Integration of Quality and Sustainability in Supply Chain Operations

Master's thesis in Quality and Operations Management and Supply Chain Management

MAZIAR SHIRINKAR
RUIYANG HAN

DEPARTMENT OF TECHNOLOGY MANAGEMENT AND ECONOMICS
DIVISION OF INNOVATION AND R&D Management

CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden 2026
www.chalmers.se

Master's thesis 2026

Integration of Quality and Sustainability in Supply Chain Operations

MAZIAR SHIRINKAR
RUIYANG HAN

CHALMERS
UNIVERSITY OF TECHNOLOGY

Department of Technology Management and Economics
Division of Innovation and R&D Management
Chalmers University of Technology
Gothenburg, Sweden 2026

Integration of Quality and Sustainability in Supply Chain Operations
MAZIAR SHIRINKAR
RUIYANG HAN

Supervisor: Ksenia Onufrey, Innovation and R&D Management
Examiner: Ksenia Onufrey, Innovation and R&D Management

Master's Thesis 2026
Department of Technology Management and Economics
Division of Innovation and R&D Management
Chalmers University of Technology
SE-412 96 Gothenburg
Telephone +46 31 772 1000

Gothenburg, Sweden 2026

Integration of Quality and Sustainability in Supply Chain Operations
MAZIAR SHIRINKAR
RUIYANG HAN
Department of Technology Management and Economics
Chalmers University of Technology

Abstract

Organizations are increasingly expected to improve both operational performance and sustainability across their supply chains. While Quality Management (QM) and Sustainable Supply Chain Management (SSCM) share several common principles, limited research has explored how they are integrated in practice. This study investigates how organizations integrate sustainability into Quality Management Systems (QMS), the challenges and trade-offs involved, and how different operational contexts influence this integration. A qualitative multiple-case study was conducted in three companies from the hygiene, telecommunications, and construction industries using semi-structured interviews and company documents. The study further demonstrates that the implementation of these mechanisms varies according to product characteristics, supply chain context, and Product Time-Value Sensitivity (MVT). The findings contribute to the literature by providing empirical evidence of how quality management supports sustainability in supply chain operations and by extending the application of the MVT framework to explain differences in sustainability integration across industries. The study also offers practical insights for organizations seeking to strengthen sustainability through existing quality management capabilities.

Keywords: Sustainable Supply Chain Management, Quality Management System, Sustainability Integration, Supply Chain Operations, Product Time-Value Sensitivity, Multiple-Case Study.

Acknowledgements

We would like to express our sincere gratitude to everyone who contributed to the completion of this thesis, which was conducted at the Department of Technology Management and Economics (TME) at Chalmers University of Technology during the Spring semester of 2026. We are especially grateful to our supervisor and examiner, Ksenia Onufrey, for her valuable guidance, constructive feedback, and continuous support throughout the research process. We also sincerely thank Per Östling for coordinating the collaboration with the participating companies and facilitating valuable industry connections. Our heartfelt appreciation goes to all the interview participants who generously shared their time, knowledge, and experiences, making this study possible. Finally, we would like to thank our families and friends for their encouragement, patience, and unwavering support throughout our studies.

Ruiyang Han and Maziar Shirinkar, Gothenburg, August 2026

List of Acronyms

Below is the list of acronyms that have been used throughout this thesis listed in alphabetical order:

AI	Artificial Intelligence
CAP	Corrective Action Plans
CE	Circular Economy
DMAIC	Define–Measure–Analyze–Improve–Control
EFQM	European Foundation for Quality Management
EMS	Environmental Management Systems
EPDs	Environmental Product Declarations
ESG	Environmental, Social, and Governance
FMCG	Fast-Moving Consumer Goods
ICT	Information and Communication Technology
IMS	Integrated Management Systems
ISO	International Organization for Standardization
KPIs	Key Performance Indicators
LCA	Life Cycle Assessment
MVT	Marginal Value of Time
PDCA	Plan–Do–Check–Act
QFD	Quality Function Deployment
QM	Quality Management
QMS	Quality Management Systems
SPC	Statistical Process Control
SSCM	Sustainable Supply Chain Management
TBL	Triple Bottom Line
TQM	Total Quality Management

Contents

List of Figures

List of Tables

1

Introduction

1.1 Background

Supply chains are increasingly expected to achieve high performance across several operational objectives while responding to growing environmental and social expectations. Traditionally, quality management (QM) has been a key element of supply chain operations, helping organizations improve process efficiency, product reliability, customer satisfaction, and continuous improvement. Established approaches such as Total Quality Management (TQM), Lean production, and Six Sigma have been widely adopted to improve operational performance and create customer value (Slack and Lewis, 2019).

Alongside these developments, sustainability has become an important strategic priority for organizations operating in global supply chains. The concept of the Triple Bottom Line emphasizes that organizations should balance economic, environmental, and social performance rather than focusing only on financial results (Flynn et al., 1994). As a result, Sustainable Supply Chain Management (SSCM) has become an important area of both research and practice, addressing challenges such as responsible sourcing, reducing environmental impacts, improving supply chain transparency, and strengthening long-term resilience (Cherrafi et al., 2016; Pagell and Wu, 2009).

Although quality management and sustainability have traditionally developed as separate management areas, they share several operational principles, including waste reduction, process control, risk management, continuous improvement, and long-term value creation. Siva et al. (2016) These common principles have encouraged organizations to move beyond treating sustainability as an independent initiative and instead incorporate it into existing operational practices. (Bastas and Liyanage 2018)

One important development in industrial practice is the increasing integration of Quality Management Systems (QMS) and Environmental Management Systems (EMS). A Quality Management System provides the organizational structure for managing quality through defined processes, standardized procedures, performance measurement, audits, and continuous improvement, commonly following the ISO 9001 standard (ISO 9001, 2015). Similarly, Environmental Management Systems, typically based on ISO 14001, provide a structured framework for managing environmental impacts, improving resource efficiency, and supporting continual environmental improvement (ISO 14001, 2015). Rather than managing these systems

independently, many organizations now integrate quality and environmental management to reduce duplicated activities, improve coordination, and align operational and strategic objectives (Bryman, 2016). This development suggests that quality management and sustainability are increasingly managed through the same operational processes rather than through separate organizational systems (Siva et al., 2016).

As organizations integrate these management systems, sustainability becomes part of everyday supply chain activities. Existing quality management processes are increasingly expanded to include supplier environmental requirements, carbon footprint measurement, emissions reduction targets, eco-design, energy efficiency, circular economy initiatives, and traceability systems that improve transparency throughout the supply chain (Hariyani et al., 2024). Instead of creating completely new sustainability structures, many organizations build on established quality management practices to support environmental objectives.

Despite these developments, integrating quality management and sustainability remains challenging in practice. Organizations must balance traditional operational priorities, such as quality, cost, delivery, and flexibility, with increasing environmental and social expectations. Bastas and Liyanage (2018) argue that suppliers selected based on conventional quality criteria, such as cost efficiency and defect rates, do not necessarily meet sustainability requirements, creating conflicting priorities in supplier selection and performance management. These challenges can be observed across different industries. For example, in the fast fashion industry, characterized by short product life cycles and global procurement, suppliers face significant pressure to balance cost, speed, quality, and sustainability. For example, SHEIN experienced a revenue growth of over 1,000% from 2019 to 2023, but its absolute emissions increased by 81% between 2022 and 2023, exceeding the 43% revenue growth during the same period (Libby, 2025). In contrast, organizations producing technologically advanced industrial products often manage long product lifecycles, strict regulatory requirements, and complex global supplier networks, where sustainability must be integrated without compromising reliability and product performance.

These practical challenges are also reflected in the academic literature. Although quality management and Sustainable Supply Chain Management have each been widely studied, relatively few studies examine how these areas are integrated within everyday supply chain operations. Existing reviews suggest that the integration of quality management, supply chain management, and sustainability remains an emerging research area, with limited empirical understanding of how organizations combine these objectives in practice (Bastas and Liyanage, 2018, 2019).

