumes the existence of a structured cost baseline, typically grounded in the logic of TCO or Total Landed Cost (TLC), which is seen as total landed cost factors in the figure. This baseline represents the expected cost of sourcing under normal operating conditions and includes both direct and indirect cost components, such as purchase price, logistics, inventory holding, tooling, and quality-related costs. The second core idea is to link which major risks have a direct on which TLC factors. For example, quality risk may increase inspection, rework, and warranty costs, while supply risk may drive higher inventory levels or expediting expenses. This mapping between risk categories and cost drivers establishes the theoretical link between risk exposure and financial impact.

The third core idea is to introduce or define major risks, which are typically organized into major risk categories such as quality risk, supply risk, financial risk, and relationship risk, each of which may affect different elements of the cost structure in distinct ways. To structure this exposure, the model draws on the logic of FMEA, in which supplier-related risks are evaluated based on their likelihood of occurrence, the severity of their potential impact, and the degree to which they can be detected or mitigated. By combining these dimensions, the model yields an aggregated risk profile for each supplier or sourcing alternative, reflecting the overall magnitude of expected disruption or deviation from normal operating conditions. In addition, the model incorporates the Analytic Hierarchy Process (AHP) to account for differences in the relative importance of major risk categories. AHP is used to derive weights that reflect how different types of risk contribute to overall exposure, acknowledging that not all risks are considered equally critical in sourcing decisions. For instance, quality-related risks may be assigned a higher weight than logistics-related risks if quality failures are perceived to have more severe or longer-lasting cost implications for the buying firm. By combining FMEA-based risk characterization with AHP-based weighting, the model integrates both the magnitude of individual risks and their strategic relevance into a unified representation of supplier risk.

3.2 Total Landed Cost

Total Landed Cost (TLC) is defined as the sum of all costs associated with obtaining a product, including transportation, inventory, administration, customs, risk and damage, handling, packaging, and hidden costs such as extra safety stock due to uncertainty (Pumpe & Vallée, 2017). In literature regarding supplier selection, TLC is described as a subset of Total Cost of Ownership (TCO) (Pumpe & Vallée, 2017) as shown in Figure 4, which covers all costs incurred over an product's life cycle, from pre-transaction activities to decommissioning and recycling (Ellram, 1993; Feller, 2008).

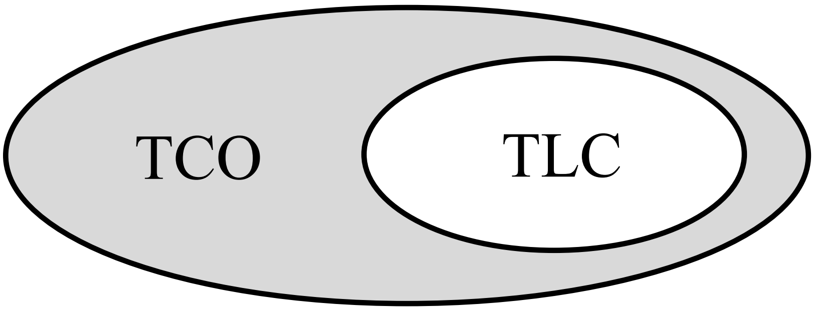

Figure 4: Venn diagram displaying the relation between TCO and TLC

Compared with the TCO field, the TLC literature is relatively narrow and fragmented with few available methods related to TCL. While a some exist, they vary strongly in complexity and accuracy, with limited guidance on when to use which method (Pumpe & Vallée, 2017). Because TLC is conceptually nested within TCO and the TCO literature offers more cost categories and modelling approaches, it is reasonable to use TCO as the main theoretical lens. In this thesis, TLC is therefore treated as the inbound, supply chain related segment of TCO, while the richer TCO body of knowledge is used as a proxy to better understand and classify TLC.

3.3 Total Cost of Ownership

Ellram (1993) defines total cost of ownership as including "all costs associated with the acquisition, use, and maintenance" (p. 3) of a product. In contrast to traditional, price-based supplier evaluation, TCO is both a philosophy on how to view prices and a modelling framework that adopts a long-term, life-cycle perspective and integrates a wide spectrum of direct and indirect costs.

TCO differs from earlier "total cost" approaches in two central respects. First, the scope of cost is broader. Besides the unit price, TCO aims to incorporate costs related to order preparation, processing, transportation, receiving, inspection, invoicing and payment, and the administrative effort associated with correcting errors (Ellram, 1993; Ferrin & Plank, 2002). Second, TCO is life-cycle oriented and considers all costs that arise throughout a product's life. To simplify this, Ellram (1993) proposed a framework that divides purchasing-related costs into three sequences where it is only transaction costs that are included in traditional TCL frameworks (Trent, 2018):

- Transaction costs occur during order placement and receival, and include factors like item price, order preparation, expediting, transportation, duties, billing, payment, and inspections; these costs are more visible because they are more closely related to the transaction. (Ellram, 1993).

Where TCO is implemented, there are indications of significant benefits and Ellram (1993, 1994) identifies five categories that typically are benefited. These are improved supplier performance measurement, enhanced purchasing decision making, improved internal and external communication, greater insight into tradeoffs between cost and risk, and support for continuous improvement. It provides a quantitative basis for supplier evaluation, for negotiating with suppliers, and for setting target prices. Lastly, it forces purchasing to identify and quantify non-price cost drivers, thereby broadening its perspective and supporting long-term decision-making.

Within this context, the design of TCO models becomes a central managerial issue. Sources shows that TCO does not correspond to a single, standardized model (Degraeve & Roodhooft, 1999; Ellram, 1993, 1994, 1995; Ferrin & Plank, 2002; Trent, 2018). Instead, it refers to a family of approaches that can be positioned along a spectrum from conceptual to highly analytical optimization-based models. The following Sections present four types of TCO approaches presented in literature.

3.3.1 Conceptual Models

At the conceptual end, TCO serves mainly as a mindset rather than a precise calculation. Its purpose is to highlight that purchase price is only one component of total cost and to identify relevant cost categories. Many firms use this "TCO logic" informally: Ellram's (1993) survey of NAPM members and Ferrin & Plank (2002) both show that buyers mentally consider quality issues, delivery problems, or administrative burdens without quantifying them or using formal models.

These approaches require few resources and help shift attention from unit prices to life-cycle costs (Ellram, 1994). However, lacking quantification, they are weak for formal comparison or supplier selection. They represent the lowest level of analytical sophistication.

3.3.2 Standardized Models

Ellram (1994) defines standardized TCO models as written, fixed frameworks, often spreadsheet based, that apply a consistent set of cost elements within a purchase category. Users enter item specific data while removing irrelevant elements. These models are suitable for categories with recurring cost structures, such as capital equipment, raw materials or components. Firms can repeatedly use elements like price, installation, freight, service, spares, training and operating costs.

Ellram (1994) presents a capital equipment template based on corporate financial assumptions. Standardized models offer a moderate level of sophistication: they require quantification and discounted cash flows while remaining manageable. Their weakness is inflexibility. If an item's cost structure differs, important drivers may be missed. Several firms in Ellram's study abandoned the idea of one universal model and used standardized models only where similarities were sufficient.

3.3.3 Unique and Modular Models

As Ellram (1994) shows, when items differ substantially in cost structures or performance requirements, standardized TCO models often become too rigid. In such cases she observed a tendency to develop unique TCO models tailored to individual purchase situations. A unique model is "created especially for a particular item or purchase", and the cost factors included "differ significantly" between models; it may still be organized under generic headings such as quality, delivery or service, but the specific cost drivers and their measurement are customized case by case. Ferrin & Plank (2002) complement this view with a more modular perspective, based on a survey from 73 companies in which they identified 237 initial drivers, 135 distinct drivers grouped into 13 categories (operations, quality, logistics, inventory cost, etc.). Respondents agreed that while a core set of drivers applies to all categories, additional ones must be added or removed depending on the situation.

Unique and modular models thus involve higher analytical and organizational demands and require careful cost-driver choices and cross-functional input. They suit high-impact, non-routine purchases. In such environments, staff are often trained to recognize when unique models are needed (Ellram, 1994).

3.3.4 Highly Analytical Models

At the most analytical end of the TCO spectrum are models that are integrated with dedicated cost accounting- and quantitative optimization systems (Ferrin & Plank, 2002). Both Ellram (1995, as cited in Ferrin & Plank, 2002) and Degraeve & Roodhooft (1999) argues that effective implementation of these models heavily depends on the use of activity-based costing methodologies and mathematical programming to optimize sourcing decisions based on extensive TCO information. A case study by Bennett (1996) confirmed these claims by concluding that activity-based approaches can be used to measure and reduce costs.
A key example of a highly analytical TCO model is the work of Degraeve & Roodhooft (1999). They decompose purchasing activities into three hierarchical levels, recognizing that not all costs are unit-related:

- Supplier-level activities are performed only when a given supplier is used, such as supplier audits.
- Ordering-level activities are triggered each time an order is placed, for example receiving, invoicing and transportation.
- Unit-level activities depend on the characteristics of individual items in an order, such as the consequences of defective components.

Degraeve & Roodhooft's (1999) TCO-based supplier-selection model showed significant savings, but such analytical approaches require extensive data and specialized skills (Ferrin & Plank, 2002). They are great for supporting sourcing decisions involving multiple suppliers and trade-offs between cost and risk, but their implementation is constrained by their complexity in selecting relevant cost drivers.

3.4 Analytical Hierarchy Process

The Analytic Hierarchy Process (AHP) is a widely adopted multi-criterion decision making method developed by Saaty (1980) for structuring decisions. The method is particularly suitable for supplier evaluation because it allows decision makers to decompose complex decisions, quantify subjective judgments, and maintain logical consistency in their preferences. It supports consensus-building among stakeholders by condensing multiple judgements into a single (Hill & Nydick, 1992).

The process of AHP as presented by Gwarda (2022) can be divided into five main stages, the first stage being a breakdown of the supplier selection problem at hand into a hierarchical structure for decision-making. Starting with criteria and sub-criteria to base the evaluation on and ending at the bottom level with the alternative decisions or suppliers to be evaluated. This hierarchical representation helps ensure that all relevant dimensions of supplier performance are captured. Empirical studies in supplier selection have validated the suitability of AHP for handling criteria such as cost, quality, delivery, financial stability, flexibility, technological capabilities, and relationship characteristics (Labib, 2011). In many applications, qualitative criteria such as reputation, communication effectiveness, or strategic compatibility are difficult to express on cardinal scales, and AHP provides structured means to transform expert judgments into criteria weights.

After establishing the hierarchical structure, the core of AHP and the second stage of Gwarda's (2022) process focuses on generating pairwise comparisons between all criteria. The number of comparisons needed increases with the number of factors, and the total number is computed using the following formula:

$$\binom{n}{2} = \frac{n(n-1)}{2}$$

With *n* representing the number of criteria (Brunelli, 2014). For example, evaluating six criteria would require 15 questions to be asked.

In the third stage of the Analytic Hierarchy Process as presented by Gwarda (2022), the user assesses the relative importance of criteria through pairwise comparisons. At this stage, each criterion is compared with every other criterion to express how much more important one is relative to another. These judgments are made using Saaty's (1980) fundamental 1 to 9 scale, where 1 denotes an equal preference, 9 denotes extreme preference and even-numbered values (2, 4, 6, 8) are intermediate levels (Hill & Nydick, 1992; Saaty, 1980, 1990). The outcome of these judgments is a pairwise comparison matrix, in which expert preferences are translated into numerical form. This stage serves two purposes. First, it establishes the relative importance, or weights, of the evaluation criteria. Second, it allows the performance of each alternative, such as suppliers, to be assessed relative to each criterion through analogous comparison matrices (Hill & Nydick, 1992; Labib, 2011). In Gwarda's application, matrices are constructed prior to weight computation. Formally, the pairwise comparisons are represented by a positive reciprocal matrix:

$$A = [a_{ij}] \in \mathbb{R}^{n \times n}$$

where each element a_{ij} expresses the importance of criterion i relative to criterion j. The matrix satisfies the reciprocal properties:

$$a_{ij} = \frac{1}{a_{ji}}, a_{ii} = 1$$

These properties ensure logical coherence, as a criterion compared with itself must have equal importance, and the relative importance in one direction is the inverse of the comparison in the opposite direction. Gwarda follows the standard AHP structure when constructing the comparison matrix of criteria.

Once the comparison matrix has been defined, priority weights are derived using the principal eigenvector method, which is central to Saaty (1980) original AHP formulation. The weights are obtained by solving the eigenvalue problem:

$$Aw = \lambda_{\max} w$$

where $\lambda_{\max}$is the maximum eigenvalue of matrix $A$and $w$is the corresponding eigenvector. The vector w represents the relative priorities of the criteria as implied by the pairwise judgments. In practical terms, and as described by Gwarda (2022) and Saaty (1980), priority weights are obtained by calculating the principal eigenvector of the pairwise comparison matrix. Specifically, the comparison matrix is used to solve the eigenvalue problem associated with its largest eigenvalue, and the resulting eigenvector represents the relative importance of the evaluated criteria. The components of this eigenvector are subsequently normalized so that their sum equals one, yielding a set of weights that form a ratio scale and reflect the decision maker's judgments.

The final step in this stage is normalization of the eigenvector, which ensures that the weights are interpretable as proportions:

$$\sum_{i=1}^{n} w_i = 1, w_i \geq 0 \ \forall i$$

Each component w_i thus represents the relative contribution of criterion i to the overall decision. For example, in Gwarda's case study, the resulting weights indicate that quality contributes the most to the supplier selection decision, followed by punctuality, price, and location. This eigenvalue-based approach is particularly important because it produces a ratio scale that accurately reflects the intensity of preferences expressed by decision makers. Saaty (1980) demonstrates that this method preserves the underlying judgment structure and allows for meaningful comparisons between criteria. As such, the third stage of Gwarda's process constitutes the analytical core of the AHP methodology, converting subjective expert judgments into mathematically grounded, quantitative weights.

A central concern discussed in Saaty (1980) original model and the fourth stage of Gwarda's (2022) process by is investigating the overall consistency of the pairwise comparisons. Decision makers rarely express perfectly consistent judgments, but AHP incorporates a consistency index that quantifies deviations from perfect logical consistency. The consistency index (CI) is computed as follows:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

A final consistency ratio (CR) is calculated by dividing CI with a random index (RI) retrieved from Table 3 developed by Saaty (1990), by averaging the consistency indices of thousands of randomly generated reciprocal matrices for each matrix size. It is generally considered acceptable if the CR is below 0,1 (Saaty, 1980) and is calculated as follows:

$$CR = \frac{CI}{RI}$$

Table 3: Random index for n=15. Adopted from Saaty (1980)

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0,00	0,00	0,58	0,90	1,12	1,24	1,32	1,41	1,45	1,49	1,51	1,48	1,56	1,57	1,58

While the last step of the AHP process by Gwarda (2022) is usually to create a structure for the final ranking of options, the framework will in this thesis only be used to develop weights for the criteria or metrics used when GBP evaluates suppliers. AHP is well suited for this purpose it offers a mathematically grounded way for translating qualitative expert judgments into quantitative criteria weights, provides a consistency index to validate the results, and it offers a transparent and structured foundation for multi-criteria decision making (Labib, 2011; Saaty, 1990).

3.5 Supply Chain Risks

The University of Virginia (n.d.) defines risk as "the potential for harm" and it is a prediction of probable outcome based on previous experiences. While physical harm is often the type of harm that comes to mind, such as the possibility of injury to a living being. While it is a serious matter, it is rarely the primary concern in the context of supply chain management. Instead, economic and legal harms are more prevalent and typically more relevant when assessing risks within supply chain networks. Other definitions, more relevant to the subject at hand is Mitchell (1995) who states it as "the probability of loss and the significance of that loss to Christopher & Peck's risk categorization

3.5.1 Christopher & Peck's Risk Categorization

Said loss can in turn be understood as vulnerabilities embedded in the processes, decision structures, relationships, and environments within which supply chains operate. Christopher & Peck (2004) conceptualize these vulnerabilities through a categorization that identifies five types of risk: process, control, demand, supply, and environmental risk. Together, these categories can be used to help understanding how disruptions arise and spread throughout supply chains, beyond isolated events and toward a systemic perspective on risk. Rather than attributing risk solely to individual nodes or points of failure, this categorization highlights how interdependencies between activities and actors shape exposure to disruption. The framework is therefore particularly well suited for analyzing modern supply chains, which are characterized by tight coupling, information asymmetries, and increasing global complexity.

Process risks concern failures in focal firm-internal value-adding activities and depend on the reliability of a firm's assets and infrastructure. Such risks include equipment breakdowns in equipment, information systems, or physical operations, as well as from rigid or poorly designed processes that limit adaptability. Examples include machine failures, IT or communication disruptions, capacity constraints, and excessive internal lead times. When processes lack redundancy, even minor interruptions can escalate into significant disruptions, delaying output and affecting downstream operations

Control risks arise from rules and decisions that govern how supply chain activities are planned and coordinated. These can include poorly designed ordering policies, forecasting methods, production planning, and batch sizes, that can amplify variability rather than dampen it. Additionally, organizational silos structures and limited information sharing may distort information and lead to delayed decision making. Control risks are therefore closely linked to the visibility across supply chains and how effectively insights are translated into operational actions.

Demand risks stem from downstream market disturbances in customer consumption patterns. Fluctuations in demand and when information about it is delayed or incomplete, this be amplified into a phenomena like bullwhip effect, where small variations result in increasingly large upstream fluctuations. The magnitude of these effects is influenced by the accuracy of forecasting methods practices, and the responsiveness of supply chain actors.

Supply risks concern disturbances in upstream flows of materials and information, affecting production and distribution. These risks may arise from extended lead times, poor supplier transparency, quality failures, insolvency, and disruptions in the supplier's own network. High dependence on critical upstream nodes raises exposure, especially when multi-tiered communications are weak. This makes it difficult to anticipate upstream disruptions before they affect operations.

Environmental risks originate outside both the focal firm and its supply chain, it includes natural disasters, extreme weather, geopolitical tensions, terrorism, worker strikes, regulatory changes, and macroeconomic shocks. Such events may disrupt transportation corridors, infrastructure, or entire regions, affecting supply chain flows even when no internal partner has failed. These are particularly challenging to manage as they often are unpredictable and can have wide-ranging, consequences. Nonetheless, their impact on supply chains is frequently shaped by prior network design decisions, such as facility location, sourcing geography, and transportation mode selection.

3.5.2 Risks Derived From Literature

Building on the above categorization by Christopher & Peck (2004), several specific risks highlighted in the literature are particularly relevant to this thesis and illustrate how these categories manifest in practice. One specific risk that is presented is single-sourcing, where a buying firm relies on the sole supplier for the procurement of a component or segment. While this approach may appear efficient at first; it heightens both supply risk and process risk. This increases supply chain risks because of any disruption to that supplier, immediately jeopardizes operations continuity. Christopher & Peck identify such reliance as vulnerability that can create pinch points within a supply network. The opposite approach is multi-sourcing, where a purchaser hedges against disruptions by sourcing the same part from at least two suppliers.

A related but distinct structural risk concerns multi-site sourcing, where a single supplier produces the same component in several production facilities (Christopher & Peck, 2004). While this arrangement may appear to be redundant, the buying firm remains dependent on the same organizational entity and risks associated with supplier dependence remain concentrated at the supplier level. Research on supply network design shows that while multi-site sourcing can mitigate local, facility-level disruptions, it does not fully eliminate exposure to supplier-wide disturbances such as insolvency, labor disputes, or centralized production planning failures. In this sense, multi-site sourcing provides partial redundancy but does not offer the diversification benefits associated with true multi-sourcing across independent firms (Maharjan & Kato, 2022).

Geographical location of production further reinforces environmental and supply risks as presented by Christopher & Peck (2004). When production is in a region prone to natural disasters, political instability, infrastructure fragility, climate-related hazards, unexpected regulatory issues, the vulnerability within the network, substantially increases (Maharjan & Kato, 2022). The literature on resilient network design has repeatedly shown that location decisions exert strong long-term effects on resilience because facilities must function in uncertain environments for many years. Political or broader instability at a supplier's site reinforces environmental risk but can also intensify supply and demand risks if disruptions spread across markets or transport corridors. Past events, such as port strikes, trade embargoes, and pandemics illustrate how environmental disturbances can spread and disrupt both upstream and downstream flows, often in ways that organizations could have anticipated but did not adequately prepare for (Christopher & Peck, 2004; Maharjan & Kato, 2022).

Upstream shortages of materials and subcomponents represent another significant risk Maharjan & Kato (2022). These shortages may stem from failures from within a supplier's own supply chain, limited global availability of rare materials, or sudden surges in market demand. As the availability of alternative suppliers affects both control and supply risks because sourcing flexibility is a critical determinant of how rapidly a firm can adapt to disruption. A system without redundancy or alternative suppliers is less resilient and more exposed to cascading failures. Christopher & Peck (2004) argue that the often-occurring idea of supply chains being linear leads firms to underestimate the complexity of their wider supplier networks and thus overlook critical vulnerabilities. Research on resilient supply chain network design has shown that incorporating redundancy, whether through multiple sourcing or the use of suppliers in stable environments, can significantly reduce disruption impacts by providing adaptive capacity Maharjan & Kato (2022).

Finally, the importance of material characteristics and production specifications relates directly to process and control risk. When materials are highly specialized or designs are tightly optimized, organizations may be faced with limited opportunities to redesign products or shift to alternative components in case of disruptions. Highly specific or unique processes increase dependencies on machines, technologies, or suppliers. Christopher & Peck (2004) emphasize that long lead times, specialized inputs, and poor visibility between nodes are features that elevate risk. In contrast, Maharjan & Kato (2022) discuss resilience measures such as alternative bills of materials, flexible facility capacity, and the ability to reallocate customers or flows as ways to mitigate rigidity.

Taken together, these categories and the specific vulnerabilities that accompany them reveal how supply chain disruptions arise from interdependence in processes, policies, supplier networks, and the broader environment. Maharjan & Kato point out that complex globalized supply chains that adopt lean or just-in-time practices often lack buffers, reducing their absorption capacity of upstream disruptions. Under these conditions, small interruptions can escalate into production shutdowns, unfulfilled customer demand, and financial losses. As a result, designers of supply chain must adopt a more deliberate and risk-aware approach when selecting and contracting suppliers, ensuring that the overall network structure can better withstand and recover from disturbances. Something that can be achieved through resilience-enhancing practices, including diversification of suppliers, geographic location of facilities, incorporation of flexible production technologies, and strengthened monitoring of political and environmental conditions.

4 Empirical Findings

This chapter presents the empirical findings gathered throughout this thesis. It is separated into five sub-chapters covering GBP's organizational structure and external relations, the sourcing process and its governance, the assessment resources available to stakeholders, the structural vulnerabilities and constraints that characterize GBP's supplier base, and the results of the online survey. Together, this chapter aims to highlight how risk and cost are currently considered within GBP's sourcing practices, which factors stakeholders identify as important when evaluating suppliers, and where gaps exist between current practice and a more integrated approach to risk and cost evaluation.

The empirical findings have primarily been generated through interviews and informal interactions conducted throughout the thesis period, and access to internal documentation via Volvo's intranet. The internal documentation includes sourcing tools, process templates, and governance frameworks.

4.1 Global Buses Purchasing

GBP is the internal purchasing function within Volvo Buses tasked with securing suppliers that meet defined requirements for cost levels, delivery performance and product quality. Its core responsibility is to ensure access to components and, managing supplier development, conducting commercial negotiations, ensuring supplier's abilities and capacity to meet production schedules, uphold quality standards and pursue defined financial and environmental targets.

GBP is staffed by roughly 170 people, structured into several areas supporting the purchasing activities. Sourcing & Platform function is responsible for long-term segment strategies, supplier selection and strategic sourcing across teams dedicated to projects and chassis platform, tender management and sourcing for North America. Service Market & Quality works to maintain supplier delivery performance and conformance with established aftermarket requirements. The Mexico based purchasing organization oversees activities for the plant in Mexico City, including commodity purchasing, supplier quality development and service market purchasing. Prevost Car, active in North American, maintains purchasing teams for supplier quality, operations and service market performance connected to its plant in Sainte Claire, Canada. Supporting functions include Sustainability & Business Development, which coordinates regulatory compliance and process development, and SNR, which manages supply chain risks and continuity. Lastly there is GBP's finance function that oversees cost control, reporting and supplier financial risk assessments.

GBP's responsibilities correspond to the global production layout of Volvo Buses. The organization coordinates a supplier base of approximately 1500 suppliers and manages around 93 000-part numbers across their four main sites. Volvo Buses production facilities include Uddevalla and Borås in Sweden, with the Borås site functioning as a major chassis production hub. Additional production takes place in Mexico City. Beyond Volvo Buses, the wider industrial footprint relevant to supply includes the Curitiba plant in Brazil, where bus chassis, including articulated and bi-articulated electric models, are manufactured for export to global Bus Rapid Transit systems. Together with the Prevost plant in Sainte Claire, Canada, which is integrated into Volvo's North American bus operations, GBP's global manufacturing network illustrates the need for coordinated supplier evaluation processes and smooth material flows within GBP.

As the Volvo Group shifts parts of it focus to electrified solutions, GBP's work increasingly involves sourcing components with new technological specifications and ensuring that suppliers can meet requirements for electrified drivetrains, battery systems and associated electronics (R17). This development places greater emphasis on supplier assessments and risk mitigation as GBP works to align with an evolving product architecture and new market expectations.

4.1.1 Volvo Buses-Prevost Relations

Prevost Car Inc. is a fully owned subsidiary of VBC and has been part of the Volvo Group since the mid-1990s, with full ownership established in 2004 (Volvo Group, 2004). As such, Prevost is formally embedded in the governance structure of VBC and with purchasing activities being organizationally grouped together with Volvo Buses' under GBP. From a governance and sourcing perspective, Prevost in theory follows the same overarching principles, processes, and evaluation frameworks as Volvo Buses. Supplier assessments are conducted using the same core Volvo Group evaluation resources and risk tools used across GBP (R9, R21, R23), that are presented under Section 4.3. This means that, at a policy level, Prevost suppliers are expected to meet the same approval and qualification requirements as Volvo Buses suppliers, including compliance with Volvo Group sustainability, quality, and risk expectations (Prevost Car, n.d., R23).

In practice, however, the application of these requirements can differ with one notable difference laying in supplier certification. While ISO 9001 and ISO 14001 are standard requirements within Volvo Buses' supply base, ISO certifications are less prevalent among North American suppliers, particularly among smaller or non-automotive suppliers (R27, R28). Suppliers that make up a large part of Prevost's supplier portfolio (R28). Although Prevost uses the same evaluation tools, there is greater operational flexibility in how strictly certification requirements such as ISO 14001, are enforced, reflecting structural and cultural differences in the North American supplier market (R21). This has implications for risk comparability across GBP, as standardized processes can yield different outcomes depending on geography and supplier maturity.

"ISO 9001 is generally understood in North America, but the real challenge is requiring our suppliers to be ISO 14001-certified." – R27

Larger sourcing cases above defined value thresholds are formally escalated to the joint SC, which includes stakeholders from across VBC (see Section 4.2). While this provides a shared forum for reviewing sourcing decisions, escalation does not remove the underlying challenges associated with Prevost's supply base. Certification gaps (R21), limited supplier alternatives (R21, R22, R23, R27, R28, R34), and regional differences in transparency and process maturity often remain unresolved even at this level (R34). Decisions are therefore frequently constrained by the reality of available suppliers rather than full compliance with nominal Volvo Group requirements.

On the product and technology side, the relationship is further reinforced through shared components and internal supply flows within the Volvo Group (R9, R23). A clear example is powertrain sourcing. Prevost sources its D13-engine from Volvo Group's powertrain plant in Hagerstown, Maryland (R23). Even though the Hagerstown plant is part of the Volvo Group and produces engines and related components for Volvo Trucks, Volvo Buses, and Prevost, and is treated as an internal supplier to the BAs. This creates a higher degree of standardization and dependency in critical systems such as powertrain compared to many externally sourced components.

Overall, the Volvo Buses–Prevost relationship can be characterized as formally integrated but operationally differentiated. Prevost is fully embedded within VBC, participates in shared governance structures such as the Sourcing Council (SC), and uses the same evaluation frameworks and internal supply sources. At the same time, supplier maturity and certification norms result in practical deviations from how supplier requirements are applied compared to European supplier.

4.1.2 Volvo Buses-Volvo Trucks Relations

Volvo Buses coordinates many of its sourcing activities with Volvo Trucks' Global Trucks Purchasing (GTP) because components used in both buses and trucks rely on shared technologies where parts sharing and GTP's scale are beneficial (R16). As a result, GTP is responsible for sourcing components within the Common Architecture & Shared Technology portfolio, while GBP instead focuses on bus unique and lower complexity parts (R9). Although the two BAs are separate, GBP follows the purchasing processes and frameworks developed by GTP. Tools like VSIB and SRET originate from GTP and form the foundation of GBP's assessments, even when adjustments are required to fit the context of Volvo Buses (R9, R16).

Beyond shared processes, GTP performs sourcing on behalf of GBP in segments where validation work is extensive or where global platforms must be maintained. This includes areas such as ECUs, telematics, engines, tires, batteries and electromobility systems (R16, R17). In these cases, GTP selects suppliers, runs Requests For Quotations (RFQs), negotiates contracts and ensures long-term technical alignment. GBP provides requirements and project specific inputs but does not run a parallel sourcing process. GTP also manages sourcing for regions where GBP lacks presence, such as Brazil, when part numbers are shared with Trucks (R9). Even for components purchased by GBP, GTP influences supplier selection through its group-wide control of technical standards and architectural compatibility. For example, wire harness suppliers must rely on components approved within GTP's technical architecture, which can restrict GBP's ability to change suppliers. As a result, single sourcing is common, and risks must instead be mitigated through long term agreements and contingency planning rather than supplier diversification (R18, R19, R28).

The purchasing relationship between GTP and GBP is characterized by GTP's ownership of strategic and technological complex sourcing segments and GBP's focus on bus specific components within the framework set by GTP. This arrangement enables Volvo Buses to leverage Volvo Trucks' purchasing scale, supplier relations and technology platforms, while also addressing the unique requirements of the bus product range.

4.2 GBP Sourcing Process

The sourcing process within GBP follows a structured, governance-controlled flow designed to ensure that suppliers deliver competitive prices, high reliability, and strong overall performance. As illustrated in Figure 5, the process begins with strategic preparation, where supplier business plans, segment strategies, technical prerequisites, manufacturing concepts, and logistics setups are developed together with cross-functional stakeholders. During this stage, the buyer responsible for the sourcing case defines which suppliers should be considered for upcoming sourcing activities based on long-term strategy, supplier capability, and expected future needs.

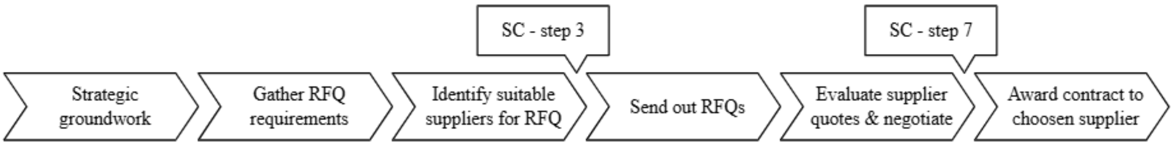

Figure 5: Overview of GBP's sourcing process

Once the strategic groundwork is in place, purchasing gathers all RFQ requirements. These include technical specifications, technical drawings of the article(s), volumes, quality expectations, commercial terms, delivery terms and conditions, sustainability requirements, and cost targets. When the RFQ package is complete, GBP identifies suitable suppliers, evaluates their readiness and compliance, and presents the proposed RFQ supplier list before the SC, referred to internally as “Step 3” of the sourcing process. This ensures cross-functional alignment and confirms that suppliers can fulfill Volvo’s purchasing policies, segment strategies, and sustainability standards before the RFQ package is sent out.

One of the major challenges during this phase lies in the specification process of the RFQ package. In practice, suppliers tend to follow the specifications provided by GBP strictly as written. If the initial specifications contain errors or omissions, suppliers may still produce parts that formally conform to the requirements, potentially resulting in quality issues discovered only during assembly or once the vehicle is in operation. At the same time, Volvo actively seeks greater engineering collaboration with suppliers and aims to leverage supplier engineering capabilities to achieve high quality standards. However, this collaboration becomes limited when requirements are not clearly defined or when supplier input is insufficiently integrated early in the process. Since the cost of correcting errors increases significantly as projects progress, ensuring accurate and validated requirements from the outset is essential to avoid delays, rework, and production disturbances. As such, GBP tend to rely on familiar suppliers rather than exploring new alternative suppliers that they have not worked with previously:

“Often we evaluate the current supplier base for new contracts, because it is already hard enough to get those approved without comments” – R14

During supplier quotation evaluation, buyers perform a comprehensive assessment of each supplier offer using various assessment resources to ensure that quality, delivery capability, cost competitiveness, feature compliance, technology level, sustainability alignment, and risk exposure are considered. Supplier performance, risk level, agreement status, and historical delivery or quality concerns are examined using the GTP Sourcing Risk Evaluation Tool (SRET), while the Supplier Evaluation Model (SEM) is used to evaluate supplier capability, capacity, and maturity. Based on these assessments, the buyer enters negotiations with shortlisted suppliers to achieve the most economically advantageous tender. Throughout this process, suppliers must comply with Volvo Group Supplier Requirements and other applicable regulatory or technical standards depending on the category.

Governance within GBP operates through two formal approval levels: Purchasing Director (PD) approval and SC approval. These approval levels determine who is authorized to approve a sourcing recommendation depending on the financial size and strategic complexity of the case. Lower-risk and lower-value sourcing cases may be approved by the PD, while higher-value, strategically important, or higher-risk sourcing decisions require SC approval. The SC functions as a cross-functional decision-making body involving stakeholders from purchasing, engineering, logistics, Supplier Network Quality, sustainability, manufacturing, cost engineering, and project management. This governance structure ensures that sourcing decisions integrate technical feasibility, operational considerations, quality requirements, sustainability ambitions, and commercial performance before suppliers are approved or awarded business.

Ideally, the buyer responsible for the sourcing case should shortlist three suppliers. However, this is often difficult in practice because many suppliers are hesitant to engage in business with Volvo Buses due to relatively low order volumes. A sourcing case typically remains active for approximately seven to nine months before a final supplier recommendation is presented for approval.

4.2.1 Step 3 of the Sourcing Process

Step 3 of the sourcing process consists of a case presentation in which the SC makes cross-functional decisions regarding which suppliers should receive the RFQ package. The main objective of Step 3 is to ensure alignment before the RFQ list is finalized and to identify any risks, issues, or constraints that may affect the sourcing process later. The buyer explains which component(s) the case covers, the type of sourcing case involved, and which Volvo facilities the component will be delivered to. The buyer then presents the sourcing timeline, including key milestones such as RFQ release, cost objective availability, supplier selection timing, tooling orders, Production Part Approval Process milestones, and SOP timing. In practice, supplier selection is typically completed approximately one to one and a half years before SOP at the Volvo facility.

If applicable, preferential origin considerations are also addressed. For sourcing cases involving parts with an estimated part price above SEK 500, the buyer is required to consult the Trade Navigation team. Preferential origin refers to whether goods qualify for reduced or zero tariffs under trade agreements or unilateral trade arrangements. Since origin status can influence duties, compliance obligations, and the total cost position of a sourcing alternative, these considerations are included early in the sourcing process. The buyer then reviews the status agreement for each supplier included in the case. This includes agreements such as confidentiality agreements, framework agreements, warranty charters, development agreements, price agreements, raw material agreements, parental guarantees, and applicable cybersecurity or software compliance documentation. The buyer also presents the supplier list together with supplier performance evaluations based on tools and resources such as SRET and VSIB. Supplier performance is presented using red-yellow-green logic to highlight strengths, concerns, and mitigation requirements.

Where performance concerns exist, mitigation plans are presented together with proposed corrective actions and target dates. Following this review, the meeting proceeds to cross-functional alignment, where each stakeholder communicates their position using the same red-yellow-green assessment logic. The presentation concludes with an open Q&A session before the Chair of the SC confirms whether Step 3 is approved.

4.2.2 Step 7 of the Sourcing Process

Once the RFQ package has been sent to shortlisted suppliers following Step 3, Step 7 focuses on making the final cross-functional decision regarding which supplier will be awarded the business. Like Step 3, the buyer presents the sourcing case before the SC and reviews the sourcing timeline. However, unlike Step 3, suppliers have now returned formal quotations, allowing the sourcing decision to be based on confirmed commercial offers rather than assumptions and preliminary estimates.

To support the evaluation process, the buyer analyzes supplier quotations using the SC Worksheet, described further in Section 4.3.1. The worksheet structures the comparison between shortlisted suppliers and supports fact-based negotiations. Elements such as quoted part price, tooling and development costs, net present value, part and tooling cost breakdowns, the gap to cost objectives, the "cost walk" (Friday to Monday), and preferential origin considerations are reviewed to identify major cost drivers and strengthen negotiation positions.

Following negotiations with suppliers, the buyer consolidates the final offers and updates the SC worksheet accordingly. The buyer then presents the outcome to the council, including a comparison of final quotations and a recommendation regarding which supplier should receive the business award. As in Step 3, agreement status is reviewed to confirm that all required agreements remain valid and that any new signatures or updates are identified for both the recommended supplier and remaining RFQ participants. Supplier performance is also revisited to confirm that the recommended supplier can meet Volvo's requirements and to evaluate whether previously identified mitigation activities have been completed, remain ongoing, or are still unresolved.

Finally, the meeting concludes with cross-functional alignment, where stakeholders communicate their go or no-go positions before the SC confirms the final supplier award decision.

4.3 GBP Assessment Resources

This chapter presents the evaluation tools available to GBP staff to support the assessment of both new and existing suppliers of Volvo Buses and Prevost. The tools address supplier capability, risk, cost, sustainability, and performance from different perspectives and with varying scopes, forming the foundation for many of the sourcing decisions made by GBP.

4.3.1 Sourcing Council Worksheet

When evaluating supplier quotations in preparation for step 7 of the sourcing process, buyers need to go through an extensive worksheet called "Sourcing Council Worksheet". The worksheet acts as a tool for breaking down the quote received from different potential suppliers for a sourcing case and is mostly automated calculations. The file can handle up to five potential suppliers.