Furthermore, most empirical research has adopted quantitative approaches based on surveys and organizational performance indicators (Kaynak and Hartley, 2008; Zhu et al., 2013). While these studies provide valuable evidence of the relationship between quality management, sustainability, and organizational performance, they provide less insight into how managers interpret sustainability requirements, adapt existing Quality Management Systems, and integrate sustainability into daily supply chain operations across different industrial contexts.

This study addresses these gaps through a qualitative multiple-case study that examines how organizations integrate quality management and sustainability within supply chain operations. By comparing companies operating in industries with different product characteristics and supply chain contexts, the study aims to provide a deeper understanding of how integration is achieved in practice and why different industries adopt different approaches while pursuing similar sustainability objectives.

1.2 Purpose

This study uses a multiple-case study to examine how organizations integrate sustainability into existing Quality Management Systems (QMS) across different industries. It compares sustainability practices across companies and investigates how quality and sustainability are integrated within their supply chain operations. The study also examines the challenges and differences that arise from varying product characteristics, supply chain structures, and product lifecycles. Based on these findings, the study aims to provide practical insights into how organizations can support both operational excellence and sustainability.

1.3 Research Questions

Although previous studies have explored quality management and sustainable supply chain management separately, limited research has examined how organizations combine these areas in practice, particularly from a qualitative and operational perspective (Bastas and Liyanage, 2018; Siva et al., 2016).
To address these objectives, the study is guided by the following research questions:
1. How are QMS and sustainability practices integrated in the supply chain operations in different industries?
2. What challenges and trade-offs do sustainability and quality managers face when attempting to integrate quality and sustainability within their supply chains?
3. How do differences in industry context and supply chain characteristics influence the integration of quality and sustainability practices?

2

Theory

2.1 Theoretical lenses

2.1.1 Triple Bottom Line

The Triple Bottom Line (TBL) is one of the most widely used frameworks for understanding sustainability in business and operations. Introduced by Elkington (1998), the framework argues that organizational performance should be evaluated across three interrelated dimensions: economic, environmental, and social performance, commonly referred to as profit, planet, and people. Since its introduction, the TBL has become a key reference for sustainable business and supply chain management by encouraging organizations to balance financial objectives with environmental protection and social responsibility (Carter and Rogers, 2008).

Within supply chain management, the TBL broadens the traditional focus on operational performance by incorporating environmental and social considerations into supply chain decision-making. As a result, organizations are expected to evaluate not only cost, quality, and delivery performance but also issues such as resource consumption, carbon emissions, labour conditions, and responsible sourcing (Seuring and Müller, 2008). Sustainable Supply Chain Management (SSCM) therefore extends conventional operations management by integrating these three sustainability dimensions throughout supply chain activities.

The literature also suggests that Quality Management Systems (QMS) can support this broader perspective. While QMS has traditionally focused on process standardization, product conformity, and continuous improvement, recent studies argue that these established management practices can also support sustainability initiatives (Siva et al., 2016). Existing quality management processes, including standardized procedures, auditing, performance measurement, corrective actions, and continuous improvement, provide organizational structures that can be applied to environmental and social objectives alongside traditional quality requirements.

Several studies further suggest that integrating sustainability into existing management systems is often more effective than developing separate sustainability structures. Boiral (2011) argues that integrated management systems reduce duplication of activities and improve organizational coordination, while Siva et al. (2016) identify quality management as an important organizational capability for supporting sustainability implementation. From this perspective, quality management provides an operational infrastructure through which organizations can coordinate multiple

performance objectives using established management processes.

At the same time, the literature recognizes that balancing the three dimensions of the Triple Bottom Line is not always straightforward. Economic, environmental, and social objectives may conflict, creating trade-offs that organizations must manage when making operational decisions (Hahn et al., 2010). For example, investments in environmentally preferable materials, responsible sourcing, or improved labour conditions may increase short-term costs while generating longer-term sustainability benefits. These competing objectives require organizations to adopt management approaches that support evidence-based decision-making and continuous improvement across multiple performance dimensions.(Hahn et al., 2010).

In this study, the Triple Bottom Line provides the conceptual foundation for understanding sustainability by defining its economic, environmental, and social dimensions. The framework is used to examine how these sustainability objectives are integrated into supply chain operations through existing quality management practices and Quality Management Systems.

2.1.2 Quality Management as an Operations Capability

Quality management has long been treated as a core element of operations management because it links process design and control to organizational learning and the delivery of customer value (Garvin, 1987). A central concern of quality management is ensuring that processes and outputs consistently meet defined requirements, while also improving them when performance does not meet these requirements. In this context, conformance refers to the ability of processes to consistently meet specified requirements, while learning describes how organizations systematically improve their processes over time based on performance feedback (Deming, 1986).

Rather than viewing quality management as a collection of tools or techniques, it is more appropriately understood as an organizational capability. Dean and Bowen (1994) argue that Total Quality Management (TQM) is built on principles such as customer focus, continuous improvement, and teamwork. These principles are implemented through practices including process management, structured problem solving, and employee involvement. In this study, these principles are important because they explain how organizations organize, monitor, and improve activities across supply chain operations.

Several quality management methods support the implementation of these principles in practice. One of the most widely used approaches is the Plan–Do–Check–Act (PDCA) cycle, which provides a structured process for planning improvements, implementing changes, evaluating results, and standardizing successful practices (Deming, 1986). The PDCA cycle forms the basis of continuous improvement within Quality Management Systems (QMS) and supports organizations in responding systematically to operational and environmental challenges. As shown later in this study, the logic of continuous improvement is reflected in activities such as supplier development, performance monitoring, and corrective action plans.

Another widely applied method is Six Sigma, which focuses on reducing process

variation and improving process capability through data-driven decision-making. Using structured approaches such as DMAIC (Define–Measure–Analyze–Improve–Control), Six Sigma helps organizations identify the root causes of quality problems and implement improvements based on objective data rather than assumptions (Pande et al., 2000). Although Six Sigma was originally developed to improve quality performance, many of its methods also contribute to sustainability by reducing waste, improving resource efficiency, and supporting continuous process improvement.

Other quality management methods further support operational decision-making. Quality Function Deployment (QFD) helps organizations translate customer requirements into product and process specifications, ensuring that customer expectations are considered during product development (Akao, 1990). Similarly, the Kano Model provides a framework for understanding different types of customer requirements by distinguishing between basic, performance, and excitement attributes, allowing organizations to prioritize product features according to their impact on customer satisfaction (Kano et al., 1984). While these methods are not examined directly in the empirical analysis, they illustrate how quality management supports product and process design by linking customer value with operational decisions.

Sousa and Voss (2002) further emphasize that quality management should not be reduced to formal systems, certifications, or individual tools. Instead, they describe it as a combination of technical and social practices that influence how decisions are made and how daily work is performed. This distinction is particularly relevant for sustainability, where the existence of formal procedures is less important than whether those procedures influence operational behaviour and support continuous improvement across the organization.

From a supply chain perspective, quality management extends beyond internal operations to include relationships with external partners. Kaynak and Hartley (2008) show that internal quality management practices can be extended upstream through supplier evaluation, information sharing, and collaborative improvement activities. In this view, supplier quality management is not a separate domain but a continuation of internal quality practices across organizational boundaries. This perspective is central to the present study because many sustainability challenges emerge through interactions with suppliers, materials, and logistics partners.

A related perspective concerns the role of the Quality Management System itself. Gremyr et al. (2021) argue that the value of a QMS depends on how it is used—whether primarily as a compliance mechanism, an improvement infrastructure, or a platform for strategic dialogue. Although their work does not specifically examine sustainability, this distinction is relevant to the present study. When sustainability is treated only as a compliance requirement, its integration with quality management is likely to remain limited. However, when sustainability becomes part of continuous improvement activities and operational decision-making, it can influence broader organizational performance.

Operations strategy provides a final perspective on the relationship between quality and sustainability. Ferdows and De Meyer (1990) propose that operational capabil-

ities such as quality, dependability, flexibility, and cost are developed cumulatively over time. In this context, sustainability can be understood as an additional operational capability that builds upon existing quality management practices. When organizations have mature Quality Management Systems and well-established improvement routines, they are better positioned to integrate sustainability into supply chain operations instead of managing it as a separate or competing objective.

2.1.3 Sustainable Supply Chain Management

Sustainable Supply Chain Management (SSCM) extends traditional supply chain management by integrating environmental, social, and economic objectives into supply chain decision-making and operations. Rather than treating sustainability as a separate corporate initiative, SSCM incorporates sustainability considerations into the planning, coordination, and management of material, information, and financial flows across the supply chain (Carter and Rogers, 2008). In this way, sustainability becomes part of everyday operational activities instead of being addressed only through corporate policies or reporting.

From an operations management perspective, SSCM requires organizations to move beyond the boundaries of individual firms and consider the environmental and social impacts created throughout the entire supply chain (Sarkis, 2012). This broader perspective recognizes that sustainability performance depends not only on internal operations but also on suppliers, logistics partners, customers, and product end-of-life activities. As a result, organizations increasingly integrate sustainability into procurement, production, product development, transportation, and recovery processes rather than managing these activities independently. (Seuring and Müller 2008)

Implementing SSCM also requires organizations to balance multiple operational objectives. While companies continue to pursue quality, cost efficiency, flexibility, and delivery performance, they must also reduce environmental impacts and respond to increasing stakeholder expectations. Pagell and Wu (2009) argue that achieving sustainability often requires organizations to rethink traditional operational priorities and develop new ways of creating long-term value. Similarly, Hajmohammad et al. (2024) show that sustainability decisions within supply chains increasingly depend on balancing environmental risks, supplier relationships, and operational performance rather than focusing only on purchasing costs.

To examine how sustainability is integrated into supply chain operations, this study adopts a lifecycle perspective consisting of three operational stages: the Material Phase, Manufacturing Phase, and Product Phase. This structure follows the view that sustainability should be considered throughout the product lifecycle rather than at isolated points within the supply chain (Srivastava, 2007). Organizing the study in this way also provides a common framework for comparing different industries while examining how quality management supports sustainability across supply chain operations.

The Material Phase focuses on upstream activities, including supplier selection, material sourcing, procurement, and supplier collaboration. At this stage, organizations

increasingly evaluate suppliers based not only on traditional quality requirements but also on environmental performance, responsible sourcing, regulatory compliance, and traceability (Pagell and Wu, 2009). These activities help organizations improve transparency across the supply chain while reducing sustainability risks associated with purchased materials and supplier operations. (Krause et al, 2009).

The Manufacturing Phase focuses on internal operations where quality management and sustainability become closely connected through process improvement and operational efficiency. Previous research has shown that many quality management practices, including waste reduction, continuous improvement, and process standardization, also contribute to improved environmental performance (Florida, 1996). As a result, organizations increasingly integrate environmental objectives into existing production systems by reducing material waste, improving resource efficiency, and optimizing manufacturing processes (Piercy and Rich, 2015). Integrating environmental management with Quality Management Systems also reduces duplication of activities while supporting continuous improvement across operations (Boiral, 2011).

The third stage is the Product Phase, which covers activities after manufacturing. Rather than focusing only on production efficiency, organizations increasingly consider product durability, maintenance, refurbishment, recycling, and end-of-life recovery. These practices are closely linked to the principles of the Circular Economy (CE), which aims to reduce resource consumption by keeping materials and products in use for as long as possible through strategies such as reuse, repair, refurbishment, remanufacturing, and recycling (Kirchherr et al., 2017). Bocken et al. (2014) further argue that slowing and closing resource loops are important strategies for improving long-term sustainability by extending product lifecycles and maintaining material value.

Although circular economy practices can improve resource efficiency, they must be implemented from a systems perspective. Simply increasing recycling activities does not automatically improve sustainability if overall resource consumption continues to increase. Castro et al. (2022) describe this challenge as the circular economy rebound effect, where environmental improvements achieved through recycling or recovery may be offset by higher levels of production and consumption. Similarly, Lorek and Spangenberg (2014) argue that long-term sustainability requires not only more efficient resource use but also more sustainable patterns of production and consumption.

While the three operational stages provide a common framework for understanding supply chain activities, this study argues that the integration of quality management and sustainability is also influenced by product characteristics. To explain these differences, the study applies the Product Time-Value Sensitivity framework developed by Blackburn et al. (2004). Blackburn et al. introduced the concept of Marginal Value of Time (MVT), suggesting that products lose economic value at different rates over time and that these differences influence supply chain design and operational priorities. Products with high Time-Value Sensitivity, such as fast-moving consumer goods, require rapid production, flexible supplier networks, and quick operational responses because their value declines rapidly (Fisher, 1997). Under these condi-

tions, organizations must integrate sustainability without reducing responsiveness or supply chain flexibility. In contrast, products with low Time-Value Sensitivity, such as buildings and infrastructure, remain in use for many decades. This longer planning horizon allows organizations to emphasize durability, preventive maintenance, lifecycle optimization, and long-term supplier collaboration. These characteristics create greater opportunities to integrate sustainability into existing quality management practices throughout the product lifecycle (Pagell and Wu, 2009).

This study therefore combines the three lifecycle stages with Product Time-Value Sensitivity to examine how quality management supports sustainability across different operational contexts. While the lifecycle perspective explains where sustainability practices occur within supply chain operations, MVT provides a theoretical explanation for why organizations adopt different integration approaches despite pursuing similar sustainability objectives. Together, these perspectives provide the analytical foundation for examining how quality management and sustainability are integrated across the three case companies.

2.2 Integration of Quality Management and Sustainable Supply Chain Management

The relationship between quality management and sustainability has been examined in several streams of literature. Siva et al. (2016) identify common principles between quality management and sustainable development, including process orientation, prevention, stakeholder focus, and continuous improvement. Their review suggests that established quality management practices can support sustainability by providing structured approaches to process management, performance monitoring, and improvement. From a supply chain perspective, Bastas and Liyanage (2018) further argue that quality management has traditionally focused on internal processes, while sustainable supply chain management requires organizations to address environmental and social issues across organizational boundaries.

Previous research also shows that established quality management methods can be used to support sustainability objectives. For example, Cherrafi et al. (2017) demonstrate how Lean and Six Sigma approaches can be combined with environmental and social objectives through structured improvement activities. Similarly, De Menezes et al. (2022) show how sustainability-related criteria can be incorporated into the EFQM quality management framework. These studies indicate that sustainability can be addressed through existing quality management approaches rather than requiring completely separate management practices.

The literature provides further support for examining specific operational areas where quality management and sustainability overlap. Bastas and Liyanage (2019) develop a framework for integrating quality management, supply chain management, and sustainability and emphasize the importance of applying management principles across supply chain activities. This provides a basis for examining supplier evaluation and performance management, where sustainability requirements can be incorporated into supplier assessment, monitoring, and improvement activities. Cor-

rective action is another relevant area. ISO 9001 emphasizes the identification of nonconformities, root-cause analysis, corrective action, and evaluation of effectiveness as part of continual improvement, while Seuring and Müller (2008) identify auditing, monitoring, and corrective actions as practices used to address sustainability risks in supply chains.

Reliable information is also important for connecting quality management with sustainability. Quality management relies on accurate and verified information for decision-making and process improvement, while sustainability management requires reliable information about environmental performance across supply chain boundaries. Sroufe and Curkovic (2008) highlight the importance of integrating quality management approaches with environmental information and management practices. Traceability further supports this connection by allowing organizations to track material and environmental information across supply chain activities.

Based on this literature, this study examines four areas where quality management and sustainability can be integrated: supplier evaluation, performance management, corrective action plans, and data quality and traceability systems. These areas are used in the following sections to examine how sustainability is incorporated into existing quality management practices and supply chain operations across the three case companies.

2.2.1 Supplier Evaluation

Supplier evaluation is one of the clearest meeting points between quality and sustainability. Kaynak and Hartley (2008) show that supply-chain quality management relies on supplier selection, communication, collaboration, and development rather than on transactional purchasing alone. This shift profoundly alters traditional purchasing logic; as Pagell et al. (2010) observed, sustainable sourcing often requires buyers to treat what were traditionally leverage-based, transactional commodities as strategic partnerships.