The first step is to put in the necessary data in the first sheet, which acts as an internal database in which later calculations are based on. The evaluation currency must be set to the currency of the main production site. Then the user enters the basic sourcing case information: buyer name, sourcing decision date for step 7, and start of production (SOP) date. These dates must follow the correct format because they drive several time-based calculations in the file. The user then lists all relevant part numbers, their descriptions, and segment codes, with a capacity of up to 500-part numbers. User enters volume information at two levels. A full-year volume is provided, and detailed annual forecasted volumes are entered by expanding the corresponding rows. The template can hold up to ten years of volumes, but the user only needs to fill in the years that match the project or production life or the duration of contract. These volumes are later used to calculate the net-present value (NPV).

Each supplier has a dedicated block that can be expanded within the file. In these blocks, the user inputs the requested data and can use free columns and fields for specific needs. For each supplier, the user selects the quotation currency, which corresponds to the currency used in the received RFQs. The template automatically converts these into the previously defined evaluation currency using embedded exchange rates. The user must mark one supplier as “Recommended” (set to “Yes”) before moving to the other sheets, as this choice controls which supplier is highlighted and considered awarded in subsequent analyses.

Moreover, the first sheet also calculates out the annual spend based on forecasted volumes and the quoted price. Thereafter, tool and logistics costs need to be manually inputted by users which they have received from cost engineering and logistic experts. According to personal communications and review of the worksheet, the TLC in the worksheet includes factors such as part price and estimates of the landed logistic costs. As seen in Figure 6 the landed logistics costs are not limited to freight alone. Packaging is a cost driver which is included in the cost model, which is particularly of high importance if the parts require re-packaging at any point during transportation, together with the weight of the part and yearly forecasted volumes. Moreover, the landed logistics costs also include the geographical location of which the part will be sourced from.

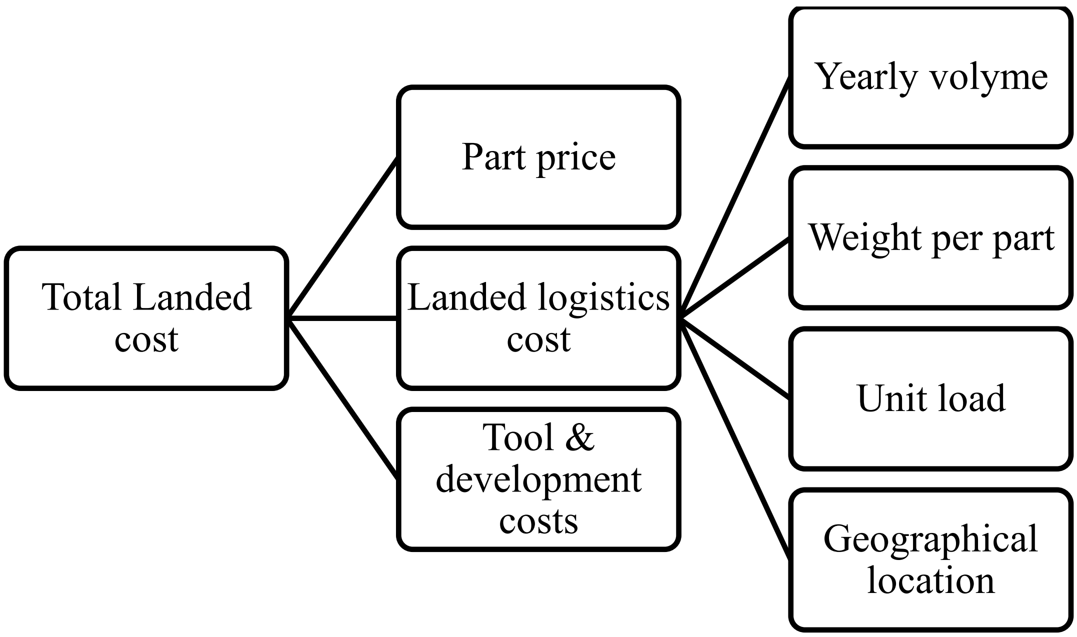

Figure 6: TLC at GBP and its constituent part

In addition to direct logistics costs such as freight and packaging, it is also important to add potential inventory carrying costs if the part is put in a warehouse for a time. Once logistics cost has been added to the database, the sheet calculates what the total landed price is by adding the part price with logistics costs together with tooling and development costs as seen in Figure 6. Then there is also additional data which can be manually inputted such as payment terms, incoterms, whether Volvo or the supplier owns the tools and have intellectual property rights and more.

The SC Worksheet further specifies the application boundary for when capital tie-up starts to accumulate. The cost of capital is applied to the capital tied up in inventory and in transit, from the moment the ownership of the goods is transferred to Volvo. This has practical implications in supplier comparisons because ownership transfer is determined by the commercial and logistical set-up. Depending on what incoterms have been agreed upon, Volvo may take ownership earlier (thereby increasing the time period over which capital is tied up) or later (thereby reducing it). Consequently, the same physical transportation route and warehousing time can generate different capital costs if ownership transfer occurs at different points in the flow.

The "Part Price, Tooling & Development" sheets are largely automated. Data from the database is pulled into summary tables, and the recommended supplier is highlighted in green based on the "*Awarded*" setting. The user can choose which other suppliers to display for comparison. The user must add payment terms and incoterms for the current supplier and fill in any known project targets such as product cost requirement and tooling budget. Productivity is automatically calculated using the average yearly productivity derived from the NPV sheet. The resulting tables are intended to be copied and pasted into a Supplier Selection Approval (SSA) presentation for the SC.

The NPV sheet is also mostly automated. It calculates the NPV of the different supplier offers based on the volume inputs and cost data. The sheet contains its own instructions indicating which additional input (such as discount rate or other financial parameters) are still required from the user. The summary table produced in this sheet is used as a key element in the SSA presentation to show the financial comparison between suppliers. Separate "Part Cost Breakdown" and "Tool Cost Breakdown" sheets are provided. These are independent from the main automated flow and are filled in manually by the user. They allow detailed decomposition of part and tooling costs into cost elements (e.g. materials, labor, overheads, amortization). Multiple pre-defined tables are available and more can be added if needed. From these tables, the user can generate graphs illustrating the cost structure and use them in the SSA presentation to explain differences between suppliers or gaps versus cost objectives.

4.3.2 Sourcing Risk Evaluation Tool

SRET is an Excel-based tool used to assess different risks associated with sourcing cases. This includes assessing the suppliers in terms of quality, supply chain design, production capacity, business and financial status. The tool is used for all new purchasing cases by purchasers, in collaboration with cross-functional teams of SNQ (Supplier Network Quality), LMS (Logistics Manager Sourcing), SML (Service Market Logistics), finance, and engineering. Once a sourcing project has been opened, the purchaser invites the other mentioned teams to the sourcing case SRET-file to make assessments based on them. According to internal documents and personal communication, SRET is to be used in Step 3 and Step 7 of the sourcing process.

The file contains several sheets, the most notable being *Sourcing Recommendation* and *Risk Analysis*. Sourcing Recommendation includes the shortlisted suppliers selected for further evaluation along with automatically fetched metrics and KPIs from VSIB. This connection has, however, deteriorated over time due to limited maintenance of the Excel file and now requires the user to manually import the data.

The Risk Analysis sheet provides a framework for assessing supplier-related uncertainties prior to making final sourcing decisions in Step 7. It serves as a mechanism for cross-functional collaboration among VBC stakeholders. Once the purchaser shares the SRET Excel file with these stakeholders, each is asked to complete a set of questions relevant to their area of expertise and to select a rating that best reflects their assessment. The available ratings are high risk, low risk, no known risk, and not applicable. These ratings are subsequently reviewed by the group in joint meetings.

In the current version of SRET, the total number of questions is 46. These questions are presented in Appendix C and cover the following areas: quality, supply chain, capacity, business, Volvo caused, and finance. Of the 46 questions, 21 (46%) are quality-related, 14 (31%) are business-related, seven (15%) are supply chain-related, two (4%) are capacity-related, one (2%) is finance-related, and one (2%) is Volvo-caused. For questions in the Risk Analysis sheet or for VSIB metrics rated as high risk or below an acceptable level, a mitigation plan must be established, presented, and approved by the SC. This describes how SRET was intended to be used according to Volvo internal documents.

However, further investigation revealed that, despite appearing useful, the Risk Analysis sheet was rarely used in practice (R13, R14, R19, R27). Instead, most supplier assessments were based solely on the metrics and KPIs presented in the Sourcing Recommendation sheet retrieved from VSIB. In the limited number of cases where the Risk Analysis sheet had been completed, the results were often not saved for later reference. Moreover, responses were frequently left blank when a question was not applicable or when no risk was identified, rather than explicitly marking these alternatives. As a result, even when the sheet was used, the data lacked interpretability, as no distinction could be made between unassessed items. As noted by an interviewee:

"The idea of SRET is good, but the questions included in the risk analysis sheet are often too vague in the current version of SRET" - R27

Due to time constraints, this observation could not be further examined, but it may reflect an understanding shared by other SRET users as well and provides some interesting opportunities for the future of SRET. Purchasing managers have requested the addition of Risk Analysis questions relevant to the VBC business environment (R8). When asked about the feasibility and timeline of this, R8 expressed concerns that this could result in there being too many questions for the users to sift through when using the tool and that adding more questions could take a few months. When asked whether it would be possible to maintain two parallel versions of SRET, one for GTP and one for GBP, the R8 said that it had not been considered. At the time of publishing this thesis, GBP continues to use the Excel-based version of SRET.

At the time of publishing, work is under way to introduce a new version of SRET based on Microsoft Power Apps. This updated version is, however, owned and operated by GTP and has primarily been developed with their needs in mind (R8, R25, R26). It is already in use within that organization. Efforts are ongoing to implement the Power Apps-based version of SRET at GBP, but few stakeholders have been able to provide a definitive timeline or clarity on the adaptations required.

4.3.3 Volvo Supplier Information Base

Volvo Supplier Information Base (VSIB) is the supplier master data solution used across all Volvo BAs. It provides a single centralized source of supplier information that Global Buses Purchasing relies on to manage known suppliers consistently across systems and processes, ensuring that supplier-related decisions and transactions are based on the same core data. VSIB uses PARMA-numbers, which are unique identifiers assigned to both Volvo-internal and external supplier facilities. This means that a supplier with multiple production sites may appear several times in VSIB, but each entry corresponds to a different physical location and therefore carries a distinct PARMA-number. In addition to the facility-level information, VSIB also displays the parent company associated with each PARMA-number, enabling purchasers to understand group structures, ownership, and how different facilities relate to the same corporate entity.

VSIB consolidates a set of key information categories that structure purchasing work and support consistent evaluations across purchasers. The following Sections outline the most relevant metrics, how they are applied, their scales, and the presence of any stopping parameters. Examples include the Supplier Evaluation Model score, which reflects the capability, performance, and overall suitability of potential or current suppliers; financial ratings assessing profitability and other economic indicators; audit results covering logistics, capacity, and quality; the supplier's dependency on Volvo Group; historical and forecasted yearly spend across all BAs; and compliance with environmental and sustainability requirements.

These metrics and data points available in VSIB support compliance-, risk-, and performance-related handling where applicable, and provide the master-data foundation that GBP relies on for supplier transparency, traceability, and reliable follow-up. VSIB also records the dates when each assessment or audit was performed, since their relevance naturally decreases over time and requires continuous refreshes to remain reliable.

4.3.3.1 Supplier Evaluation Model

The Supplier Evaluation Model (SEM) is Volvo Group's framework used for evaluating potential suppliers and to reevaluate previously used suppliers in a structured and consistent way. It provides a shared basis for understanding supplier capability, performance, and alignment with Volvo requirements at the level of each PARMA-number. All SEM scores are expressed on a scale from 0 to 100 percent, where scores of 90 percent or above are considered Excellent, scores between 70 and 89 percent are Approved, scores between 60 and 69 percent are Approved with conditions, and scores below 60 percent are Not Approved and business with that specific PARMA-number is blocked. Score thresholds may vary slightly across Volvo BAs.

There are two versions of SEM when evaluating suppliers, this is the Normal SEM and the Short SEM. The two versions differ mainly in the depth of assessment and how the evaluation is carried out.

The Normal SEM is the most extensive version of the evaluation with parts of the audit being performed on-site at the supplier facility corresponding to a specific PARMA-number. It is required before final selection of a new supplier and includes a broad review of the supplier's operational capability, management processes, quality systems, logistics performance, environmental practices, and financial situation. Although the full SEM covers many detailed criteria, its core purpose is to give a comprehensive view of whether a supplier can reliably meet Volvo's expectations over time.

After the evaluation, results are converted into a percentage between 0 and 100 percent, and these outcomes are used to the approval level of the PARMA-number. Scores of 90 percent or above are considered excellent, while scores below 60 percent are not approved, scores that fall in between these two are either approved or conditionally approved depending on BA rules.

A Normal SEM is not required for prototype or aftermarket suppliers, where sourcing volumes are smaller and the demand on serial production is lower, a Short SEM is sufficient. However, whenever a supplier relocates or opens a new facility, a new Normal SEM audit must be performed for the associated PARMA-number, regardless of previous evaluations. This ensures that the new site is validated before being approved for business.

The Short SEM is a streamlined evaluation used to quickly assess the standard of a supplier that is being evaluated for a new contract. It is most often carried out as a desk review, allowing the evaluation to be done without traveling to the supplier. In specific cases, such as certain aftermarket suppliers, it may be conducted on site for greater depth.

The Short SEM uses the same 0 to 100 percent scale as the Normal SEM, which allows for better comparability between the two types of results. While it covers fewer elements than the full SEM, it still reviews key aspects such as basic management systems, quality and delivery performance, financial stability, and major risk indicators. The Short SEM provides an initial indication of supplier capability and is used for all existing production facilities as well as the first step when assessing new PARMA-numbers.

4.3.3.2 Financial Scorecard

The financial scorecard is a tool used to evaluate the financial health of suppliers. It is based on figures from the balance sheet and profit and loss statement and may include an external Dun & Bradstreet rating, a third-party that provides data and analytics insights for businesses. The scorecard compiles this information to help indicate financial risks and support purchasing decisions. The evaluation is carried out through a set of key performance indicators including cash position, solvency, and profitability, where each of these KPIs has an internal scale used by auditors to classify performance into categories. The KPIs themselves are only visible to the auditors to support them in making a concise written assessment, later made available to anyone with access to VSIB. An example of such an assessment can be *"Very Good Profitability and good Solvency, Cash position."*

Although several internal scales exist, the only score visible to users of VSIB is a general financial rating that uses an integer scale from 0 to 3, where 3 is excellent, 2 is good, 1 means average and 0 means poor. This rating is calculated from the KPIs mentioned above and the Dun & Bradstreet data when available and provides a simplified view of the supplier's financial stability. The financial scorecard is assessed only at the parent PARMA level, which means the financial rating is not separately applied to each of a supplier's facilities.

4.3.3.3 Dependency

Supplier dependency is a supplier specific indicator captured within VSIB that measures how much a supplier relies on Volvo Group for its overall business. It provides insight into how reliant a supplier is on Volvo Group, helping purchasers identify potential vulnerabilities and manage supplier relationships more effectively. The metric is presented as a percentage from 0 to 100 percent, and a level of 30 percent or below is generally preferred. A dependency above 30 percent is, however, not connected to any stopping parameter but is discouraged. A high dependency level indicates that the supplier is more exposed to fluctuations in volumes and profitability related to its business with Volvo, and this increases the risk of financial distress if the relationship becomes unprofitable.

Because of this, purchasers often prefer suppliers that also work with other customers, including competitors. A more balanced customer portfolio spreads financial exposure and lessens the likelihood that Volvo Group will carry most of the risk associated with sustaining the supplier's operations. Within VSIB, the dependency metric supports risk assessment and sourcing decisions by providing insight into how reliant a supplier is on Volvo Group, helping purchasers identify potential vulnerabilities and manage supplier relationships more effectively.

4.3.3.4 Logistics Audit

Logistics audits assess a supplier's materials planning and logistics capability using the MMOG/LE standard, an evaluation tool for logistics processes in the automotive industry. Each audit receives both a grade of A, B or C, with A as the highest level, and a result total from 0 to 100, with 100 being the most desired. The grades are set by the auditor responsible with no formal result total-to-grade mapping. Audits may be performed as self-assessments or as auditor-verified evaluations. Logistics audits have no stopping parameter. VSIB records both planned and performed audits, including the date when the audit or assessment took place, the method used, and the resulting grade and score.

4.3.3.5 Capacity Audit

Capacity audits are used to verify that a supplier's production system can support the expected customer production volume. Capacity must be demonstrated across relevant production processes, including internal sub-assembly and sub-tier components, to ensure that the supply chain can meet demand. The capacity planning element assesses whether suppliers have a "true production environment" in place and whether both their own organization and their suppliers are adequately prepared for start of production and ramp-up. Each audit receives both a score from 0 to 100, with 100 being the most desired, and a Capacity Risk Level of Low, Medium, High, or Severe. Scores and the Capacity Risk Level are set by the responsible auditor, and the mapping between the two depends on the auditor's judgement. Short notes may be added by the auditor to clarify the result and the dates for both planned and performed capacity audits are included in VSIB. Capacity audits are used for determining the supplier's capacity risk level, which reflects the likelihood that the supplier may face challenges in meeting required output by Volvo.

4.3.3.6 Quality Audit

Quality audits are performed to assess how well suppliers meet defined requirements that are relevant to the industry they operate in. Each supplier is evaluated on specific indices that reflect the characteristics of what they provided. For example, a supplier of plastic components can be assessed using a Polymer index while a supplier of wire harnesses may be evaluated using a wire harness index along with any other indices that apply to their scope of supply. Audits can be categorized as either short or normal depending on how extensive they are and is closely related to whether they are conducted on site or as a desk review. The outcome of the audit is given as a result between 0 and 100 percent where a higher percentage indicates better adherence to expectations and requirements. Based on this percentage, the supplier is assigned a status. Results below 60 percent lead to the status Not Approved. Results between 60 and 79 percent lead to the status Approved with conditions. Results between 80 and 89 percent lead to the status Approved. Results between 90 and 100 percent yields Excellent as status.

4.3.4 Operational Risk Matrix

As an operative tool within GBP, the Operative Risk Matrix (ORM) supports the evaluation and monitoring of current suppliers by providing a comparable overview of their risk profiles. Purchasers' assessments and supporting data are collected and maintained in a standardized Excel spreadsheet, which serves as the underlying data source. For review and decision support, ORM is presented as a Power BI dashboard, where the results can be filtered and analyzed across suppliers, risk dimensions, and appointed buyer. In the underlying spreadsheet, each row represents a supplier and consolidates information such as multi-dimensional risk assessment, general supplier information, which Volvo BAs contract them, estimated annual spend in total and per BA, appointed purchasing manager at Volvo Buses, and other function hosts.

The core of the risk matrix is a four-dimensional assessment that evaluates each supplier's status in terms of quality, delivery, financial, and business risk. Current suppliers are evaluated on a quarterly basis by the Supplier Quality Network and the purchasers responsible for each supplier. In some respects, it intersects with the areas assessed by SEM (see 4.3.3.1), although ORM is more frequent but less thorough. It is also largely operative and reactive, since it focuses on how past events may affect near-term deliveries and does not assess future potential suppliers, a gap instead addressed by the short SEM (see **Error! Reference source not found.**).