As sustainability has become an integral part of supply chain management, supplier evaluation has expanded beyond traditional quality criteria, such as cost, quality, and delivery performance. Organizations increasingly assess suppliers based on labour conditions, environmental management practices, material compliance, and traceability requirements, guided by internationally recognized frameworks such as ISO 14001 and the United Nations Global Compact (ISO 14001, 2015; United Nations Global Compact, 2024).

Seuring and Müller (2008) help explain why this broadening is necessary. Because sustainable supply chains are shaped by customer and stakeholder requirements across economic, environmental, and social dimensions, procurement can no longer optimize only price, lead time, and defect rates. Faced with the potential for adverse stakeholder reactions, procurement managers are forced to proactively manage supplier sustainability risks. Hajmohammad et al. (2024) demonstrate that their decision-making now hinges on complex trade-offs between perceived risk and supplier dependence, leading them to deploy specific governance strategies ranging from intensive monitoring and collaborative mitigation to outright avoidance. In prac-

tice, supplier evaluation becomes the place where competing definitions of performance are negotiated and institutionalized. This negotiation is inherently political; Touboulic et al. (2014) highlight how stark power imbalances within the supply chain dictate whether a dominant buyer uses structural leverage to force compliance or collaboratively support smaller suppliers in adopting sustainable practices.

Institutional pressure often accelerates this shift. Zhu et al. (2013) demonstrate that green supply chain practices are affected by pressures coming from regulation, markets, and broader legitimacy expectations. This helps explain why assessment mechanisms have become more common in industries that face scrutiny over sourcing and upstream impacts. These mechanisms are not merely administrative; they shape which suppliers are considered acceptable and what evidence counts as acceptable performance.

2.2.2 Performance Measurement

Continuous improvement is a core principle of QMS and is closely linked to organizational performance. Kaynak (2003) shows that quality management practices influence performance through interconnected routines, including process management, training, and feedback mechanisms, rather than isolated tools. These routines support systematic improvement and the development of organizational learning capabilities over time.

The role of learning and adaptation has also been emphasized in the literature on sustainable supply chain management. Siems et al. (2021) show that sustainability-related capabilities are developed through repeated processes of adaptation and reconfiguration over time. This suggests that sustainability integration, similar to quality management, depends on iterative learning processes rather than one-time implementation efforts. Their findings indicate that the implementation of sustainability practices is not a one-time activity but involves continuous adjustment of processes, requirements, and coordination mechanisms.

Rather than focusing on specific supply chain practices, the key implication for this study is that both quality management and sustainability rely on similar underlying mechanisms of feedback, evaluation, and continuous adaptation. These mechanisms provide the foundation for integrating sustainability into existing quality management routines, which is further explored in later sections.

2.2.3 Corrective Action Plans (CAP)

Auditing and corrective actions are central elements of QMS. International Organization for Standardization 9001 specifies that organizations shall manage nonconformities through identification, root-cause analysis, corrective action, and evaluation of effectiveness as part of continual improvement processes (ISO, 2015). These mechanisms provide a structured approach to monitoring performance and addressing deviations from defined requirements.

The literature on integrated management systems shows that these routines can be applied across different domains. Integrated management systems (IMS) refer to

the alignment and combination of multiple management standards—such as quality, environmental, and social management systems—into a unified organizational system with shared processes and procedures. Bernardo et al. (2015) report that integration enables organizations to use common audit procedures, documentation systems, and review processes for multiple management standards. Their study primarily focuses on integration at the organizational (firm) level rather than the supply chain level, but the findings are relevant as they illustrate how audit and corrective action routines can be shared across different domains. This shared use of audit and corrective action systems is identified as a key benefit of integration, particularly in reducing duplication and improving consistency.

In the context of sustainability, organizations also use auditing and monitoring to verify whether suppliers meet defined environmental and social requirements. While supplier evaluation concerns the broader assessment of suppliers during selection and development, auditing provides a more specific means of verifying compliance with established requirements (Seuring and Müller, 2008). They identify auditing, monitoring, and corrective actions as common practices for managing supplier-related sustainability risks in supply chains.

2.2.4 Data Quality Control and Traceability Systems

Reliable data is an important part of quality management because decisions and process improvements need to be based on accurate and verified information (ISO, 2015). This is also relevant to sustainability, where organizations increasingly need reliable environmental data to assess performance and monitor areas such as greenhouse gas emissions (Schaltegger and Burritt, 2014). However, collecting sustainability data across supply chain partners can be difficult because information comes from different organizations and may vary in quality and format. Scope 3 emissions are one example where data collection across organizational boundaries can involve considerable uncertainty (Matthews et al., 2008). Research also shows that low-quality data, limited verification, and information gaps between supply chain partners can make it difficult to monitor environmental performance and demonstrate sustainability improvements (Downie and Stubbs, 2013). Therefore, quality management practices for data control can help organizations improve the reliability of sustainability information (Sroufe and Curkovic, 2008).

Traceability is closely related to data quality because it allows organizations to follow materials and products through different stages of the supply chain. In traditional quality management, traceability is mainly used to identify materials, monitor process compliance, and support the investigation of quality problems (Garvin, 1987). In closed-loop and sustainable supply chains, its role becomes broader. Organizations may also need to track the environmental origin of materials, recycled content, and other sustainability-related information throughout the product lifecycle (Seuring and Müller, 2008). This makes traceability useful not only for quality control but also for supporting sustainability requirements and information sharing between supply chain partners (Bastas and Liyanage, 2018). Thus, data quality and traceability can help organizations connect traditional quality information with sustainability information within supply chain operations.

3

Method

3.1 Research Design and Process

This study adopts a qualitative, comparative multiple-case study design. A qualitative approach is suitable due to the exploratory nature of the research questions and the focus on managerial practices, interpretations, and decision-making processes. Integration between quality and sustainability is a complex and context-dependent phenomenon that cannot be fully captured through quantitative indicators alone (Yin, 2018).

To facilitate a structured analysis, supply chain operations are categorized into three modules based on our theoretical framework (Srivastava, 2007):

- Material: Sourcing, raw material standards, and supplier quality.
- Manufacturing: Internal production processes and operational efficiency.
- End-product: Final quality assurance and customer delivery standards.

3.2 Case selection

The selection of case companies in this study is strategically grounded in the theory of product time-sensitivity and the Marginal Value of Time (MVT) proposed by Blackburn et al. (2004). According to this framework, products with high time-sensitivity experience rapid value degradation, necessitating highly responsive supply chain structures, whereas time-insensitive products prioritize cost-efficient operations due to their slower rate of value loss. To capture a comprehensive spectrum of industry practices, this study employs a theoretical sampling approach by selecting three companies with starkly contrasting product lifespans and time-sensitivity profiles: a Hygiene Company, a prominent telecommunications firm, and a large-scale construction enterprise. To intuitively illustrate this theoretical sampling strategy, the selected cases are mapped across the dimensions of product lifespan and time-sensitivity, as depicted in Figure 3.1.