The evaluation is based on qualitative, verbal descriptions of the indicators associated with each risk level for the four dimensions, where each dimension is rated on a five-level scale: Critical, High, Medium, Low, and No-known risk. To make these ratings amenable to aggregation and quantitative analysis, they are converted into numeric scores using a non-linear scale, where Critical corresponds to 27 points, High = 9p, Medium = 3p, Low = 1p and No-known risk = 0p. This scale was chosen because it effectively captured the increasing levels of severity between risk categories, as noted by R16. The nonlinear numeric mapping emphasizes higher risk levels and allows qualitative judgments to be aggregated and analyzed quantitatively. The numeric scores are then combined into a supplier-individual Probability Score, where each of the four dimensions are weighed equally. R10 and R16 stated that the primary purpose of the matrix is to minimize the risk of disturbances impacting the production line, where if a failure was to occur, every dimension is estimated to have an equal ability to cause the same magnitude of disturbances.

For most suppliers, an additional, separate financial rating (VSIB) is also available, as mentioned in 4.3.3.2, which offers further data on which supplier evaluations can be based on. Alongside the numeric data, there are free-text comment fields for the last two quarters, such as "Q1 2026 comments". Here, evaluators can manually record incidents or observations, i.e. recurring delivery delays, threats to stop deliveries, financial problems, name and location changes. These narrative comments provide important context for interpreting the numeric ratings and reveal underlying reasons behind the scores.

Because the matrix includes both risk ratings and spend data, it enables links to be made between operational risk and financial exposure. A supplier with high or critical ratings and large estimated yearly presents a greater material threat than a low-spend supplier with similar risk ratings. This example assumes that the parts sourced from the two suppliers are equally critical for production contingency.

Overall, the GBP Operational Risk Matrix provides a basis for evaluating the risk profiles of current suppliers and is therefore a valuable empirical foundation to this thesis. Its standardized scoring, multidimensional assessment, and integration of spend data enable meaningful comparison of suppliers, while qualitative comments add important contextual insight. Its reliance on subjective judgments, the equal weighting of diverse risk types, and its limited use of external indicators further constrain its predictive and strategic capabilities. Despite these limitations, the matrix remains a useful tool for understanding operational risk within the existing supplier base and offers indirect guidance for more informed supplier selection.

4.3.5 Country Risk Atlas

The Country Risk atlas available on Volvo's intranet is based on extensive third-party research done by Maplecroft, a global risk analytics and strategic consulting firm based in the UK, part of the American data analytics and risk assessment firm Verisk Analytics (n.d.). It is updated on April 1st every year by Volvo Group's Corporate Responsibility business function. The purpose of the risk atlas is to support Volvo employees across all BAs in making informed decisions when corporate responsibility and sustainability-related risks need to be considered. Some of the use-cases of the risk atlas as suggested by Volvo are for conducting supplier risk assessments and supplier audits.

Some of the use cases of the Risk Atlas, as suggested by Volvo, include conducting supplier risk assessments and supplier audits. For purchasing functions within the different Volvo Group BAs, the Country Risk Atlas can serve as a resource for determining when audits should be conducted as part of due diligence processes. One example of this is that corporate social responsibility live audits are mandatory for suppliers located in countries classified as high or extreme risk, or when the risks of human and labor rights violations are rated as high or extreme. If a supplier does not pass such an audit, there is a high likelihood that the supplier will be blocked, as it does not meet Volvo's minimum supplier requirements. During the writing of this thesis, it has also become evident that GBP is actively strengthening the integration of country risk considerations into the sourcing process. Ongoing initiatives aim to incorporate the Country Risk Atlas more systematically as an input in sourcing decisions before moving to step 7. These developments are reflected in internal documents on the sourcing process, where risk analysis is increasingly formalized and integrated before key decision gates.

For the period 2025 to 2026, the Risk Atlas covers 198 countries and includes 23 indices related to the environment, human and labor rights and business landscape. For each index, every country receives a score between 0 to 10 with 2 decimal places, where a low score is regarded as negative and a high score as positive. An example is terrorism intensity, where a score of 10 indicates a low risk of terrorist attacks. If no information is available for an index, that country's score is left blank. Based on the assigned score, each index is classified as low, medium, high or extreme risk. All available scores for each country are then combined into an overall score in accordance with the table shown in Appendix D.

4.3.6 Prevost Supplier Scorecard

The Prevost Supplier Scorecard is a Power BI–based performance management tool used to evaluate and monitor current Prevost suppliers in a data-driven manner. It brings together operational, quality, and logistics data into a single dashboard that provides a clear and objective view of supplier performance across multiple dimensions. Each supplier is assigned an overall score derived from key quantitative metrics such as On-Time Delivery, Quality Performance Measure, Capacity, Back Orders, and other production impact indicators. These metrics are calculated into a combined score for each supplier, ensuring that results are based strictly on factual data rather than personal judgment.

The scorecard is automatically updated on a weekly basis using data sourced directly from internal databases, ensuring that supplier performance is continuously monitored with minimal manual intervention. While the numerical results remain fully objective, the dashboard is reviewed in detail during monthly joint cross-functional meetings. During these sessions, development trends are analyzed, recurring issues are identified, and contextual or subjective insights are shared. As highlighted by R32, the product owner, the scorecard itself remains purely data-driven, while judgment and operational experience are applied during discussions of trends rather than embedded in the calculations.

Visually, the dashboard combines high-level indicators and detailed supplier views. Aggregated gauges display overall performance levels for the previously mentioned metrics, and the total score. Below these indicators, a table lists individual suppliers along with their specific performance values, total score, spend, and a trend status that highlights persistent performance issues. Other pages within the report include supplier analysis, graphic dashboards, and score evolution views which support deeper analysis and historical tracking. Filters allow users to segment results by supplier, timeframe, geography, criticality, category, and spend.

The scorecard is exclusively used within Prevost and is not applied by other parts of GBP. According to R32, its main value lies in creating a shared, factual foundation for discussions on supplier performance with internal stakeholders, while also making it easy to identify low-performing suppliers, evaluate supplier reliability and long-term performance trends.

4.4 Vulnerabilities and Structural Constraints at GBP

The following Sections present empirical findings from interviews conducted with staff at GBP. The themes discussed reflect risk areas derived from the literature review, which guided the interview questions, and illustrate how these issues manifest in Volvo Buses' sourcing practices.

4.4.1 Single-Sourcing & Alternative Suppliers

A recurring theme during the interviews was the prevalence of single-sourcing at Volvo Buses and Prevost, as it emerges as both common practice and, in other cases, an unavoidable outcome of the company's structural constraints (R12, R13, R14, R16, R17, R18, R19, R21, R22, R23, R28, R33, R34). With the most consistent driver for this being their low volumes compared to other Volvo BAs, which makes it difficult to attract or retain multiple qualified suppliers. Several buyers highlight that many potential suppliers decline participation simply because GBP's business cases are unattractive. This is particularly evident in segments with high part complexity or significant engineering involvement, such as wire harnesses, electronics, and telematics. In these areas, single sourcing is the norm rather than the exception.

For example, one of the electronics segments relies solely on one regional supplier and their ability to handle GBP's low volumes, high customization and production sequencing requirements make them irreplaceable (R18, R19). Similarly, the ECU and fuse box segments are all single-sourced, where the suppliers themselves often own critical IP-rights and BOMs for each part number (R16). When these segments are outsourced, Volvo Buses instead provides the suppliers with requirement specifications rather than finished designs. These factors make switching suppliers time-consuming, costly and lead times can be extreme for establishing alternative suppliers, even when alternatives exist on paper (R16, R18, R19).

Several buyers also stress that multi-sourcing is theoretically desirable but economically unrealistic (R14, R16, R19, R21, R23). Volumes are too small to justify parallel tool investments or dual validation cycles. In the electric mobility-segment, the dependency becomes even more pronounced (R17). Battery suppliers operate in a seller's market where Volvo Buses extremely low volumes offer limited leverage, even when pooled with other Volvo BAs. Changing battery suppliers also means changing battery technology and requires one to two years of testing and validation, making multi-sourcing infeasible. As one buyer expressed it:

"Volvo needs the supplier more than the supplier needs Volvo." – R17

Multi-site sourcing is also uncommon at Volvo Buses, even in cases suppliers operate multiple plants, Volvo Buses source from only one of them (R15). The low business volumes do not justify validating several production sites, and suppliers themselves rarely offer multi-site production for Buses because the additional tooling, coordination and quality assurance work cannot be justified for the small order sizes. In practice, this means that Volvo Buses receives no real redundancy from suppliers having multiple plants. A few isolated cases exist, such as certain air bellows that a supplier can produce in both Germany and Romania, but situations like these are exceptions rather than the norm. And in many other segments, the complexity of parts, supplier ownership of IP rights and obstacles of validating facilities make multi-site sourcing almost as unrealistic as multi-sourcing (R15, R16).

Even in lower complexity segments like sheet metal and brackets, where alternative suppliers exist, single sourcing is still common for individual part numbers (R12, R27, R28, R33). While these parts can often be shifted to new suppliers more quickly, buyers still report that the path of least resistance is to rely on a single approved supplier due to the administrative burden of onboarding new ones (R12).

The dependence created by single sourcing also introduces switching barriers. When supplier issues arise, turning to a new supplier is described as the last resort and slow, disruptive and costly process (R12, R14). Under these conditions, supplier financial stability instead emerged as one of the most important factors in the interviews. As noted in an interview:

"The worst decision you can make is to award contract to a supplier who is near bankruptcy. If the supplier goes under, there is nothing you can do and there is no higher level to escalate to" – R16

Consequently, financial risk assessments such as the VSIB financial scorecard play a central role in supplier selection and monitoring (R9, R10, R15).

While these financial assessments primarily address Volvo Buses' dependency on critical suppliers under single-sourcing conditions, the interviews also highlighted a related risk in the opposite direction, namely supplier dependency on Volvo for their business (R9, R33, R34). Several respondents note that suppliers who become overly dependent on Volvo or Prevost for a large share of their total business may experience financial strain when volumes are low or margins are insufficient. Under such conditions, suppliers may choose to terminate the relationship or withdraw from the segment altogether, thereby reversing the assumed dependency structure.

In segments characterized by high switching costs and long validation lead times, alternative sourcing is often not feasible without creating significant downstream effects in the service market (R28, R33). Interviews related to service market operations emphasize that supplier changes during or after series production can severely strain long-term support obligations, particularly given that Prevost supports certain discontinued vehicles indefinitely and Volvo Buses for 15 years (R33). This extended responsibility has led to a steadily expanding spare parts portfolio, including restarted production runs of legacy parts based on original drawings and without design updates, often because dedicated spare parts engineering resources are lacking. Under such conditions, switching suppliers risks the loss of tooling, documentation, and design knowledge, especially when suppliers are not clearly informed of service market responsibilities and therefore scrap equipment once series production ends. These risks are unevenly distributed across components, as simpler parts such as metal brackets are more easily supported by alternative suppliers, whereas electronics can be significantly harder to sustain over long-time horizons. R33 says that many service market issues could be mitigated through change management and consideration of the issues during supplier evaluation and design, such as ensuring backward compatibility, managing supplier switches transparently, and securing design ownership. This introduces the need for buyers to also account for service market exposure when evaluating suppliers, rather than treating it solely as a production-related issue.

Overall, these bilateral dependencies significantly limit GBP's ability to substitute suppliers and increase vulnerability to supply disruptions. They reduce the use of traditional risk mitigation strategies such as dual- or multi-sourcing, and GBP instead becomes increasingly reliant on alternative risk mitigation mechanisms. Mechanisms like contingency planning, long-term agreements, and continuous monitoring of supplier financial health when entering and managing supplier relationships (R4, R18, R28, R34).

4.4.2 Geographical Location of GBP Suppliers

The interviews conducted with people at GBP revealed something interesting, that Volvo Buses in large parts sources from regional 1st tier suppliers (R12, R13, R14, R16, R18, R19, R23, R24). Something which closely aligns with literature on how the vulnerability of a supply chain is shaped by the political and business landscape of countries it involves. Volvo Buses' purchasing organization confirmed what was said by Christopher & Peck (2004) and Maharjan & Kato (2022), particularly how regional sourcing, geopolitical conditions, and location-driven constraints influence resilience.

Buyers across categories like sheet metal, brackets, hoses, pipes, ECUs, fuse boxes, telematics describe a supplier portfolio concentrated in European countries near Sweden (R12, R13, R14, R16, R18, R19). Several interviewees mention sourcing closer to the Borås plant and using suppliers within Europe to avoid long-distance uncertainty with points being made that while China and India were attractive 15 years ago, they now avoid such setups due to long lead times, logistical and geopolitical risk (R2). But despite this European shift, critical electronics like PCBs and semiconductors are still heavily reliant on sourcing from Asia and particularly China, illustrating a location-driven vulnerability (R16). Even in cases when the tier-1 electronics suppliers are European, underlying tier N suppliers are often Chinese, creating structural dependence that is hard to change given this global production concentration in the east. Similar challenges appear with electromobility, where battery suppliers are of Chinese origins in particular (R17). In relation to these segments, interviewees cite cost and a limited capabilities of alternative suppliers as key reasons behind their reliance on Asian suppliers (R2, R6, R16, R17, R20). This effectively locks Volvo into politically sensitive regions despite the sometimes-poor working conditions at suppliers, global tensions, and shipping disturbances.

"Even though there is more risk associated with purchasing from Chinese and other Asian battery OEMs, there are few other actors to choose from, and when the financial aspects have been weighed, it becomes it almost impossible to seriously consider the others" – R17

Other regions introduce risks more related to political and economic conditions than distance. Mexico and Brazil are examples of this, where volatile business environments and unpredictable administrations influence supply decisions (R5, R6). Brazil is characterized by high inflation and political unpredictability that can affect margins, and buyers note the need to quantify or at least acknowledge such risks when shifting or expanding production (R5). Mexico is used both short- and long-term, while their local suppliers operate with infrastructure constraints and fluctuating working conditions, supporting the argument that weak institutions and instability increase regulatory and logistical uncertainty.

In Canada and the United States, where Prevost operates, the political and business environment is more stable but still creates geography-related challenges. Cross-border trade between Canada and the US introduces tariffs, time zones, customs procedures, and communication barriers, echoing the literature's view that dispersion and border complexity can slow response during disruptions even in stable regions (R21, R23). The interviews also indicate that Prevost's geographical dispersion seems to be larger than that of Volvo Buses as it relies not only on its own supplier base in Canada and the US but also on suppliers used by Volvo Buses (R21, R22, R23, R27, R34), who are overwhelmingly located in Europe. This extends Prevost across both sides of the Atlantic, increasing its exposure to long-distance transport risks and differentiated political environments. In addition to these factors, interviews at Prevost indicated that geographical risk in North America is also shaped by compatibility issues between Volvo Group's supplier requirements and the local supplier base. Several respondents describe difficulties in qualifying otherwise capable suppliers due to limited implementation of certifications such as ISO 14001 and to some extent, ISO 9001, particularly among non-automotive suppliers (R21, R22, R27, R34). Respondents where however careful to not frame it because of poor performance, but rather as a characteristic of the North American industry.

Trade agreements and preferential origin rules further shape supplier geography. Interviewees indicate that since the late 2010s, these rules have become increasingly important (R24), particularly as battery and electronics components account for a growing share of the vehicles' Ex Works value while being predominantly sourced from China (R17, R24). As a result, greater emphasis is placed on sourcing other components from countries with which the EU has free trade agreements or, in the case of Prevost, from countries that Canada has free trade agreements with, to offset the high share of non-originating content (R17).

Preferential origin requirements thus restrict sourcing from non-EU suppliers, or non-Canadian suppliers in Prevost's case, as failure to meet origin thresholds would result in significant duties on the finished vehicles. For this reason, and in combination with considerations related to reduced lead times and shipping costs, near-sourcing has become increasingly more important for GBP over the past decade.

Put together, the findings show that GBP's supplier geography reflects a balance between risk mitigation and structural constraints. Near-sourcing in Europe reduces lead times, geopolitical exposure, and trade compliance risk, but critical electronics and battery components remain heavily dependent on Asia, creating persistent vulnerabilities. Additional exposure stems from politically volatile regions and Prevost's transatlantic supply base, illustrating how regionalization improves resilience while global dependencies remain difficult to avoid.

4.5 Online Survey Results

The survey results provide insight into how the relative importance of different risk categories and the spacing between severity levels in SRET are perceived by its users within GBP. Responses were aggregated using AHP principles, presented under Section 3.4 to derive comparable weights and scale values. Respondents evaluated the relative spacing between four severity levels using Saaty's (1980) original 1 to 9 scale. In addition to the severity levels currently used in SRET, a medium severity level was introduced as part of the survey. At the time of this study, this level does not exist in the current version of SRET. The Medium severity level was included to offer a deeper level of detail into how respondents perceive the intermediate risk levels, which is considered in the subsequent discussion of potential implications for the SRET model. Participants were therefore asked to assess how they perceived the severity of this additional level in relation to the existing ones. The resulting values were translated into a 0-10 scale and are presented in Table 4 with No Risk being anchored to 0,0 and High Risk being assigned the maximum value of 10.0. A 0–10 scale was chosen because it is familiar, intuitive, and easy to grasp, while still providing sufficient granularity for meaningful differentiation. The distribution indicates that severity is not perceived as increasing linearly, with significantly larger perceived impact at the upper end of the scale.

Table 4: Perceived spacing between severity levels

Levels	0-10 Scale
No Risk	0,0
Low	0,5
Medium	2,6
High	10,0

In addition to severity level spacing, respondents also assessed the relative importance of the six risk categories within the SRET framework. The aggregated weights for each category are presented in Table 5. Quality emerged as the most important category with a weight of 0.255, indicating that quality-related risks are perceived as particularly critical. While Volvo Caused risks were assigned the lowest weight of 0.098.

Table 5: Aggregated weights for risk categories

Categories	**Weights**
Quality	0,255
Capacity	0,183
Finance	0,170
Supply Chain	0,162
Business	0,132
Volvo Caused	0,098

To assess the internal coherence of respondents' judgments, a CR was calculated for both the severity level spacing and the category weighting results. The CR for the category weights was 0,012, indicating a very high level of logical consistency in respondents' evaluations. For the severity level spacing, the CR was calculated as 0.100, which falls on the edge of the generally accepted threshold proposed by Saaty (1990). These values suggest that the derived weights and severity scale are based on coherent and consistent judgments.

Together, the severity spacing and category weighting results provide a quantitative representation of how procurement professionals interpret and prioritize risk within the SRET framework. Calculations, underlying data, and aggregation steps supporting these results are provided in Appendix E.

5 Analysis & Discussion

The following is an analysis of the empirical findings and the opportunities identified relative to the purpose of this thesis and the previously established theoretical framework.

5.1 Current Sourcing Process

The current sourcing practices employed at GBP illustrate a clear recognition of supplier-related risks, but also a structural separation between risk assessment and cost evaluation. Although risk is explicitly discussed and assessed through tools and resources such as VSIB, sub-metrics, and SRET, these assessments do not influence the total landed cost figures used when comparing supplier quotations. As a result, the TLC calculated in the SC Worksheet (see Section 4.3.1) is treated as a deterministic estimate based on quoted prices and estimated logistics costs, effectively reflecting operations under normal circumstances. Risk, by contrast, enters the decision process as a parallel qualitative dimension discussed verbally during SC meetings rather than being embedded in the cost calculation itself. From a theoretical perspective, this separation reflects a recurring pattern identified in TCO literature, where organizations acknowledge the relevance of non-price factors and risk but struggle to incorporate them into formal cost considerations (Ellram, 1993; Ferrin & Plank, 2002). From a decision-making standpoint, this can create a disconnect between the information discussed in governance forums and the inputs that structurally shape supplier comparisons, potentially exposing the organization to suppliers that appear cost-efficient initially but become significantly more costly once risks materialize (Degraeve & Roodhooft, 1999).

The limited practical use of the SRET tool reinforces this separation. Although SRET is designed to structure and formalize supplier-related risk assessments, its current use at GBP is inconsistent and often disconnects from the evaluation of quotations received from suppliers. This finding aligns with observations from supplier evaluation literature presented in Section 3.1, where risk assessment tools are frequently used as compliance or screening mechanisms rather than as integrated decision-support systems (Monczka et al., 2009). In GBP’s case, risk assessment primarily appears to serve the purpose of identifying stopping parameters or mitigation requirements if the risk is considered critical, rather than influencing supplier attractiveness in economic terms.

However, recent initiatives within GBP seek to address this disconnect by introducing a more structured integration of risk into the sourcing process. As reflected in updated sourcing procedures, risk considerations such as geographical exposure and supplier-related risks are increasingly formalized through predefined assessment criteria and incorporated into key decision stages. These ongoing initiatives at GBP of introducing country-level risk considerations using the Country Risk Atlas further illustrate this pattern. In Section 3.5.2, geopolitical, environmental, and country-level risks are described as significant sources of cost volatility and disruption (Christopher & Peck, 2004). Yet, despite the Country Risk Atlas being available as a resource within GBP and explicitly recommended for supplier risk assessments, the empirical findings revealed that there had been little systematic use of it in GBP’s sourcing process. This suggests that even where tools exist to capture environmental and geopolitical risk dimensions, the organizational mechanisms required to translate their output into sourcing decisions are absent. In other words, risk information is available but not structurally connected to cost evaluation.

This separation between risk assessment and cost evaluation becomes particularly visible in the structure and use of the SC Worksheet described in Section 4.3.1. The SC Worksheet represents GBP's primary instrument for comparing supplier quotations and supporting final sourcing recommendations in Step 7 of the sourcing process. From a theoretical perspective, the structure and use of this worksheet can be understood through the lens of TLC and TCO, as discussed in Sections 3.2 and 3.3. The empirical findings show that while the worksheet aligns well with key principles of TLC, it captures only a subset of the broader cost drivers emphasized in TCO literature, as illustrated by Figure 4.

According to literature, TLC focuses on the inbound supply chain-related costs associated with obtaining a product, including transportation, handling, packaging, duties, and capital tied up in inventory and transit (Pumpe & Vallée, 2017). The SC Worksheet largely operationalizes this perspective. Beyond the quoted part price, the worksheet incorporates estimated logistics costs. Moreover, the inclusion of incoterms and payment terms further reflects the logic of TLC models, as ownership transfer and cash flow timing directly influence capital costs. In this regard, the worksheet can be viewed as a standardized cost model based on Ellram's (1994) taxonomy. The current worksheet employed by GBP uses a fixed structure with predefined cost elements applied consistently across sourcing cases, enabling comparability between suppliers. But when it is examined against the broader TCO framework described in Section 3.3, several limitations emerge. TCO theory emphasizes that supplier decisions should account for all costs incurred throughout the product lifecycle, including transaction costs, coordination costs, quality-related costs, disruption costs, and long-term support obligations (Ellram, 1993; Ferrin & Plank, 2002). While some of these elements are indirectly reflected in the worksheet, such as tooling, development effort, and inventory holding, many other TCO factors remain unquantified or entirely absent. Costs related to supplier reliability, quality deviations, production disturbances, warranty exposure, and long-term service support are discussed during SC meetings but are not embedded in the numerical comparison produced by the worksheet.

This corresponds closely to the distinction between conceptual (see Section 3.3.1) and highly analytical TCO models (see Section 3.3.4). Conceptual TCO models encourage decision-makers to consider non-price factors and long-term implications without necessarily quantifying them, whereas highly analytical models aim to translate these factors into monetary terms for direct comparison. The SC Worksheet primarily operates at an intermediate level where it goes beyond unit price and captures several tangible transactional costs elements but stops short of analytically incorporating risk-related and lifecycle-dependent cost drivers. As a result, the worksheet implicitly assumes normal operating conditions where suppliers perform as expected and where disruptions, quality issues, or strategic constraints do not materialize.

The empirical material further indicates that risk and uncertainty are instead handled separately through supplier data available from VSIB and through additional artefacts such as SRET, SEM, ORM, and SC approval processes. This mirrors findings in TCO literature suggesting that many organizations mentally account for risk and non-price factors without formally integrating them into cost models (Ellram, 1993; Ferrin & Plank, 2002). In GBP's case, this separation means that suppliers with different risk profiles may appear economically equivalent in the current cost estimation model, even though their expected cost exposure over time may differ substantially. From a theoretical standpoint, this undermines the core rationale of TCO and TLC, which seek to make such trade-offs visible and comparable. The SC Worksheet can therefore be interpreted as a strong TLC foundation that lacks a mechanism for incorporating risk-adjusted cost logic. Rather than representing a deficiency in GBP's cost modelling capability, this reflects a deliberate trade-off between analytical precision and usability. As discussed by Ellram (1994), highly analytical TCO models require extensive data, cross-functional involvement, and significant maintenance effort, conditions that are difficult to sustain in a low-volume, high-complexity environment such as Volvo Buses.

In this context, the relevance of the proposed risk-adjusted multiplier model becomes apparent. Instead of attempting to expand the SC Worksheet to include a full set of TCO cost drivers, the model builds on the existing TLC structure and introduces risk as a cost modifier. By doing so, it preserves the standardized and decision-ready nature of the worksheet while conceptually aligning it more closely with TCO theory. The risk-adjusted TLC approach can therefore be interpreted as a pragmatic bridge between GBP's current practice and the theoretical ideal of integrated cost and risk evaluation.

5.2 Risk Considerations at GBP

To have an effective supplier evaluation, theory stresses out that a multi-criteria approach extending beyond unit price to cover quality, delivery performance, financial stability, management capability and long-term relationship potential are vital (Weele & Rozemeijer, 2022; Monczka et al., 2009). VSIB broadly operationalizes this logic by consolidating capability scores, financial ratings, audit results and dependency metrics into a single centralized platform, covering risk dimensions that can be found across several of Christopher & Peck's (2004) risk categories mentioned in 3.5.1. However, there is an important and meaningful gap that exists between how these assessment resources can be integrated. While each individual assessment resource addresses a relevant dimension of supplier risk, their outputs are expressed in incompatible scales where they use either percentage scores, linear ratings, audit grades and qualitative risk levels. These cannot be directly compared or aggregated without an additional integrative mechanism. As a result, these assessment resources available supports screening and compliance checking effectively but falls short of what Ellram (1993) describes as analytical TCO modelling where risk and cost drivers are translated into monetary terms that allow suppliers to be compared on a consolidated basis. The assessment resources available are acknowledged and important but are not currently quantified in a way that connects to cost figures in sourcing decisions.

5.2.1 Strengths and Weaknesses of SRET

One tool that grew into significant interest for this thesis was SRET (see 4.3.2) which addresses this incompatibility. Based on empirical findings of SRET and interview material, the current version of SRET can capture many of the risks mentioned in 3.1. From a theoretical perspective, this alignment is consistent with established supplier evaluation frameworks which typically emphasize quality performance, capacity sufficiency, delivery reliability and financial stability as foundational screening criteria for potential suppliers (Monczka et al., 2009; Tahriri et al., 2008). In this sense, SRET reflects what could be described as a baseline risk taxonomy that is broadly applicable across sourcing contexts. Moreover, SRET is to be carried out for both step 3 and step 7 in GBP sourcing process (see Section 4.2), which was another factor that contributed to this significant interest. The following Sections will analyze the collected material from interviews concerning SRET's risk assessment questionnaire.

The comparison between the SRET Risk Analysis questionnaire in Appendix C and through the empirical findings indicates that the current tool captures a substantial share of the risk dimensions that buyers and purchasing stakeholders consider when running sourcing cases. In several areas, SRET aligns well with how interviewees describe general purchasing risks in Section 4.4. The supplier's financial status is consistently treated as a central decision input in practice, commonly operationalized through the financial VSIB rating (R16, R12, R17, R9, R21). This is mirrored by SRET's inclusion of supplier financial situation and supplier performance. Likewise, the interviews repeatedly stress supplier responsiveness, relationship quality, and the ability to manage deviations and communicate effectively (R16, R5, R6) which correspond closely to SRET items addressing project organization, supplier responsiveness, and performance follow-up. Capacity and delivery continuity are also re-occurring themes that can be found from the interviews conducted (R21, R9, R29, R30, R31) and SRET. This is evident since SRET prompts buyers to consider the impact of new volumes on capacity as well as past delivery issues and critical supplier status. In addition, the need to understand sub-suppliers and lower tiers appears in both the SRET questionnaire and the interview findings. Interviewees acknowledge the importance of Tier N visibility and the challenges of sustaining detailed mapping, while SRET explicitly requires supply chain mapping, identification of risks connected to sub-suppliers, and evaluation of Tier 1 suppliers' ability to manage Tier 2 (R10, R13, R6, R24). Literature on supplier selection consistently highlights financial health as one of the most important prerequisites to ensure supply continuity, while also emphasizing the importance of assessing capacity, quality, delivery performance, and business relationships (Christopher & Peck, 2004; Giunipero & Monczka, 1997).

However, there are gaps that can be identified. Geographical risk appears in both SRET and conducted interviews, but with different degrees of inclusion and emphasis. In interviews, many describe geographical risks as something that is at most kept in mind (R12, R16, R17, R19, R24,), and there have been internal discussions about integrating external country risk information into governance processes (R10). If compared to SRET, which includes "*logistics reliability and stability of supplier country*" with attention to infrastructure and political and cultural factors, the interviews suggest that geopolitical risk often is more manifested through trade and compliance constraints such as sanctions, restricted origins, preferential origin and the need for supplier attestations regarding material provenance. These dimensions are not explicitly foregrounded in SRET beyond regional value content compliance, which addresses a different regulatory logic than sanctions and trade restrictions. Consequently, SRET provides a basis for discussing geographic risk, but not necessarily the standardized decision input that interviewees indicate is missing in current practice.

A further design-related weakness identified through direct inspection of the SRET Risk Analysis sheet concerns the formulation of certain assessment items, where multiple risk definitions are given on the same risk. This appears to be a systematic issue rather than an isolated exception. Buyers are required to assign a single risk level to each assessment cell. However, when several distinct questions are embedded within the same risk assessment cell and these vary in severity, the assessment task becomes more demanding. This can further reinforce the general vagueness of the questions noted by R27 in Section 4.3.2, as different definitions within the same cell may point to different risk levels. In such cases, users are left without guidance on conflicting signals, which can undermine the reliability and comparability of the resulting risk scores. Alternatively, there is a risk that buyers implicitly base their assessment on only one of the included aspects, leaving other relevant risk drivers unaddressed. While the low usage of the SRET Risk Analysis sheet limited opportunities to empirically confirm how buyers resolve this, the presence of combined assessment items nonetheless represents a limitation that may reduce transparency in how supplier risks are evaluated across sourcing cases.

Another theme that emerged from the interviews is two-way dependencies. Buyers describe scenarios in which Volvo is a small customer relative to a supplier, creating a risk of Volvo not being prioritized and has limited power over the supplier (R17, R34). There are also cases where Volvo is the more dominant party and suppliers instead become overly dependent on Volvo's business (R18, R19), potentially increasing the risk of supplier instability if the account is unprofitable, which can lead to suppliers going bankrupt and stopping deliveries to Volvo's plants (R9). SRET partially captures this risk of dependency through questions on what the potential dependency will be after contract is rewarded to supplier. Similarly, several interviewees note that low-spend, "tail" suppliers can still create disproportionate delivery and price issues (R6, R34), which is not clearly singled out in SRET.

Service market support is another area where the interviews introduce a stronger emphasis than SRET presently makes explicit. Multiple respondents reference the requirement to offer service market support products for up to 15 years (R9, R10, R16, R33), which has proven to be challenging for rapidly developing technologies such as semiconductors and batteries (R16). The empirical material illustrates how carry-over of older architectures can reduce near-term development costs but increase exposure to component end-of-life events where for example microprocessors are discontinued, forcing redesigns that may be financially unrealistic with the lower bus volumes. In addition, the interviews highlight that material compliance issues can re-emerge in legacy components as regulations tighten or as material declarations are reviewed more stringently (R6, R16), creating a latent risk even without physical design changes. Compared to SRET, which touches on service parts supplier status and phase-out considerations, but it does not directly require an assessment of obsolescence monitoring capability, last-time-buy strategies, supplier commitments for long-term support, or the feasibility of redesigning pathways when obsolescence occurs. Given the importance of long-term service obligations in buses and the described difficulty of supplier switching in key technologies, this represents a substantial mismatch between the tool's visible focus and the risk realities perceived by its users. Something which is even more important to Prevost, that has a "*red-carpet*" policy where many components have an indefinite service market support (R33).

At the same time, the interviews suggest that some of the most consequential risks in the Volvo Buses setting are not primarily driven by whether a supplier can execute Advanced Product Quality Planning (APQP) activities or whether a project plan aligns with milestones, but by structural constraints that limit the feasible set of sourcing strategies. A recurring theme is that single sourcing is the practical default, not an exception, largely because of low purchasing volumes, high product variety, and limited supplier willingness to engage in small bus-specific business (R12, R13, R14, R16, R17, R18, R19, R21, R22, R23, R28, R33, R34). Several interviewees describe commodities where multi-sourcing is theoretically attractive but economically and technically difficult to implement, particularly in electronics, brackets and wire harnesses (R12, R17, R18, R19). In such cases, the risk is less about selecting the "right" supplier among many and more about being locked into a supplier due to switching costs, validation lead times, design ownership, or architecture dependencies. SRET does not explicitly ask whether the intended sourcing setup is single sourced, nor does it require a structured evaluation of whether that single-sourcing position is acceptable given the criticality of the part and the availability of viable mitigations. The consequence is that a risk driver that dominates buyers' reasoning in interviews can remain implicit in the assessment, even if some related aspects are indirectly covered through items such as "new supplier," "supplier switch checklist," and general supply chain mapping.

Additionally, when there is a supplier switch, interviews describe that "alternative supplier" can exist but are practically inaccessible due to extensive re-testing, re-validation (R17), tooling requirements (R33), or high non-recurring engineering costs that cannot be justified at bus volumes (R9, R16, R34). This is particularly evident for electronics where suppliers may own the intellectual property and bill of materials (R16), and for batteries where qualification cycles and validation horizons are long (R17). SRET includes a question about supplier switching risk and feasibility reference but does not consistently operationalize supplier switch as a quantified risk item that can be compared across sourcing options. This matters because buyers often mitigate single-sourcing risk not by establishing a second supplier, but by building long-term agreements, partnerships, buffer strategies, and contingency plans with the current supplier (R14, R18, R23, R28, R33). Such mitigation logic is described in the interviews as a realistic substitute for multi-sourcing, yet it is not made explicit as something that is assessed in SRET. In contrast, multi-sourcing can be comparatively straightforward to assess, for example by determining whether the same part is sourced from multiple suppliers and how order volumes are distributed between them. A possible explanation for why relationship-based mitigation is not assessed more explicitly is that the quality of a buyer-supplier relationship is difficult to objectively determine when the supplier is being evaluated for a new contract, and even more difficult when considering a future relationship with a supplier that is new to the buyer/company.

Another clear difference concerns commercial and contractual risk. Interviewees emphasize that payment terms (R6), pricing model changes, cost breakdown transparency, and the practical enforceability of agreements (R15) can be decisive, especially as Volvo Buses' low volumes give them a relatively weak bargaining position (R9, R15, R17, R19, R20). This includes situations where suppliers can impose updated payment terms, initiate price increases that are difficult to resist, or break agreements with limited risk of legal escalation due to the cost and time associated with litigation (R15). While SRET includes budget alignment checks for development costs and tooling, it does not explicitly structure the evaluation of contractual robustness, termination clauses, notice periods, commercial leverage, or the risk of opportunistic renegotiation under supply constraint conditions. As a result, a set of risks that buyers describe as highly salient may be treated as "outside" the formal risk tool, even though they directly influence total cost and continuity of supply.

5.2.2 Risk Areas Absent from Empirical Findings

Analysis of the interview material shows that while several risk categories identified in the literature are reflected in GBP's sourcing practices, other risk areas only partly appear or are not explicitly articulated by interviewees. The risk categories not discussed in Section 4.4 were not omitted during analysis but rather did not emerge from the empirical material as explicit or systematically managed risks and could therefore not be integrated into those Sections. Instead, they appear to be addressed indirectly, handled reactively, or lie outside the primary scope of GBP's sourcing decision making as described by respondents.

One such area concerns upstream material scarcity and shortages beyond tier 1 suppliers. While buyers occasionally referenced raw material shortages or semiconductor constraints, these issues were discussed mainly in response to concrete delivery problems rather than as proactively managed risk categories. Similarly, although several interviewees acknowledged the relevance of tier N transparency, dependencies, and ownership structures, and some initiatives aimed at improving this were mentioned, comprehensive mapping and continuous monitoring of supply networks were generally described as infeasible under normal operating conditions. As a result, risks related to limited information flow across tiers, delayed risk detection, and constrained control beyond tier 1 suppliers remained largely unstated in formal sourcing practices. A comparable pattern appears for internal process and production flexibility. Sourcing vulnerability was primarily framed as originating from supplier structures, volume constraints, and external dependencies, whereas issues such as internal manufacturing flexibility, rapid production reconfiguration, or process redesign in response to disruptions were not discussed in depth. This suggests that sourcing related risk awareness at GBP is predominantly externally oriented.

Relatedly, the role of inventory buffers and absorption capacity is largely absent from the interview narratives. While contingency plans and agreements with key suppliers are mentioned, there is little explicit discussion of safety stocks or deliberate buffering strategies as a sourcing level mitigation approach. When asked why relatively low cost and physically small components are not buffered, R6 emphasized the negative impact of such measures on tied up capital, indicating that inventory-based mitigation is deprioritized in favor of capital efficiency. This may partly reflect GBP's low volume production context, but it also points to a resilience logic that favors relationships, contracts, and contingency agreements over buffer-based mechanisms. An additional explanation is that responsibility for safety stocks often shifts to the logistics function after supplier contracting (R29, R30, R31), which may contribute to purchasers not considering inventory buffering as part of their remit during supplier evaluation and integration. Finally, demand risks and their interaction with supply risks did not emerge from the interviews. Demand was mainly discussed in terms of volume commitments and penalty structures rather than as a source of uncertainty that could amplify supply disruptions (R9, R17). Taken together, these findings indicate that the absence of certain risk categories does not reflect an analytical oversight, but rather the boundaries of what emerged from the empirical material. GBP's risk management focus appears centered on supplier structure, geographic exposure, and regulatory constraints, while other dimensions of supply chain resilience emphasized in the literature receive less attention in sourcing level decision making.

5.3 Translating Risk into a Cost Multiplier

This Section of the report presents the results from iterative work related to the development of two models and feedback received from project stakeholders and their potential users. It begins by outlining the original concept of the model, then describes subsequent iterations made to align it with GBP's current assessment resources.