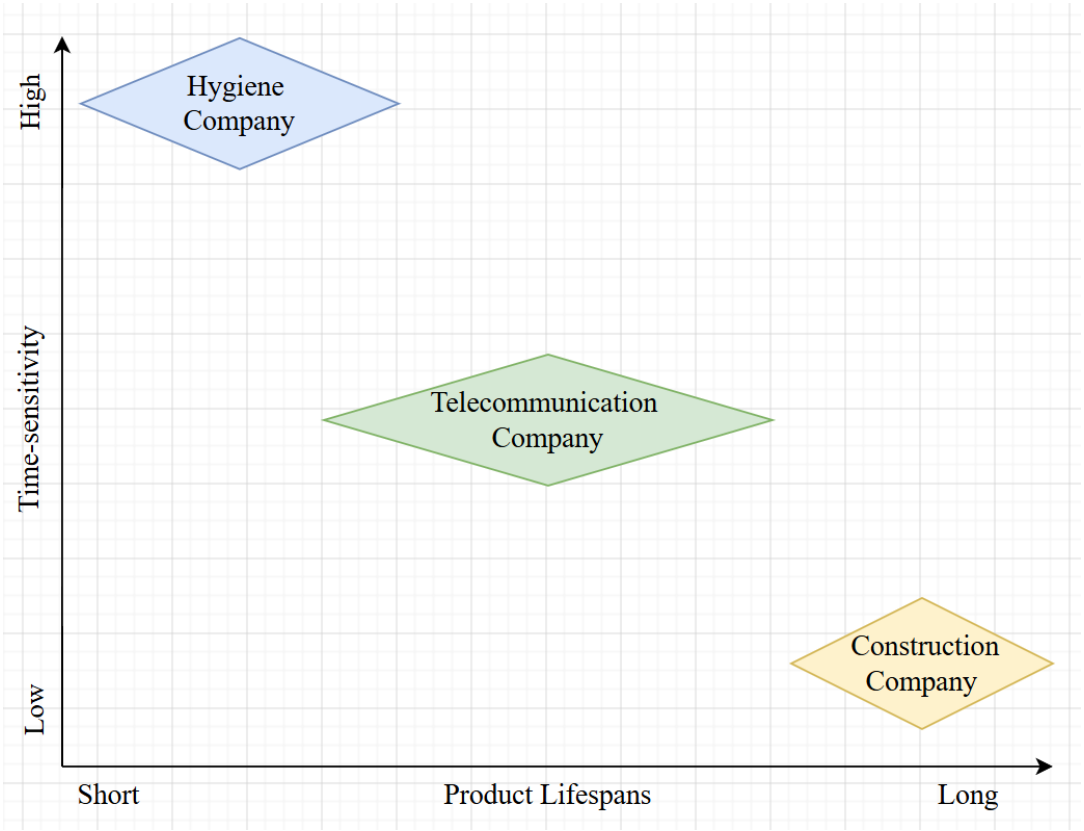

Figure 3.1: Mapping case companies based on the product marginal value of time (Blackburn et al., 2004) and lifecycle characteristics. The diversity in time-sensitivity and product longevity provides a comprehensive basis for identifying both universal and sector-specific mechanisms.

According to the Marginal Value of Time framework by Blackburn et al. (2004), a product's lifespan and time-sensitivity are strictly linked. Short-lifecycle products rapidly lose their economic value, inherently creating high time-sensitivity that demands fast supply chain responses. Conversely, low time-sensitivity only applies to products whose value degrades slowly over long lifespans. Therefore, it is impossible for a situation like low time sensitivity and short product lifespans to occur.

3.2.1 Company Background

The hygiene company is a leading global provider of personal care, tissue, and health products, reaching a billion people daily across more than 150 countries (Hygiene company annual report 2025). Its core business revolves around daily-use hygiene products categorized as Fast-Moving Consumer Goods (FMCG). Due to the inherent nature of these products—which are typically single-use and possess extremely short product lifecycles—they exhibit high time-sensitivity and a high Marginal Value of Time (MVT). According to the framework proposed by Blackburn et al. (2004), such characteristics necessitate a highly responsive and high-volume supply chain to ensure constant product availability and rapid replenishment. This operational pressure drives the company to integrate sustainability into its QMS through the

rigorous responsible sourcing of raw materials (such as sustainable fibers), strict adherence to health and safety quality standards, and the pioneering of circular economy models, including closed-loop recycling services for paper hygiene products.

The telecommunications company is a leading global provider of Information and Communication Technology (ICT) infrastructure and hardware (Telecommunication Company annual report 2025). Unlike fast-moving consumer goods, its primary products, such as network base stations and large-scale communication hardware, possess a multi-year lifespan, representing a medium level of time-sensitivity and MVT in the Blackburn (2004) framework. This moderate rate of value degradation requires the company to balance the need for rapid technical updates with the absolute necessity for long-term equipment reliability. Consequently, the organization's sustainability integration focuses on rigorous multi-tier supply chain compliance, the implementation of sophisticated e-waste recovery and closed-loop mechanisms, and the continuous optimization of energy efficiency across the extended operational phase of its hardware products.

The construction company is a major regional developer and manager of commercial real estate and infrastructure (Construction company annual report 2024). Its end-products—namely large-scale buildings—are designed for lifespans spanning several decades, placing them at the lowest end of the time-sensitivity spectrum with a very low MVT. Based on this long-term asset characteristic, the company's operations prioritize lifecycle cost efficiency, structural durability, and long-term regulatory compliance over short-term responsiveness. This provides a significant strategic buffer for integrating sustainability into quality standards. The integration efforts are primarily centered on managing the total environmental footprint of the buildings' lifecycle, aligning with science-based climate targets, and ensuring high-level green building certifications for its long-term assets.

By selecting these three distinct cases, the study aims to analyze the similarities and variances in how sustainability is integrated into their respective QMS. The inclusion of such diverse product characteristics—ranging from transient consumer goods to long-term industrial assets—allows for the identification of a universal mechanism for sustainability-QMS integration applicable across the industrial landscape. Furthermore, this comparative design enables the extraction of sector-specific mechanisms tailored to the unique operational requirements and product lifecycles of different industrial domains.

3.3 Data Collection

To investigate how quality management and sustainability are integrated within supply chain operations, this study uses two main sources of data: semi-structured interviews and company documents. The interviews provide insights into how managers understand and implement quality and sustainability practices in their daily operations. Company documents, such as annual reports and other relevant organizational documents, provide additional information about the companies' sustain-

ability objectives, policies, and practices. Using both sources allows the study to compare managers' accounts with documented information and identify similarities or differences between them. This is particularly relevant to the research questions because the study examines both how integration is implemented in practice and how organizations describe their sustainability and quality management practices. Using multiple sources of evidence is also consistent with the case study approach, where different sources can be used to develop a more detailed understanding of the topic under research (Yin, 2018).

3.3.1 Literature Review

According to Blomkvist and Hallin (2015), the purpose of a literature review is to identify, categorize, and critically analyse previously published research relevant to the research topic. The literature review provided the theoretical basis for identifying areas where quality management and sustainability overlap in supply chain operations. These areas were then considered during the analysis of the empirical data. Through the thematic analysis, four recurring areas were identified across the cases: supplier evaluation, performance management, corrective action plans, and data quality and traceability systems. Product Time-Value Sensitivity (MVT) was used as an additional theoretical lens to examine how these areas were implemented differently across the three companies.

The literature review also informed the development of the interview questions used in this study. The questions were adapted to the roles and activities of the interviewees in the three case companies, with a focus on how these practices were applied in their supply chain operations. The interviews also included questions about challenges and trade-offs, particularly when sustainability requirements affected established quality, material, or operational requirements. This approach allowed the interviews to address the research questions while giving the participants the opportunity to describe how quality and sustainability were managed in their specific organizational contexts.

The literature review also provided a basis for interpreting and discussing the empirical findings. The findings from the three case companies were compared with the concepts and relationships identified in the literature, particularly regarding the integration of quality management and sustainability, the four identified areas, and the role of Product Time-Value Sensitivity (MVT). This comparison helped identify similarities and differences between the empirical findings and previous research and supported the development of the cross-case analysis. The literature was also used when discussing the theoretical and managerial implications of the findings, allowing the conclusions to be related to existing research rather than being based only on the individual cases.

3.3.2 Pre-interview Document Review

Prior to conducting interviews with the case companies, a preliminary phase of document analysis was carried out by reviewing the 2025 edition of each company's annual report, supplemented by relevant internal company documents. Specific

examples of these internal materials include the hygiene company's regulations on Sourcing Risk Management, the Global Supplier Standard, and dedicated documentation detailing the hygiene company's closed-loop project. The analysis primarily focused on sustainability-related chapters and internal guidelines. The objective of this review was to comprehensively understand each company's core sustainability targets and identify the critical tools utilized to achieve them, such as Key Performance Indicators (KPIs), relevant strategic projects, and specific operational metrics.