5.3.1 First Model Iteration

The first and initial model, based on Sharma's (2016) work which is described in more detail in section 3.1.3, formed the primary basis for a general baseline proposition (GBP) at the outset of this thesis. The intent of adopting this existing model was to provide a practical toolkit where management could better analyze the strategic sourcing decisions with their risk implications into a total cost of ownership framework. Sharma's work is particularly relevant as it does not treat risk and cost as separate decision dimensions, instead frames supplier risk as a driver of expected cost escalation. As such, this initial model was used as a guiding point to see whether it would be possible to establish a similar model at GBP by building on the same conceptual framework and developing a generalized logic for risk-adjusted cost evaluation within GBP. In the context of Volvo Buses, where risk assessments and cost breakdowns exist but are not systematically integrated, the relevance of this initial model is further reinforced.

To visualize what a potential end-deliverable might look like, an initial prototype was developed, based on Sharma's (2016) work, with the support of the vibe coding tool Loveable. This version was intended as a conceptual illustration rather than being a potential finalized solution. However, when this model was presented to R9, the thesis supervisor at Volvo, several challenges emerged though the feedback. The interface of the first model iteration can be seen in Appendix F.

A major challenge concerned the difficult to integrate the model with already existing tools, processes and data sources currently used at GBP. Rather than building familiar decision artefacts such as TLC calculations and existing risk assessment outputs, the model appeared as an additional stand-alone work moment. This reduced its perceived usability and conflicted with the expressed requirement that any new analytical support should be embedded in existing workflows and rely on already available and approved data. Another point of concern was the issue of practicality. R9 highlighted that the model was overly complex and difficult to use in a real sourcing context. The most prominent feedback concerns the number of required steps for the model to generate output. As mentioned in 3.1.3, the model relied on a combination of AHP and FMEA, followed by the need to identify which major risk categories had direct cost implications, together with the need to define and establish appropriate criteria for both AHP and FMEA and design appropriate detailed risk questionnaires. From a user perspective, this sequence was perceived as too demanding in relation to time, effort and user familiarity of FMEA and AHP. As a result, the model was seen as theoretical sound but misaligned with the operational realities and time constraints of the purchasing function.

As previously mentioned, there were issues regarding which questions to include in the FMEA risk assessment questionnaire step, how granular they should be and how risks could be categorized in a way that was both comprehensive and manageable and was aligned with risk mentioned in 5.2. Moreover, the inclusion of AHP as a step for generating model output was also a challenge. Based on insights from AHP literature (see 3.4) and together with stakeholder feedback, AHP typically requires a substantial heavy data set-up and the involvement of multiple subject matter experts to produce credible and robust results. In the context of GBP, this level of analytical effort was determined to be un-realistic to do on an ongoing basis for every sourcing case, particularly given the variability across commodities, regional differences between European, North America and Central America based suppliers, and the limited availability of experts for repeated pairwise comparisons.

5.3.2 Second Model Iteration

Based on the issues identified with the first model and additional empirical insights gathered, a second model iteration was developed with a strong emphasis on practical integration, usability and alignment with existing GBP tools. The guiding principle for this iteration was not to introduce new analytical procedures for buyers and stakeholders, but instead to build on risk assessments and cost calculations with the availability of SRET and the SC Worksheet, and to connect them through a transparent and conceptually consistent approach.

Figure 7 illustrates the conceptual design of the second model iteration. The figure is intended to convey the underlying logic of the proposed approach rather than provide a detailed representation of the computational procedure. The model starts with quotations from suppliers and logistics cost estimates, which constitute central inputs to the TLC calculations currently performed and described in 4.3.1. In parallel, supplier-related risks are assessed through SRET, which is already required in Steps 3 and 7 of the sourcing process according to internal documents.

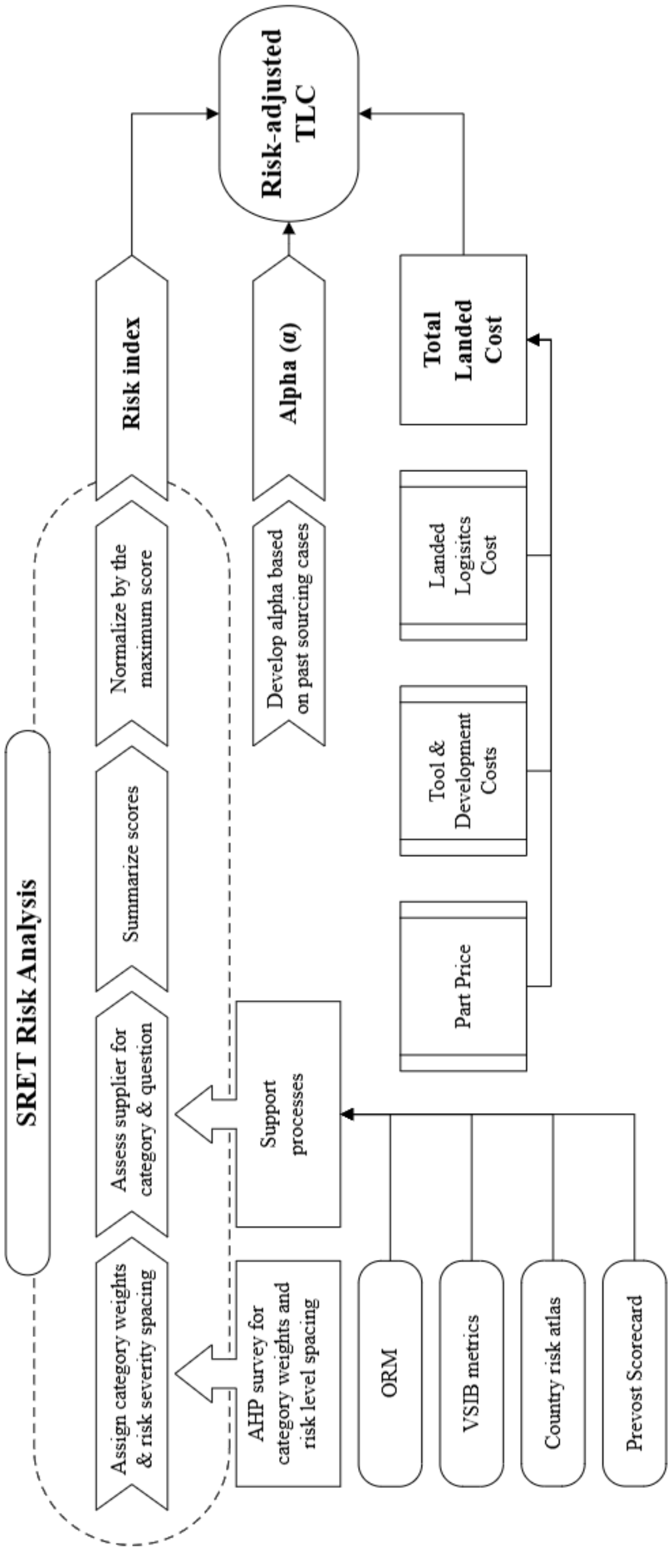

Figure 7: Conceptual workflow for integrating supplier risk into TLC calculations

The core idea of the second iteration is to translate the output from the Risk Analysis in SRET into a single, aggregated risk index that can be used as a multiplier to adjust the baseline TLC. In this way, risk is no longer treated as a parallel discussion but instead becomes a factor that directly influences the economic comparisons between suppliers presented to the sourcing council. While Figure 7 illustrates this linkage, the translation from qualitative supplier risk to a risk-adjusted cost measure requires a series of underlying calculations. The following Sections detail the methodological steps used to generate the aggregated risk index.

A key design decision in this iteration was to base the risk score entirely on SRET rather than introducing a new risk assessment framework. As analyzed in 5.2.1, the findings showed that SRET already captures many of the risk dimensions emphasized by internal stakeholders, such as quality performance, capacity constraints, delivery reliability, and supplier financial stability. At the same time, SRET is a familiar tool within GBP and is supposed to be embedded in sourcing process. Using SRET as the foundation for the risk index therefore addresses one of the main shortcomings of the first model, namely its poor integration with existing workflows. Although several complementary risk assessment tools and resources were identified in the empirical material, like ORM, VSIB sub-metrics, Country Risk Atlas, and Prevost Supplier Scorecard (for Prevost users), these are not formally integrated into the second model iteration. Instead, they are intended to serve as supporting inputs for buyers when answering the Risk Analysis questionnaire in SRET, ensuring that the SRET assessments are informed by existing analyses rather than conducted in isolation.

However, the empirical material also revealed two structural limitations of SRET that needed to be addressed to make it suitable as an input to a quantitative risk index. First, the qualitative risk levels used in SRET (no risk, low risk, high risk) do not define the nature of the scale between levels. It therefore remained unclear whether the spacing between the levels was linear, exponential, or if it followed another growth curve. Second, the number of questions differs substantially across risk categories. If the assessment were based solely on the count of questions per category, those represented by many questions, such as quality, would exert a disproportionate influence on the aggregated risk score. Conversely, categories that are critical but covered by fewer questions, such as financial risk, would risk being systematically underweighted, regardless of their actual importance or severity. These observations motivated the continued but restrained use of AHP in the second iteration. In contrast to the first iteration, AHP is not used as an operational decision-making tool. Buyers are not required to perform pairwise comparisons or redo AHP for each sourcing case. Instead, AHP is applied once, which was done through an online survey (see 4.5), to calibrate two elements of the SRET-based risk assessment. Importantly, this one-time application does not imply that the results are fixed indefinitely. Rather, AHP is intended as a periodic calibration mechanism that can be reapplied if users and/or decision makers feel that risk perceptions and relative priorities have changed to an extent that the current scaling no longer reflects reality. In this way, AHP supports organizational alignment and transparency in risk interpretation without creating additional administrative burden in day-to-day sourcing work.

The first element concerned the scaling of qualitative risk levels. Results from the survey showed that the perceived difference between risk levels is not uniform or linear, as moving from medium to high risk is perceived as significantly more severe than moving from low to medium risk. Using AHP to derive the spacing of the scale increments allowed the qualitative SRET inputs to be translated into a numerical scale that better reflected how practitioners perceive risk escalation in practice.

The second element concerned the relative importance of the risk categories in SRET. Interviewees consistently emphasized that some risk categories, such as finance-related risks, could potentially carry a greater cost impact than others, even when they were represented by fewer questions in the tool. By using AHP to derive category weights, the model corrected for structural imbalances in the questionnaire and ensured that the aggregated risk index reflected managerial priorities rather than the mechanical distribution of questions. Importantly, these weights were fixed and reused across sourcing cases, reflecting GBP's general risk exposure rather than supplier-specific judgments. This approach avoided repeated expert involvement while still grounding the weights to the same expert judgments.

The first step of the model involved evaluating suppliers using the existing Risk Analysis questionnaire in SRET. While the aggregated risk index is computed exclusively from SRET responses, buyers are expected to draw on complementary tools such as ORM, VSIB sub-metrics, Country Risk Atlas, and Prevost Supplier Scorecard when assessing suppliers within SRET. At this stage, risk identification remained unchanged compared to current GBP practice. A supplier s was assessed across a set of risk assessment questions q, grouped into risk categories c, such as quality, supply chain, capacity, business, financial, and Volvo-caused risks. By explicitly indexing suppliers, categories, and questions, the model preserved traceability between individual SRET inputs and the resulting aggregated risk score, which was important for transparency and for facilitating later review by the SC.

Each risk assessment question in SRET is assessed using risk severity levels "no risk", "low risk" and, "high risk", along with the added "medium level" described in Section 4.5. These qualitative judgements are converted into numerical values using a non-linear scale derived from the SRET-related online survey presented in Table 4 in Section 4.5. The resulting values are defined as

$$r_{q,s} \in \{0.0,\ 0.5,\ 2.6,\ 10.0\}$$

This conversion step is essential for two reasons. First, numerical representation is required to enable aggregation and comparison across suppliers. Second, the use of a non-linear scale reflects how risk escalation is perceived by sourcing stakeholders. The survey results indicate that the perceived increase in exposure when moving from medium to high risk is substantially larger than the increase when moving from low to medium risk. By incorporating these perceived distances into the scale, the model avoids imposing an artificial linear structure on risk data and instead captures how risk severity is understood in practice.

In the next step, question-level risk scores are aggregated to form a category-level risk score for each supplier. This is expressed as

$$R_{c,s} = \sum_{q=1}^{Q_c} r_{q,s}$$

The purpose of this aggregation is to translate detailed questionnaire inputs into a level of abstraction aligned with managerial decision-making. While individual SRET questions captured specific risk drivers, sourcing decisions were typically discussed in terms of broader categories such as quality risk or financial risk. Aggregating scores at the category level therefore reduced complexity while retaining information about the overall exposure within each risk dimension. This step also established a consistent structure for later aligning risk categories with cost drivers in the model.

To avoid distortion arising from the unequal number of questions across risk categories, for example with financial risk accounting for only 2% of the questions in SRET, category weights are employed that corrects for this structural imbalance.

$$w_c \geq 0 \text{ with} \sum_{c=1}^{C} w_c = 1$$

The weighted category-levels scores are then combined into a single supplier risk index which is expressed as the following

$$RI_s = \frac{\sum_{c=1}^{C} w_c \cdot \sum_{q=1}^{Q_c} r_{q,s}}{\sum_{q=1}^{Q_c} r_{Max}}$$

The normalization by the maximum possible score ensures that the risk index is dimensionless, comparable across suppliers, bound within the interval $[0, 1]$, where 0 represents the lowest possible risk exposure and 1 represents the highest. Importantly, the risk index does not represent the expected monetary value of risk events, nor does it predict specific disruptions. Instead, it provides a relative measure of overall supplier-related risk exposure in which qualitative assessments are aggregated into a single, transparent indicator that can be used for supplier evaluation and comparison.

The final steps consist of integrating the risk index by applying it as a multiplier to the baseline TLC for a supplier (TLC_s),

$$TLC_s^{risk} = TLC_s \cdot (1 + \alpha \cdot RI_s)$$

By design, this formulation ensures that the risk-adjusted TLC (TLC_s^{risk}) is always greater than or equal to the original TLC_s, as both $\alpha \geq 0$ and $RI_s \in [0,1]$. Consequently, a supplier for which no risk is identified ($RI_s = 0$) will have a TLC_s^{risk} equal to TLC_s that was estimated based on the supplier's submitted quote, meaning that identified risk can only increase, but never decrease TLC_s^{risk}. This ensures that a supplier's quote acts as a lower bound and keeps the risk adjustment mechanism from artificially improving cost estimates.

This formulation differs from the approach of the first model iteration and Sharma's (2016), where a risk adjustment factor was applied directly to the base cost to obtain a risk adjusted cost. In that approach, the risk adjustment factor was defined on an unbounded interval, allowing increasing levels of perceived risk to translate directly into proportionally higher costs without an explicit upper limit. As a result, the measurement of risk and its economic impact were combined within a single multiplicative factor.

By contrast, the formulation of the second iteration decouples these two components. Supplier risk is first quantified through a normalized risk index (RI_s), providing a bounded and comparable measure of relative risk exposure. The strength with which this risk affects TLC is then governed by a separate sensitivity parameter α, defined as a constant within a given evaluation context. This separation allows risk to be scaled without altering the underlying risk classification and improves interpretability by giving explicit control over how risk exposure is translated into economic consequences, while preserving the normalized structure of the risk index.

The parameter α governs the sensitivity with which supplier risk exposure translates into an increase in risk-adjusted cost. An α value of 1 implies that the growth of TLC_s^{risk} fully aligns with the scoring logic of SRET, such that a supplier with the maximum risk index $RI_s = 1$

yields a risk-adjusted cost equal to twice the original TLC. As α increases beyond 1, the penalty associated with risk exposure becomes progressively stronger, resulting in a steeper increase in TLC_s^{risk} for a given level of RI_s. For comparability between supplier quotations within the same sourcing case, the same α value must be applied. While α could in principle be defined as a single global constant across all segments, a more appropriate approach is to vary α by segment. Segments that are less sensitive to supply risk can be assigned lower α values, thereby dampening the cost impact of risk, whereas segments where TLC is highly sensitive to disruptions, uncertainty, or resilience considerations can be assigned higher α values to reflect the greater strategic importance of risk mitigation.

The absence of any formal requirement to present SRET Risk Analysis results to the SC meant that purchasers rarely completed the Risk Analysis sheets, resulting in a lack of historical sourcing cases with populated Risk Analysis sheets. Consequently, there was no empirical basis on which to calibrate α values. This low level of SRET usage, further discussed in Section 4.3.1, also implied that the second model iteration could not be implemented through an existing tool without imposing significant additional workload on users. Implementing the risk adjusted TLC would require an additional risk assessment to be completed for every supplier in every sourcing case, rendering the approach impractical within current sourcing workflows and preventing its implementation of the proposed model.

5.4 Evaluation of the Proposed Model

This thesis set out to develop and evaluate a risk adjusted cost model to support supplier selection within GBP. While the proposed second model iteration offers conceptual clarity and improved structure compared to existing practices, several contextual and methodological limitations affect its implementation and empirical validity. These reflections combine the key insights emerging from the empirical findings.

5.4.1 Advantages & Opportunities

The second model iterations offer several advantages over both the first iteration and current practices at GBP. Together, these advantages position the model as a meaningful step toward a more structured way of linking risk to cost in sourcing decisions. Key advantages and opportunities can be seen in Figure 8.

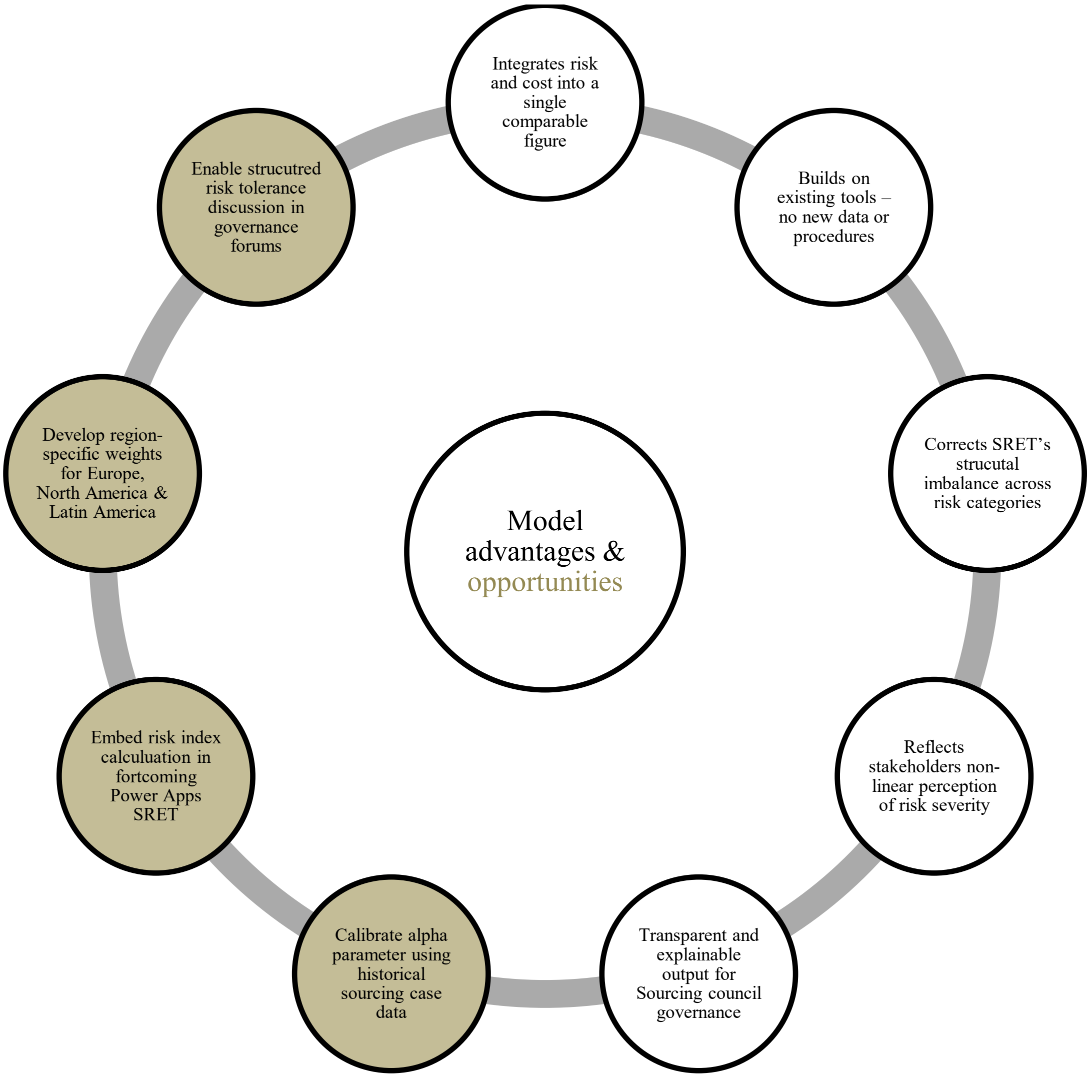

Figure 8: Overview of the second model's iteration advantages and opportunities.