3.3.3 Interviews

The publicly available information and sustainability initiatives of the case companies were used to develop and tailor the interview questions. Since the study aims to explore how sustainability is integrated with existing quality management practices, the semi-structured interviews were conducted with participants whose roles and responsibilities provided relevant knowledge of sustainability, environmental issues, circular economy practices, and quality management. The interview questions were adapted to the background and responsibilities of each participant while maintaining a common structure across the cases. This allowed the study to explore how quality and sustainability were addressed within each company and to compare the different perspectives and practices across the three cases. It also provided an opportunity to identify challenges and trade-offs that arose when sustainability requirements were integrated into existing quality and operational practices.

To provide context for the interviews, it is important to note that sustainability and quality responsibilities are not organized into separate departments across the three participating companies. Instead, these responsibilities can overlap, with some participants having roles related to sustainability, environmental issues, circular economy, or quality management. The participants were therefore selected based on their roles and knowledge relevant to the research topic. The specific roles of the participants are presented below:

At the Hygiene Company, the interviewee from the Sustainable Procurement department actively manages the intersection of sustainability goals and supplier quality standards, noting that sustainability criteria are embedded into routine supplier evaluations.

At the Telecommunications Company, the Global Program Manager for embodied carbon reduction operates within the global operations and supply chain organization, where their work is intrinsically linked to quality-related hardware design and manufacturing standards.

At the Construction Company, the Chief Sustainability Officer oversees both the reporting strategy and the broader operational practices related to property development and material quality, illustrating a holistic approach where sustainability and quality management are treated as mutually reinforcing objectives.

The interviews were designed as exploratory conversations that allowed participants to describe their perspectives and experiences in their own words. Table 3.1 provides

an overview of the anonymized respondents and their organizational responsibilities. The complete semi-structured interview guide, detailing the specific questions formulated for each of these three supply chain phases, is provided in the Appendix of this thesis.

Table 3.1: Overview of study participants, designated professional roles, and interview duration.

Company category	Position of the Respondent	Code	Interview time
Hygiene and Health company	Sustainable Procurement Manager	A	44 min
			32 min
	Program Account Manager	B	43 min
Construction Company	Chief Sustainability Officer	D	41 min
			35 min
			30 min
Telecommunications company	Circular Business Lead	E	52 min
	Global Program Manager	F	46 min
			48 min

3.4 Data Analysis

This section outlines the systematic approach employed to process and interpret the collected qualitative data, primarily consisting of primary interview transcripts and secondary corporate annual reports. The core objective is to reveal how the selected case companies integrate sustainability strategies into their daily QMS. Guided by the theoretical framework derived from the preceding literature review, this structured analytical process directly integrates empirical data with established theoretical insights. Ultimately, the analysis aims to formulate actionable optimization suggestions for managers, ensuring that operational standards are maintained while providing comprehensive answers to the research questions defined in Section 1.3.

3.4.1 Thematic Analysis

The qualitative data analysis in this study follows a progressive path from empirical data deconstruction to theoretical synthesis. The entire analysis process is divided into three sequential stages: within-case analysis, cross-case comparison, and synthesis. To ensure deep analytical immersion, manual textual processing within Microsoft Word is employed. Utilizing highlighting, commenting, and table functions, the researcher systematically color-codes and organizes raw data, ensuring that every code remains strictly traceable to its original context.

Within-case Analysis: In the first phase, each company is examined independently to reconstruct its operational reality. Drawing primarily on empirical evidence—specifically internal supporting documents (e.g., standard operating procedures,

annual reports) and verbatim interview transcripts—the researcher extracts and categorizes specific managerial practices. This within-case analysis strictly follows the physical flow of the supply chain, structuring the findings into three sequential phases: the Material Phase, the Manufacturing Phase, and the Product Phase. By mapping out exactly what practices are implemented and how they function in their original context, this stage provides a thick, empirical description of the integration landscape for each firm before applying higher-level theoretical abstractions.

Cross-case Comparison: The second phase elevates the empirical findings into a theoretical discussion through a comprehensive cross-case comparison. Here, thematic analysis (Braun and Clarke, 2006) is applied using a theory-driven approach anchored in the four operational overlap areas identified in Chapter 2: Supplier Evaluation, Performance Management, Corrective Action Plans (CAP), and Data Quality Control and Traceability Systems. Crucially, the differences in how companies operationalize these four areas are analyzed through the theoretical lens of the Marginal Value of Time (MVT) framework (Blackburn et al., 2004), combined with relevant supply chain literature. For instance, the analysis explores how a hygiene company with high time-sensitivity (high MVT) relies on rapid, automated supplier evaluation roadblocks and behavioral nudging in performance management to handle the volatility of sustainable materials. Conversely, it contrasts this with a construction firm (low MVT), which prioritizes long-term durability and relies on highly granular data traceability systems for lifecycle footprinting. This MVT-driven thematic comparison reveals how fundamental product characteristics dictate the strategic priorities and pathways of sustainability-QMS integration.

Synthesis: Finally, the comparative findings are consolidated in the synthesis phase. Based on the identified similarities and MVT-driven variances within the four theoretical domains, the study formulates actionable optimization suggestions for managers. This synthesis aims to provide both universal mechanisms for sustainability-QMS integration—spanning supplier evaluation, performance tracking, corrective actions, and data traceability—as well as sector-specific strategies tailored to unique product lifecycles. The ultimate goal is to enable organizations to incorporate sustainability into their existing quality frameworks without compromising stringent production standards.

3.5 Ethical Aspect

Ethical considerations were important in this study because it involved interviews with employees from three companies. Before the interviews, participants were informed about the purpose and scope of the study and how the collected information would be used. Participation was voluntary, and participants could decline to answer questions or withdraw from the study. Confidential company information was not shared between the participating organizations, and identifying information was removed from the final thesis. Interview data were stored securely and handled in accordance with relevant research ethics and data protection requirements.

3.6 Methodological Reflection

The methodological choices also involve some limitations. First, the study is based on a small number of case companies from different industries, which limits the extent to which the findings can be generalized to other organizations. The purpose of the multiple-case design was therefore not statistical generalization, but to compare different operational contexts and identify patterns across the cases (Yin, 2018). The use of companies with different product characteristics and supply chain structures also provided variation that supported the cross-case analysis.

Second, the study relies mainly on interviews and company documents. Interviews provide direct insights into participants' experiences and views, but the responses may reflect individual perspectives and may not represent all activities within an organization. To address this limitation, participants were selected based on their roles and knowledge of sustainability, environmental issues, circular economy, quality management, and supply chain operations. Interview questions also followed a common structure while allowing participants to explain issues relevant to their specific roles. Company documents were used as an additional source of information, allowing interview responses to be considered together with publicly available organizational information.

Third, the cross-case design also involves a limitation. Since the study covers three companies, participants may be less willing to share detailed internal information than they might be in a single-company study. This can limit the depth of information available about specific organizational processes. However, this limitation is also related to the purpose of the study. The research focuses on the managerial level, rather than examining the detailed processes of one organization. Comparing multiple cases therefore provides a broader view of common practices, differences, and challenges across industries. This broader perspective also supports analytical generalisability, as the findings can be compared across different contexts and may provide insights relevant to organizations with similar product and supply chain characteristics (Yin, 2018).

These measures support the credibility and consistency of the findings, although they cannot eliminate the limitations associated with qualitative case research. The use of multiple cases, different data sources, a common interview structure, and a systematic thematic analysis strengthens the reliability of the research process. The comparison with existing literature also supports the validity of the interpretation by allowing the empirical findings to be considered in relation to established research. However, the findings should be understood in relation to the specific companies and contexts studied rather than as universally generalizable conclusions (Lincoln and Guba, 1985).

3.7 AI statement

In accordance with academic transparency guidelines, the authors disclose the use of Artificial Intelligence (AI) tools in the preparation of this document. Specifically,

Otter.ai was employed to transcribe interview audio recordings into text. Additionally, ChatGPT was utilized to proofread and optimize the language, grammar, and phrasing of the manuscript.

The AI tools were not used to generate core ideas, analyze data, or draw conclusions. The authors have carefully reviewed, edited, and verified all AI-assisted outputs, and take full responsibility for the accuracy, originality, and final presentation of the content.

4
Findings

This chapter presents the empirical findings from the multiple-case study. The findings are based on interviews and company documents and describe how the three case companies integrate quality management and sustainability within their supply chain operations. Rather than interpreting the findings, this chapter presents the practices, processes, and activities identified in each organization. The findings are organized separately for each company and follow the main stages of supply chain operations: the material phase, manufacturing phase, and product phase. This structure provides the empirical foundation for the cross-case analysis presented in Chapter 5.

The empirical findings in this chapter are presented according to the main areas identified from the previous chapter and used to guide the study. However, the specific subheadings and level of detail are adapted to the findings from each case company and the practices identified during the interviews. The findings are presented in this way to reflect the specific context of each company, while the following analysis chapter brings these findings together and categorizes them according to the four main analytical areas.

4.1 Hygiene Company

4.1.1 Material Phase

4.1.1.1 Supplier Qualification and Sustainability Requirements

The findings show that the hygiene company integrates sustainability into supplier qualification by combining traditional quality requirements with environmental and social criteria. Supplier approval begins with a structured site audit where quality specialists evaluate production processes, quality control, and supply security. At the same time, suppliers are assessed for health, safety, and environmental practices to ensure they meet the company's sustainability expectations.

Interviewee A explained that supplier audits primarily focus on operational quality but also include observations of environmental management and workplace safety, such as the use of personal protective equipment and the presence of environmental management systems. In addition to these operational assessments, suppliers are expected to comply with ethical requirements through Sedex registration and ethical audits before they are approved.

The findings indicate that the level of assessment depends on the supplier's risk pro-

file. Suppliers with established quality systems and a long history of cooperation are evaluated differently from new suppliers operating in regions with higher sustainability risks. As Interviewee A explained, suppliers located in higher-risk countries are required to complete mandatory ethical audits before purchasing commitments are made. This demonstrates that supplier qualification considers both operational capability and sustainability risks when selecting new suppliers.

Company documentation supports these findings by showing that supplier approval requires compliance with quality, environmental, and ethical standards before suppliers become part of the supply chain. Together, the interview and documentary evidence suggest that sustainability has become an integrated part of supplier qualification rather than an additional requirement introduced after supplier selection.

4.1.1.2 Supplier Development and Collaboration

The findings indicate that supplier development is an important part of how the hygiene company integrates sustainability into its supply chain. Rather than replacing suppliers that do not immediately meet new sustainability expectations, the company works with existing suppliers to improve their environmental performance and support long-term collaboration.

Interviewee A explained that the company's main objective is to develop suppliers instead of ending the relationship when sustainability challenges arise. Environmental improvements are discussed jointly with suppliers, allowing both parties to identify practical solutions and gradually adapt to new sustainability requirements. Particular attention is given to suppliers that contribute most to the company's Scope 3 emissions, especially suppliers of pulp, plastics, and chemicals, because these materials have the greatest environmental impact throughout the product lifecycle.

The collaboration focuses on identifying lower-carbon alternatives while maintaining the required quality standards. Interviewee A described several improvement activities, including increasing the use of recycled materials and encouraging suppliers to replace fossil-based energy with renewable energy sources during production. These initiatives allow the company to reduce the environmental impact of purchased materials while ensuring a stable supply of key raw materials.

However, supplier development also involves limitations. Interviewee A explained that suppliers may be less willing to invest in environmental improvements when the hygiene company represents only a small share of their total business. In such situations, the company has less influence over the supplier's sustainability activities. The company may therefore need to reduce purchasing volumes or consider alternative suppliers when sufficient improvement cannot be achieved. This creates a practical balance between maintaining an established supplier relationship and meeting sustainability requirements.

The company's sustainability reporting supports these findings by highlighting the importance of supplier engagement in achieving its science-based climate targets. Company documents show that reducing Scope 3 emissions depends largely on close cooperation with suppliers responsible for the greatest share of environmental impacts. Together, the interview and documentary evidence show that supplier devel-

opment is used to improve sustainability performance while maintaining long-term supplier relationships and supply continuity.

4.1.1.3 Supplier Approval and Disqualification Criteria

Although the company prioritizes supplier development, the findings show that clear sustainability requirements must still be met before suppliers are approved or allowed to continue supplying the company. Sustainability therefore forms part of the company's overall supplier approval process alongside traditional quality requirements.

Interviewee A explained that suppliers are expected to demonstrate satisfactory environmental performance and comply with mandatory sustainability requirements. When significant environmental risks remain unresolved, suppliers may not be approved or may be removed from the supplier base. The company's supplier scorecard supports this decision-making process by identifying critical issues that prevent further supplier approval.

The findings also show that the company's ability to influence suppliers depends partly on its purchasing position. Interviewee A explained that suppliers may be less willing to invest in environmental improvements when the company represents only a small share of their total business. In these situations, the company may reduce purchasing volumes or seek alternative suppliers if sufficient progress cannot be achieved. Similarly, suppliers with poor environmental performance are not accepted when their materials could affect products carrying environmental certifications such as the Nordic Swan Ecolabel.

These findings show that the company combines collaboration with clearly defined sustainability expectations. While supplier development is the preferred approach, supplier approval continues to depend on meeting both quality and environmental requirements throughout the business relationship.

4.1.1.4 Circular Material Sourcing

The findings show that the hygiene company has expanded its sourcing activities by introducing circular material flows alongside traditional procurement. Instead of relying only on industrial suppliers, the company also recovers used paper products from customers through a closed-loop recycling system. This changes the role of sourcing by introducing secondary raw materials into the supply chain.

Interviewee B explained that maintaining the quality of recovered materials begins during collection. Customers are encouraged to use transparent collection bags so that cleaning staff can identify contamination before the materials enter the recycling process. Materials that contain unsuitable waste are separated from the recycling flow and redirected to other waste treatment methods.

The findings also show that transportation is organized to reduce the environmental impact of the reverse logistics system. According to Interviewee B, recovered materials are transported together with other recyclable materials whenever possible to maximize vehicle utilization and avoid unnecessary transport. Company documentation supports this approach by reporting that the closed-loop recycling system

reduces the carbon footprint of paper hand towels compared with conventional waste management alternatives.

Overall, the findings demonstrate that circular material sourcing depends not only on collecting used products but also on maintaining material quality and organizing efficient reverse logistics throughout the supply chain.

4.1.1.5 Recycled Material Requirements

The findings indicate that the company increasingly incorporates recycled materials into new products while maintaining established quality requirements. Sustainability considerations are therefore included in material selection and product development alongside traditional quality criteria.

Interviewee A explained that the company specifies minimum recycled material content for several products, including dispensers that contain recycled plastic. The company is also exploring new technologies to recover materials from products that have traditionally been difficult to recycle. One example is a pilot project that converts used incontinence products into raw materials through chemical recycling, allowing recovered materials to replace virgin fossil-based resources.

Company documentation also highlights the company's commitment to increasing the use of recycled materials and supporting circular resource flows as part of its broader sustainability strategy. These initiatives demonstrate that the company continues to investigate new material solutions while maintaining the quality and functionality required for its products.

Overall, the findings show that the hygiene company integrates recycled materials into its sourcing activities through both established recycling practices and the development of new recovery technologies.

4.1.2 Manufacturing Phase

4.1.2.1 Managing Recycled Materials in Production

The findings show that introducing recycled materials into production creates new quality management challenges. While recycled paper fibres can generally be incorporated into existing production processes, recycled plastics require additional process adjustments because their material properties differ from those of virgin materials.

The findings show that introducing recycled materials into production creates a quality-related challenge. While recycled paper fibres can generally be incorporated into existing production processes, recycled plastics have different material properties from virgin plastics. Interviewee A explained that recycled plastics have lower purity, which can affect product appearance and physical performance. As a result, production parameters may need to be adjusted to maintain the required product quality while increasing recycled material content. The company therefore has to balance the use of recycled materials with established requirements for product quality and manufacturing performance.

Overall, the findings indicate that the use of recycled materials requires continuous quality control to ensure that environmental improvements do not compromise product performance.

4.1.2.2 Waste Reduction through Process Control

The findings indicate that waste reduction is managed as part of the company's existing quality management practices. Rather than introducing separate environmental controls, the company uses established quality improvement methods to reduce material losses during production.