The most fundamental advantage of the proposed model is that it integrates risk and cost into a single comparable figure. As discussed in 5.1, GBP currently treats risk and cost as parallel but separate dimensions where risk is verbally discussed but not used as a way of influencing the numerical cost comparison. Hence, the risk-adjusted TLC changes this by producing a figure that allows sourcing alternatives to be compared on a consolidated economic basis, directly addressing the gap identified by Degraeve & Roodhooft (1999) and Ellram (1993) regarding the failure to link cost drivers to supplier-specific risk profiles.

Moreover, the second model iteration's foundation is entirely built on existing tools and requires no new data collection procedures. Rather than introducing additional analytical steps for stakeholders, as with the issue discussed for the first model, the second model uses SRET as its primary input and connects it to the TLC figures already produced in the SC Worksheet. The model also corrects a structural imbalance in SRET's current design of risk assessment framework. As shown in 4.3.2, the distribution of questions is highly uneven with quality-related questions accounting for 46% of the questionnaire while financial risk is represented by a single question. Without category weighting, this imbalance would cause quality risk to disproportionately dominate the aggregated risk score, regardless of the actual severity of financial or capacity-related risks. Thus, by applying AHP-derived category weights, as presented in Table 5, the model ensures that the risk index reflects the relative importance that stakeholders at GBP assign to each risk dimension, rather than the mechanical distribution of questions. In relation to this, the model is also able to reflect the stakeholder's non-linear perception of risk severity levels. The online survey results presented in 4.5 showed that the perceived difference between risk levels is not uniform and not linear. Instead, the results showed that the jump from medium to high risk is perceived as substantially more severe than the increase from low to medium. By translating SRET's qualitative ratings into a non-linear numerical scale derived from this survey response, the model can capture how risk escalation is understood in practice, rather than imposing an artificial linear structure on assessment data. Another advantage of the model is that the produced output is transparent and can be addressed by the SC. The risk index is normalized to a bounded interval between 0-1, where each supplier's score can be traced back to a specific SRET risk category. This traceability offers stakeholders a basis for cross-functionally discussing why one supplier may receive a higher risk-adjusted TLC than another and what the potential risk tolerance should be.

Looking ahead, several opportunities can be identified to further strengthen and expand the model over time. If SRET usage is to become consistent, historical sourcing case data will enable the calibration of the alpha parameter, which currently cannot be set empirically due to limited prior use of the risk analysis sheet as described in 5.3.2. Once calibrated against actual cost deviations and disruption outcomes across segments, alpha can be refined and more accurate in adjusting the parameter based in the sourcing segment. Moreover, embedding the risk index in the forthcoming version of Power Apps version of SRET as previously discussed in 4.3.2 is another future opportunity. Integration at the tool level would remove the need for manual calculations and ensure that risk-adjusted figures can be automatically produced as part of the sourcing case workflow.

Moving beyond calibration and integration, the model's structured output opens the door for more deliberate risk tolerance discussions within governance forums. Rather than treating risk as a pass or fail concern with the use of stopping parameters, the risk index enables the sourcing process to evaluate the degree of risk premium. This means that the sourcing process can move beyond asking whether a supplier's risk level is acceptable in absolute terms and instead engage with the question of whether the cost advantage offered by a higher-risk supplier is sufficient to justify the additional risk exposure it introduces. For instance, if supplier A quotes a TLC that is 8 percent lower than supplier B but carries a roughly 9 percent higher risk index, the resulting risk adjusted TLC indicates that the cost advantage of supplier A is fully offset by the higher risk, leaving no effective cost benefit.

5.4.2 Challenges & Limitations

A central observation is that GBP operates across a heterogeneous global sourcing environment, where regional differences influence both supplier characteristics and the conditions under which risk is assessed. An example, while not directly assessed in the SRET questionnaire, is that European suppliers generally operate within more mature frameworks, where certifications such as ISO 14001 and ISO 9001 are widely established and often treated as baseline requirements in supplier evaluations (R6, R21, R27). As highlighted in Sections 4.1.1 and 4.4.2, this contrasts with parts of the North and South American supplier base, particularly within Prevost, where such certifications are less common. In these contexts, suppliers may not be ISO 14001-certified, and in some cases even ISO 9001 (R27), not necessarily due to poor operational performance but because these standards are less institutionalized or enforced in the region. This means that, although sourcing cases follow the same procedural path as within GBP, outcomes can differ. Risk acceptance levels may be higher, deviations from standard requirements more frequent, and mitigations less robust when compared to equivalent cases within a solely European context. In this sense, the SC seems to function more as a mechanism for alignment and escalation than as a tool that fundamentally equalizes sourcing conditions.

As a result, systematically applying a uniform risk assessment framework can potentially lead to assigning higher risk scores for capable suppliers, simply because they do not meet certification norms that are regionally specific rather than globally indicative of risk exposure. For example, a supplier lacking ISO 14001 certification may be assigned a higher environmental or compliance risk score, even if this absence reflects regional norms rather than a higher likelihood of environmental violations or operational disruption. These observations suggest that the use of a globally uniform risk assessment model and weighting structure may capture regional conditions rather than true supplier risk. A way forward could be the development of region-specific calibrations of the SRET Risk Analysis sheet, where questions and weights are adjusted to local norms while maintaining overall comparability. The AHP derived weights developed in this thesis could serve as a global baseline, with future refinements informed by regionally targeted data collection.

Closely related to regional variation are the geopolitical and structural constraints shaping sourcing decisions. The findings indicate that geopolitical risk considerations are often embedded indirectly in sourcing strategies rather than explicitly quantified. For example, Volvo Buses' concentration of suppliers in Europe reflects not only operational considerations but also compliance with preferential origin requirements and the need to balance unavoidable dependencies on Asian suppliers for critical electronic components. As electrification increases, this dependency is expected to remain. At the same time, additional risks linked to sourcing in regions such as Brazil and Mexico, characterized in the empirical findings by political volatility, regulatory unpredictability, and infrastructure constraints, introduce forms of uncertainty that are difficult to fully capture within the current SRET based evaluation framework. These region-specific risk factors are therefore not always fully reflected in formal risk assessments. In this context, the proposed model should be understood not as a fully objective measure of supplier risk, but as a decision support tool operating within broader strategic and systemic constraints. Although the second model improves transparency in how SRET inputs are aggregated as previously discussed in 5.4.1, the underlying assessments remain dependent on stakeholder judgment, experience, and incentives. The model standardizes the treatment of subjective inputs instead of eliminating subjectivity itself. As such, the resulting risk index should be interpreted as a structured aggregation of expert judgment rather than an empirically validated measure of risk exposure.

The absence of a robust empirical benchmark further complicates the evaluation of the model's accuracy. Limited and inconsistent use of SRET's Risk Analysis functionality prevented the construction of a sufficiently large dataset linking assessed risks to actual outcomes such as cost deviations or supply disruptions. This lack of historical data made it impossible to calibrate or validate the model's key parameter α, which is intended to translate the risk index into a cost multiplier. While α introduces conceptual flexibility, its practical application remains uncertain, and it cannot be determined whether the resulting cost adjustments reflect a *"fairly correct"* accuracy of risk pricing or an embedded bias in the assessment process. This also highlights a limitation related to tool adoption and data integration. The effectiveness of the model depends on consistent and rigorous use of SRET, which was not observed in practice. Future improvements could focus on reducing reliance on manual input by integrating existing data sources such as VSIB metrics, the Country Risk Atlas, and ORM directly into the assessment process. While such integration would not remove subjectivity entirely, it could improve consistency across evaluations and reduce variability between users.

In summary, the second model represents a conceptually grounded but empirically unverified approach to incorporating supplier risk into cost comparisons. Its primary contribution lies in enhancing transparency, comparability, and structure in decision making rather than providing a precise quantification of financial risk. However, its applicability is constrained by regional differences, data availability, and the use of subjective assessment practices. As such, the model should be primarily understood as a decision support tool, whose outputs require careful observation through the lens of the contextual and methodological limitations identified in this study.

6 Conclusion

This thesis makes important contributions to GBP's context and for business research. First, it provides a structured empirical account of how risk is currently managed and assessed within GBP's sourcing process, identifying both the tools currently used, which includes VSIB, SRET, ORM, Country risk atlas, Prevost supplier scorecard, and the gaps between formal requirements and actual use. This empirical account reveals a pattern where risks are being treated as a separate qualitative discussion to cost evaluation, rather than risk being an integrated component of supplier cost comparison. Second, the thesis proposes a conceptual model for bridging this gap through a risk-adjusted TLC model that translates SRET-based risk assessments into a cost multiplier. While the model is not yet operational, it establishes methodological logic and identifies the remaining steps needed to move from concept to implementation. This thesis approached this case through three research questions, each addressing a distinct dimension of the overall issue as explained in 1.3.

RQ1 – Which cost- and risk factors are most relevant when evaluating a supplier within Volvo Buses' sourcing process?

Research question 1 was answered through a combination of the literature review, the empirical interviews, and the analysis of GBP's existing assessment resources. From a cost perspective, the SC Worksheet was found to operationalize a well-structured TLC framework covering part price, logistics costs, tooling and development costs, and potential inventory-related capital costs. From a risk perspective, the interviews consistently highlighted supplier financial stability, quality performance, capacity constraints, single-sourcing exposure, geographical and geopolitical risk, and the complexity of switching suppliers were the most mentioned factors. These risk factors were found to broadly align with the risk categories covered by SRET, although gaps were identified. The supply chain risk literature from Section 3.5 provided a useful framework for organizing and analyzing the empirical findings.

RQ2 – How can these cost and risk factors be integrated into a risk-adjusted cost model when evaluating suppliers?

Research question 2 was addressed through the iterative model development as described in Sections 5.3.1 and 5.3.2. The first model iteration, based on Sharma's (2016) framework of combining FMEA and AHP was found to be theoretically sound, but misaligned with GBP's operational realities due to its complexity, heavy data set-up and poor integration with existing workflows. The second iteration addressed these shortcomings by anchoring the risk assessment entirely on SRET and connecting its output to the TLC figures already produced in the SC Worksheet. The resulting model translates SRET's qualitative ratings into a normalized risk index by using AHP-derived category weights and a non-linear severity scale, both calibrated through the online survey. This index is then used as a multiplier for the baseline TLC together with the adjustment parameter α to produce a risk-adjusted TLC. While the model has not been empirically validated against sourcing cases, its methodological logic is transparent and its integration points with existing tools are clearly defined.

RQ3 – How can risk integration be designed to better align with existing sourcing tools and processes?

Finally, research question 3 was addressed through the design principles underlying the second model iteration and the subsequent analysis done of the second model in Section 5.4.

By building on SRET rather than introducing a new risk framework, and by connecting the risk index to the SC Worksheet that stakeholders use for step 7, the model is positioned to complement, rather than to replace current practices. Moreover, consistent usage of SRET risk analysis is identified to be a prerequisite for the model to function as intended. The governance structure at GBP, with its cross-functional SC and clearly defined approval levels provides a natural form in which risk-adjusted TLC figures can be presented and discussed.

6.1 Recommendations for GBP

Based on the empirical findings and the model development process, the following recommendations are directed at GBP and organized into actions that can be initiated in the near term and those that represent longer-term development.

The most immediate recommendation concerns the usage of SRET. The empirical findings showed that the risk analysis within SRET is rarely completed in practice, despite being formally required at both step 3 and 7 of the sourcing process according to internal documents. As such, this thesis recommends that GBP should consider making the risk analysis sheet a mandatory step in the sourcing process, with governance support to ensure compliance. This could be facilitated by making a complete SRET risk analysis a required submission criterion for step 7 presentations, like the existing requirements for showing agreement status and cost breakdown documentation from the SC Worksheet. Moreover, the alpha parameter is another factor that relies on SRET usage. To derive values for alpha, consistent SRET usage is a prerequisite.

Moreover, it is recommended that the content of SRET be reviewed and adapted to better reflect the sourcing context of GBP. As discussed in 5.2.1, several risk dimensions that stakeholders consistently highlighted from interviews, including single-sourcing exposure, contractual robustness, service market obligations, and switching cost barriers are either absent from or insufficiently highlighted in the current form of SRET questionnaire. Given that the Power Apps version of SRET is currently being developed and soon launched, this represents a timely opportunity to influence the design.

In terms of the risk-adjusted TLC model itself, it is recommended that GBP treat the second model iteration as a conceptual framework to be piloted on a small number of sourcing cases before broader rollout. Such a pilot would allow buyers to become familiar with the model's logic, identify practical challenges in completing the required inputs, and generate preliminary data for calibrating the α parameter.

Finally, it is recommended that GBP use the structured output of the risk index to initiate more explicit risk tolerance discussions within the SC. Rather than waiting for the model to be fully calibrated before using it in governance settings, the normalized risk index can immediately serve as a basis for comparing the relative risk profiles of shortlisted suppliers, even if the precise monetary translation remains approximate. Over time, this will build organizational familiarity with risk-adjusted reasoning and create the conditions for a more data-driven approach to balancing cost efficiency and supply chain resilience.

6.2 Future Research

As for future research, the main direction of this stems from the limitations and findings of this thesis. One of these concerns the empirical calibration of the alpha parameter. As discussed in 5.3.2, the absence of historical SRET risk analysis data prevented any empirical grounding of this parameter within the scope of this thesis. Moreover, a related area to this concerns the regional calibration of the model's weighting structure. The AHP-derived category weights used in this thesis were based on responses from GBP staff of whom the majority operate within a European sourcing context. As such, the derived category weights may not adequately reflect the risk landscape faced by Prevost in North America, or by GBP in Mexico. As such, future research could explore whether region-specific weight calibrations can improve the model's accuracy and fairness when applied across GBP's full geographical scope, using targeted data collection within each regional context. The potential integration of complementary data sourcing into the risk assessment processes also warrants further research. Currently, resources such as VSIB sub-metrics, ORM ratings, and the country risk atlas are used as background inputs, and future work can therefore examine how structured data from these sources could be used to pre-populate or validate SRET inputs.

From a broader research perspective, the thesis contributes a case-specific illustration of risk-adjusted cost modelling in a low-volume industrial purchasing context. As such, future research could examine whether the model's logic and design principles are transferable to other organizations under similar conditions. Such comparative studies could help establish whether the design behind the conceptual model of prioritizing usability and integration over analytical precision represents a broadly applicable approach or one that is specific to GBP's organizational context.

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Appendix

This appendix contains supplementary material that supports the analyses and findings presented in the thesis. It includes empirical material, interview guides, questionnaires, calculations referenced in the main text, provided to enhance transparency and to support the final conclusions

Appendix A

Semi-Structured Interview Guide

This Section features the interview guide used to guide the semi-structured interviews conducted with personnel at GBP. The questions explored purchasing risks, dependencies, geographical and material-related risks, approval processes, and criteria used in supplier evaluation.

- **GBP Sourcing segments**
  - I have been told that GTP sources most critical components and systems on behalf of Volvo Buses.
    - What does critical components refer to?
- **Single sourcing risk**
  - Are efforts made to find multiple suppliers and not to single-source?
    - Dependence on a single supplier creating a "pinch point"
    - Immediate operational jeopardy if that supplier is disrupted
- **Pool of alternative suppliers**
  - In case of failure, are alt. suppliers kept on file?
    - To deliver replacement components as part of a contingency plan.
- **Supplier approval hurdles**
  - Do you ever feel it is difficult to get new supplier approved by the sourcing council?
    - Does this build a bias towards suppliers that appear on preferred supply lists?
- **Geographical location-related risk**
  - In what parts of the world are your suppliers located?
  - How are such risks currently considered when selecting suppliers?
    - Exposure to geopolitical tension
    - Infrastructure fragility
    - Corruption
- **Financial risks**
  - How are they considered in your work and what tools do you use?
    - Insolvency
    - Failure to deliver
- **Upstream material shortage risks**
  - Do you ever deal with material or Tier-N suppliers that have imposed restrictions on them?
    - Materials banned for health/environmental concerns
    - Materials with for example Russian origins
  - Are efforts made to avoid materials that are shortage-prone?
    - Sensitive supply chains
    - Limited availability of materials

- **Material & specification rigidity**
    - Are efforts made to reduce reliance on certain suppliers or manufacturing techniques?
        - Not to over-specify material needs.
        - Optimized components give limited options to redesign or substitute components
- **What factors do you consider the most when evaluating suppliers?**
- **Can you think of any aspects or previous sourcing cases that you feel highlights risks that were not brought up?**

Appendix B

AHP-based Online Survey

The full set of AHP survey questions used to elicit expert judgments on supplier risk severity and the relative importance of risk dimensions within the SRET Risk Analysis sheet.

A. Severity comparison of SRET risk levels

Q1. How much more severe is a High risk level compared to No Risk when rating a supplier using SRET?
- Integer scale from 1 to 9

Q2. How much more severe is High compared to Low?
- Integer scale from 1 to 9

Q3. How much more severe is High compared to Medium?
- Integer scale from 1 to 9

Q4. How much more severe is Medium compared to No Risk?
- Integer scale from 1 to 9

Q5. How much more severe is Medium compared to Low?
- Integer scale from 1 to 9

Q6. How much more severe is Low compared to No Risk?
- Integer scale from 1 to 9

B. Pairwise comparison of supplier risk dimensions

Q7. Between Quality and Finance, which is more impactful when evaluating supplier risk using SRET?
- Quality / Finance / They are equally important

Q8. How much more important is your chosen option?
- Integer scale from 1 to 9

Q9. Between Quality and Supply Chain, which is more impactful?
- Quality / Supply Chain / They are equally important

Q10. How much more important is your chosen option?
- Integer scale from 1 to 9

Q11. Between Quality and Capacity, which is more impactful?
- Quality / Capacity / They are equally important

Q12. How much more important is your chosen option?
- Integer scale from 1 to 9

Q13. Between Quality and Business, which is more impactful?
- Quality / Business / They are equally important

Q14. How much more important is your chosen option?
- Integer scale from 1 to 9

Q15. Between Quality and Volvo Caused, which is more impactful?
- Quality / Volvo Caused / They are equally important

Q16. How much more important is your chosen option?
- Integer scale from 1 to 9

Q17. Between Finance and Supply Chain, which is more impactful?
- Finance / Supply Chain / They are equally important

Q18. How much more important is your chosen option?
- Integer scale from 1 to 9

Q19. Between Finance and Capacity, which is more impactful?
- Finance / Capacity / They are equally important

Q20. How much more important is your chosen option?
- Integer scale from 1 to 9

Q21. Between Finance and Business, which is more impactful?
- Finance / Business / They are equally important

Q22. How much more important is your chosen option?
- Integer scale from 1 to 9

Q23. Between Finance and Volvo Caused, which is more impactful?
- Finance / Volvo Caused / They are equally important

Q24. How much more important is your chosen option?
- Integer scale from 1 to 9

Q25. Between Supply Chain and Capacity, which is more impactful?
- Supply Chain / Capacity / They are equally important

Q26. How much more important is your chosen option?
- Integer scale from 1 to 9

Q27. Between Supply Chain and Business, which is more impactful?
- Supply Chain / Business / They are equally important

Q28. How much more important is your chosen option?
- Integer scale from 1 to 9

Q29. Between Supply Chain and Volvo Caused, which is more impactful?
- Supply Chain / Volvo Caused / They are equally important

Q30. How much more important is your chosen option?
- Integer scale from 1 to 9

Q31. Between Capacity and Business, which is more impactful?
- Capacity / Business / They are equally important

Q32. How much more important is your chosen option?
- Integer scale from 1 to 9

Q33. Between Capacity and Volvo Caused, which is more impactful?
- Capacity / Volvo Caused / They are equally important

Q34. How much more important is your chosen option?
- Integer scale from 1 to 9

Q35. Between Business and Volvo Caused, which is more impactful?
- Business / Volvo Caused / They are equally important

Q36. How much more important is your chosen option?
- Integer scale from 1 to 9

C. Open-ended feedback

Q37. Do you have feedback on the design of the form or additional thoughts?
- Open-ended free text response

Appendix C

SRET Risk Analysis Questionnaire

Risk Analysis questionnaire from SRET with 46 questions split into 5 categories.

	RESP.	Risk	Risk definition
Quality	Buyer	Supplier status in serial production	Is there any risks / crisis identified in CRL, CSL or Risk files for this supplier in any region? Is the supplier part of eg RMM (Risk and Crisis Governance meetings)?
	SQE	Performance for this segment (Epurch results, Engineering and Q&CS input)	Do we see this segment to be difficult to manufacture with good quality performance whatever process used, look for historical data.
	Eng.	Design complexity and technology readiness level	What is the complexity/maturity of the technology? TRL 6 is the minimum level to put parts into a project.
	Eng.	Part safety / legal impact (refer only to criticality and T marking)	Does this segment/design have any critical features[1],[2],[3],[2R] and [3R] characteristics or [SC] / [CC]characteristics?
	SQE	New supplier	To bring in a new supplier is a critical risk as Volvo and supplier have no experience of each other and to mitigate this will require a high workload at supplier and Volvo.
	Eng.	RTS - features design compliance	In the RTS response by supplier (with RFQ), has PD and SQE been able to assess technical feasibility of the parts? Has supplier been transparent on his manufacturing process, and has supplier showed manufacturing knowledge of the parts (tool design, tolerances, material spec, etc…). Do we have any highlighted risk? No received RTS or all green RTS without detailed discussion with PD and SQE to be assessed as critical.
	SQE	Project organization and supplier responsiveness	Consider project complexity, planning, resources (flexibility), skills, ability to handle deviation in the project plan. Evaluate availability, accessibility of the supplier and communication.
	SQE	Project workload for the supplier	Does supplier have adequate resources (manning) to handle this project? Have in mind supplier full project scope (including to other custumers).
	SQE	Experience in APQP management and other Volvo demand (SQAM)	To what extent is this supplier used to APQP management and Volvo way of working?
	SQE	Project Timing (preliminary APQP plan)	Is the preliminary APQP plan provided by supplier, in the RFQ answer, compliant with Volvo project milestones? If missing- risk to be assessed as high.
	SQE	Supply chain mapping	Has the supplier provided the supply chain mapping? Is there any risk connected to a sub-supplier or a sub-supplier process ? Is there any sub-supplier Index audit or other assessment to be performed ? This item should be rated as risk in case of e.g. new or unknown sub-suppliers, critical sub-processes, lack of automotive experience, complex relations with sub-suppliers, lack of transparency, major warranty issues connected to supply chain,…
	SQE	Tier 2 management by Tier 1	What experience/resources does the supplier have in tier 2 management? Does the supplier have the ability to drive/manage its sub-suppliers? (for new supplier consider the ratings of the SEM questions connected to Tier 2)
	Eng.	Supplier Design - experience for the function / feature/ system	What experience does the supplier have to develop this system? (e.g. we usually develop injectors but in this project will develop a control unit)
	Eng.	Experience in Volvo project requirement and competence in project management	Suppliers' competences in project management: good communication both with the customer and internally, project organisation is well defined and performing, decisions are made in well anchored forum, ability to incorporate Volvo's DVP requirements (Developments loops, req on drawing releases, CPOT-IPD, TRL, RTS etc) in supplier development plan.
	Eng.	Numerical Simulation and Calculation capabilities and experience in testing capability	Experience in simulation and physical testing proven in previous project to Volvo or other customers. To what extent does the supplier have competence in simulation and ability to run physical verification as a natural part of verification?

			Does the supplier have all needed SW and material models in house and test rigs to run the key tests?
	SQE	Performance of this supplier with its customer (SEM if new or VSIB if current)	Quality performance for this supplier, use VSIB & E-purch for existing suppliers. Perform SSEM and SEM audit for new suppliers
	SQE	Production technology for the supplier	What knowledge does the supplier have to manufacture this technology for the segment? (experience in manufacture “brackets” in iron casting but not in high pressure die casting)
	SQE	Production process line/ plant for the supplier (investment plan)	Does the supplier have a mature process with controls meeting our requirements?
	SQE	Preliminary process flow chart	Is it a new process flow?
	SQE	Tooling (evaluate the difficulty to get the tool adjusted to expectations)	How complex is the tooling and what experience has supplier to handle this?
	SQE	Supplier's ability to manage safety/ legal characteristics in production	How good is the supplier to manage critical characteristics?
	SQE	Launch experience	What experience do we have of activity launch with this supplier? (good and effective pre-launch control plans)
Supply Chain	Logistic	Supplier logistics overall performance	The combination of hard inputs SCPM (SCPM = score summarizing SDP, CSL, charge back and IR Log) and soft inputs (SRM, MC, Log Eng) for the particular Parma ID involved.
	Logistic	Compliance with KEP7	Highlight any area of the KEP7 that the supplier will not comply to.
	Logistic	New logistics flow / relationship (due to new supplier to Volvo or to site)	Supplier is new to Volvo, new to the site or the type of logistics flow is not existing today between supplier and Volvo site
	Logistic	Part Characteristics for Logistics	Are the characteristics of the part (bulkiness, weight, dangerous goods, risk of rust, replenishment method etc) making the suggested setup unsuitable? (for example very expensive air shipments)
	Logistic	Total leadtime from supplier to Volvo user site	Suggested setup has a mismatch between the lead time needed for Volvo user and what can be expected from suggested setup.
	Logistic	Supplier experience in international logistics	Evaluate the supplier experience in international trading and shipping (export documentation, contact with international logistics providers, etc) to conclude in what area(s) the supplier needs to be developed
	Logistic	Logistics reliability & stability of the supplier country	Infrastructure (information, road, rail, ports, etc), political situation, language, culture/communication/behavior, corruption, access to logistics providers, etc of all the countries involved in the suggested logistics flow
Capacity	Buyer	Impact of the new business volume on the overall supplier capacity	Is there a risk that the new business volume to the recommended supplier will cause capacity issues in the supplier´s production and supply chain?
	Buyer	Past delivery / capacity issues with Volvo (Critical Supplier List ?)	Is supplier part of Critical Supplier List? Is there any past known delivery/capacity issues?
Business	Buyer	New Supplier/New Supplier region	Is the supplier new to VBC, even if it’s a supplier to Trucks, CE or Penta? Is the supplier new in the project region, even if they are a supplier in other VBC region?
	Buyer	Scope represent minor Business/non-core for Supplier	Does this segment/product represent minor part of supplier’s revenues and/or is non-core business for the supplier?
	Buyer	Change in Supplier Ownership/Strategy	Is there a recent change in ownership or supplier vision/strategy for this supplier?
	Buyer	Recently awarded/removed business (Not visible in current spend)	Evaluate the impact of supplier dependency at Group/MFG level. Has the supplier been awarded and/or had business removed recently which is not visible in the current spend? What would be the dependency after award ?
	Buyer	Regional Value Content (RVC) compliance	Is Volvo compliant with Regional Value Content? (NAFTA, MERCOSUR, D566 in Russia, etc…)
	Buyer	Development Cost Budget & Payment Plan	Are development cost & associated payment plan aligned with project budget?
	Buyer	Volvo Tooling ownership	Does/Will Volvo own the tool for production & aftermarket?
	Buyer	Tooling Cost budget	Is tooling cost aligned with project budget ?

	Buyer	IPR ownership	Does supplier have Intellectual Property Rights (patents, trademarks and design rights) for this business?
	Buyer	Service Parts supplier Status	Is the recommended supplier preferred for Service Parts business?
	Buyer	Branding of Parts	Is the BDAT (branding of the part) communicated to the supplier and accepted?
	Buyer	Supplier Switch checklist (Link included)	For supplier switch on all or majority of business from current supplier to another, is there any risk identified based on the review of legal supplier switch guidelines and supplier switch checklist? Link to supplier switch checklist. If yes, add and list risks separately.
	Buyer	Supplier Phase-out	Is there a risk to the current parts or existing business at current supplier due to the award of replacing parts to new supplier?
	Buyer	Compliance with Packaging compliance	Is the supplier compliant to AM Packaging Requirements, if available?
Volvo Caused	Buyer	Communicated volume	Is there a risk that volumes communicated to suppliers will change significantly?
Finance	Buyer	Supplier financial situation	Has the financial status been checked with financial analyst? What will be the dependency after awards?

Appendix D

Country Risk Atlas Indices

Scoring methodology and weights for the overall score. Retrieved from Violin, Volvo Group's Intranet on February 27, 2026.

Risk Pillar		Pillar Weight	Index
Environment		25%	Environmental Regulatory Framework
			Low Carbon Economy
			Waste Management
			Water Quality
Human and Labor Rights	Human Rights (25%)	50%	Freedom of Opinion and Expression
			Minority Rights
			Security Forced and Human Rights
			Sexual Minorities
			Women's and Girls' Rights
	Labor Rights (25%)		Child Labor
			Decent Wages
			Decent Working Time
			Discrimination in the Workplace
			Freedom of Association and Collective Bargaining
			Migrant Workers
			Modern Slavery
			Occupational Health and Safety
Business Landscape		25%	Terrorism Intensity
			Civil Unrest
			Government Stability
			Conflict Intensity
			Corporate Governance
			Corruption

Appendix E

Online Survey Calculations

The data used for the calculation are the responses received to the online survey presented in Appendix . The 2 tables feature the calculation that were used to develop the spacing between the severity risk levels in the SRET Risk Analysis questionnaire, as well as the CR of the responses received. The formulas used are presented in Section 3.4.

Positive reciprocal matrix

	No Risk	Low	Medium	High
No Risk	1	2,235	4,665	7,450
Low	0,447	1	4,089	6,954
Medium	0,214	0,245	1	5,940
High	0,134	0,144	0,168	1

Priority weights	Summed weights	Normalized weights (w)	Aw	Aw/w	λmax	CI	CR
2,969	5,843	0,508	2,131	4,195	4,274	0,091	0,100
1,888		0,323	1,357	4,200			
0,747		0,128	0,559	4,369			
0,239		0,041	0,177	4,333			

The 2 tables feature the calculation that were used to develop weights of the 5 categories featured in the SRET Risk Analysis questionnaire, as well as the CR of the responses received.

Positive reciprocal matrix

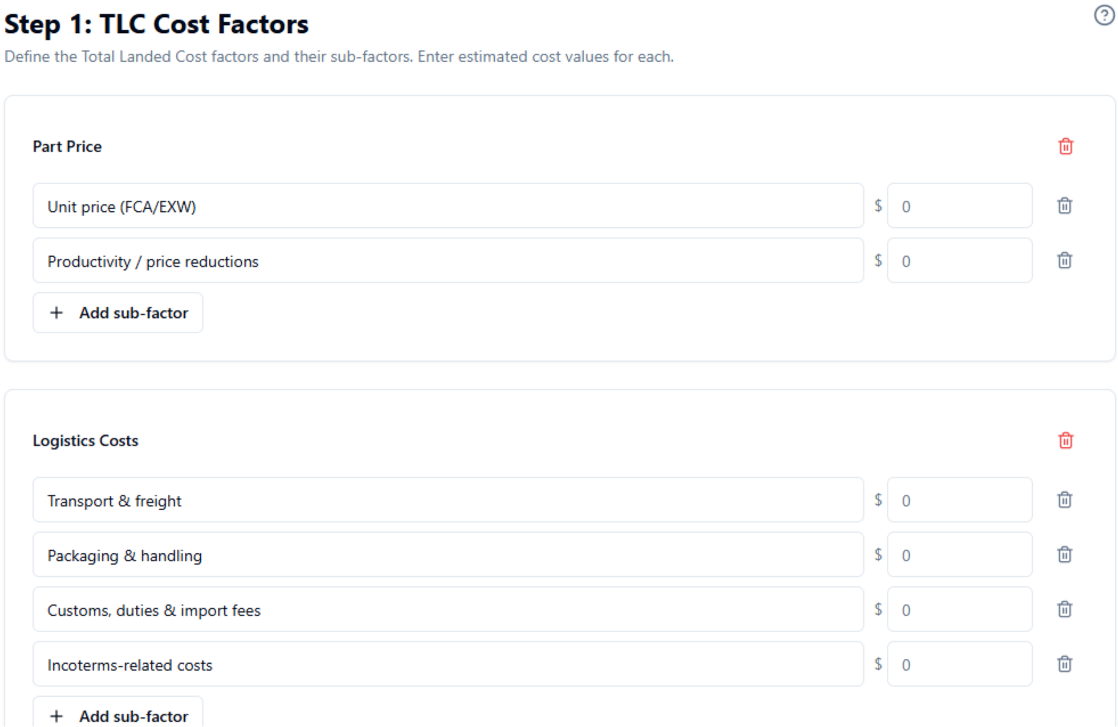
	Quality	Finance	Supply Chain	Capacity	Business	Volvo Caused
Quality	1	1,334	1,764	1,804	2,264	1,734
Finance	0,750	1	1,065	0,883	1,086	1,922
Supply Chain	0,567	0,939	1	0,796	1,245	2,044
Capacity	0,554	1,132	1,255	1	1,673	1,701
Business	0,442	0,921	0,803	0,598	1	1,606
Volvo Caused	0,577	0,520	0,489	0,588	0,623	1

Priority Weights	Summarized Weights	Normalized Weights	Aw	Aw/w	λmax	CI	CR
1,598	6,260	0,255	1,566	6,134	6,077	0,015	0,012
1,067		0,170	1,027	6,028			
1,013		0,162	0,976	6,036			
1,144		0,183	1,107	6,060			
0,824		0,132	0,798	6,061			
0,614		0,098	0,603	6,141			

Appendix F

First Model Iteration Interface

The interface of the pages of the first model iteration that based on Sharma's (2016) work and developed using the AI-tool Loveable.



Step 2: Risk Factors

Define major risk factors and their sub-risk factors. FMEA scoring will come in Step 4.

Supply Risk

- Single-source dependency
- Capacity constraints
- Supply delays / lead time risk
- Market availability of material
- Availability of alternative suppliers

+ Add sub-risk

Quality Risk

- Incoming quality defects (PPM/QPM)
- Manufacturing capability
- Reliability / product conformance

+ Add sub-risk

Step 3: Risk → TLC Mapping

Select which major risk factors directly influence each TLC cost factor.

Risk ↓ / TLC →	Part Price	Logistics Costs	Tooling & Development Costs	Inventory Costs
Supply Risk	☐	☐	☐	☐
Quality Risk	☐	☐	☐	☐
Financial Risk	☐	☐	☐	☐
Business & Environmental Risk	☐	☐	☐	☐
Relationship Risk	☐	☐	☐	☐

Step 4: FMEA Scoring

Rate each sub-risk factor on Likelihood, Severity, and Detection (1–5). RPN is auto-calculated.

Supply Risk

Sub-Risk Factor	Likelihood	Severity	Detection	RPN
Single-source dependency	2	4	2	**16**
Capacity constraints	2	3	3	**18**
Supply delays / lead time risk	3	3	2	**18**
Market availability of material	2	3	3	**18**
Availability of alternative suppliers	2	3	2	**12**

Step 5: AHP Pairwise Comparison

Compare sub-risk factors within each major risk factor. Rate relative importance on a 1–9 scale.

Supply Risk CR: 0.000 ✓

	Single-source depe...	Capacity constraints	Supply delays / lead...	Market availability o...	Availability of altern...	Weight
Single-source dependency	1	1 –...	1 –...	1 –...	1 –...	**20.0%**
Capacity constraints	1.00	1	1 –...	1 –...	1 –...	**20.0%**
Supply delays / lead time...	1.00	1.00	1	1 –...	1 –...	**20.0%**
Market availability of ma...	1.00	1.00	1.00	1	1 –...	**20.0%**
Availability of alternative ...	1.00	1.00	1.00	1.00	1	**20.0%**

Quality Risk CR: 0.000 ✓

	Incoming quality defects (PPM...	Manufacturing capability	Reliability / product conforma...	Weight
Incoming quality defects (PPM/QPM)	1	1 –...	1 –...	**33.3%**
Manufacturing capability	1.00	1	1 –...	**33.3%**
Reliability / product conformance	1.00	1.00	1	**33.3%**

Step 6: Weighted RPN & Risk Adjustment

Auto-calculated from your FMEA scores and AHP weights.

Supply Risk

Cumulative RPN: 16.40

Sub-Risk	RPN	AHP Weight	Weighted RPN
Single-source dependency	16	20.0%	**3.20**
Capacity constraints	18	20.0%	**3.60**
Supply delays / lead time risk	18	20.0%	**3.60**
Market availability of material	18	20.0%	**3.60**
Availability of alternative suppliers	12	20.0%	**2.40**

Quality Risk

Cumulative RPN: 22.00

Sub-Risk	RPN	AHP Weight	Weighted RPN
Incoming quality defects (PPM/QPM)	36	33.3%	**12.00**
Manufacturing capability	18	33.3%	**6.00**
Reliability / product conformance	12	33.3%	**4.00**

Step 7: Risk-Adjusted TLC Results

Export Excel

Download Report

Compare original vs. risk-adjusted costs across all TLC factors.

Original TLC	Risk-Adjusted TLC	Risk Premium
$0	**$0**	**+0%**

Cost Comparison

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