Interviewee A explained that Statistical Process Control (SPC), standardized operating procedures, and machine capability management are used to maintain stable production processes and minimize process variation. By monitoring machine performance and keeping production within predefined operating limits, the company reduces material waste while maintaining consistent product quality.

Company documentation supports these findings by stating that the organization aims to recover all production waste through either material recycling or energy recovery. Together, the interview and documentary evidence show that waste reduction is managed through existing production control processes while contributing to both quality and sustainability objectives.

4.1.2.3 Production Process Adjustments for Circular Materials

The findings show that recycled materials are processed within the company's existing production facilities rather than through separate manufacturing lines. However, the characteristics of recycled materials require modifications to existing production processes.

Interviewee B explained that recovered paper fibres are introduced into the same production line as conventional raw materials. Because recycled hand towel fibres are more difficult to separate than traditional recycled paper, additional processing is required before the fibres can be reused. The company also applies high-temperature treatment during the recycling process to remove biological contaminants and ensure that the recovered fibres meet hygiene and product quality requirements before entering production.

These findings indicate that the company adapts existing production processes to accommodate recycled materials while maintaining the quality and safety standards required for hygiene products.

4.1.2.4 Integrated Quality and Environmental Management Systems

The findings indicate that quality and environmental management are closely integrated within the company's manufacturing operations. Instead of operating separate management systems, the company increasingly combines different management standards into a single audit and monitoring process.

Interviewee A explained that quality, environmental, and energy management re-

quirements are assessed through integrated audits covering multiple ISO standards, including ISO 9001, ISO 14001, and ISO 50001. This approach reduces duplicated auditing activities while allowing different operational requirements to be reviewed through one management system.

The company's sustainability reporting supports these findings by showing that a large proportion of its production sites are certified according to internationally recognized quality, environmental, and occupational health and safety standards. These certifications demonstrate that quality and sustainability are managed through closely connected operational processes rather than separate organizational systems.

Overall, the findings show that manufacturing activities integrate sustainability into existing quality management practices through production control, waste reduction, process adjustments, and integrated management systems.

4.1.3 Product Phase

4.1.3.1 Product Design for Circularity

The findings show that the hygiene company incorporates sustainability into product design by considering recycling, material selection, and product lifecycle during the development stage. Environmental considerations are included alongside traditional quality requirements to ensure that products remain functional while supporting circular material flows.

Interviewee A explained that packaging development focuses on improving recyclability through material selection. For example, the company increasingly uses mono-material packaging because it is easier to recycle than packaging made from multiple material types. Packaging for several personal care products also contains recycled material, allowing the company to reduce the use of virgin resources while maintaining product quality.

The findings also show that sustainability challenges differ depending on the type of product. For products that require high hygiene standards, such as diapers and incontinence products, complete product reuse is not possible. Instead, the company applies a modular design approach where reusable and disposable components are separated. Interviewee A explained that the reusable outer layer can be used multiple times, while the absorbent insert remains disposable. This approach extends the useful life of part of the product without compromising hygiene or product performance.

Overall, the findings indicate that product development considers both quality and sustainability from the early design stage by selecting materials and product solutions that improve circularity while maintaining functional requirements.

4.1.3.2 Product Life Extension and Material Recovery

The findings indicate that the company applies different circular strategies depending on the characteristics of its products. While disposable products mainly focus on

material recovery, longer-life products emphasize refurbishment and life extension.

Interviewee A explained that used dispensers are collected, repaired, and returned to customers in several European markets. When refurbishment is no longer possible, dispenser components are designed to support material recycling through standardized plastic identification markings. These markings improve material sorting and increase the recovery of high-quality plastics at the end of the product's life.

The findings also show that the company is exploring additional methods for recovering valuable materials from products that have traditionally been difficult to recycle. Together, these initiatives demonstrate that product value is maintained through both refurbishment and material recovery, depending on the product's expected lifetime.

4.1.3.3 User Participation in Circular Recycling

The findings show that end-users play an important role in maintaining the quality of materials collected through the company's closed-loop recycling system. Because customers become part of the reverse supply chain, their behaviour directly influences the quality of recovered materials.

Interviewee B explained that users receive clear instructions through signs and visual guidance placed in washrooms to encourage correct waste separation. These communication activities are intended to reduce contamination and improve the quality of materials entering the recycling process. Company documentation also highlights user communication as an important element of the recycling programme, emphasizing the use of information and signage to encourage correct disposal behaviour.

The findings also show that the quality of the circular material flow depends partly on customer behaviour. Contamination during collection can reduce the quality of recovered materials and prevent them from being returned to the production process. The company therefore uses instructions, visual guidance, and collection procedures to reduce contamination. This means that maintaining product and material quality in the circular supply chain depends not only on internal processes but also on the behaviour of actors outside the company's direct control.

The findings indicate that maintaining material quality depends not only on internal production activities but also on customer participation during product disposal. As a result, user behaviour becomes an important part of the company's circular supply chain.

4.2 Telecommunications Company

4.2.1 Material Phase

4.2.1.1 Supplier Evaluation and Sustainability Requirements

The findings show that supplier evaluation is the main approach through which the telecommunications company integrates sustainability into its upstream supply

chain. Because the company operates through a global network of specialized suppliers, environmental requirements are incorporated into existing supplier management processes rather than managed separately.

Interviewee F explained that the company does not manufacture products through its own production lines but instead works with a large number of suppliers responsible for different materials, components, and subassemblies. Suppliers are evaluated using structured performance criteria covering quality, delivery, compliance, and sustainability. According to Interviewee F, suppliers receive detailed requirements before entering the supply chain and are continuously assessed through a grading system that influences future business opportunities.

The company's sustainability reporting supports these findings by stating that suppliers are expected to comply with the Code of Conduct for Business Partners as well as environmental requirements related to climate action, responsible sourcing, emissions reporting, and circularity. Environmental performance therefore forms part of supplier approval and ongoing supplier evaluation alongside traditional quality requirements.

Overall, the findings show that sustainability is incorporated into supplier evaluation through existing governance processes, allowing quality and environmental requirements to be managed together throughout the supplier relationship.

4.2.1.2 Sustainable Material Selection and Carbon Reduction

The findings indicate that sustainability is also considered during material selection. The telecommunications company increasingly evaluates materials based on both their technical performance and their environmental impact throughout the product lifecycle.

Interviewee F explained that reducing embodied carbon has become an important objective when selecting materials and suppliers. Environmental information, including emissions data and material documentation, is collected, verified, and stored to support sustainability decision-making. The company uses this information to evaluate the environmental impact of purchased materials and to monitor progress towards its long-term climate targets.

The findings also show that the introduction of lower-carbon and recycled materials creates technical challenges. Interviewees E and F explained that alternative materials, including recycled aluminium and recycled plastics, must meet the same technical requirements as conventional materials before they can be introduced. Changes in material composition may affect durability, thermal performance, or signal transmission. In particular, materials used in radio equipment must meet strict requirements because material properties can directly affect signal performance. As a result, alternative materials require extensive testing and validation before they can be used in commercial products. Sustainability improvements are therefore introduced gradually when they can be demonstrated to meet the established quality and reliability requirements.

4.2.1.3 Supplier Collaboration for Climate Performance

The findings show that the telecommunications company works closely with suppliers to improve environmental performance throughout the supply chain. Rather than relying only on supplier compliance, the company encourages long-term collaboration to support climate targets and improve sustainability performance.

Interviewee E explained that the company works with key suppliers to establish climate reduction targets aligned with international climate goals. Suppliers with significant environmental impacts are encouraged to develop emission reduction plans and improve environmental reporting. Company documents similarly state that strategic suppliers are expected to contribute to greenhouse gas reductions and increase transparency throughout the supply chain.

The findings further indicate that supplier sustainability performance cannot always be improved as quickly as the company would prefer. Some suppliers provide technically important components for which suitable alternatives are not readily available. In these situations, the company may continue working with the supplier while supporting gradual environmental improvements rather than immediately replacing the supplier. This creates a trade-off between achieving sustainability improvements quickly and maintaining access to suppliers with important technical capabilities.

Overall, the findings show that supplier collaboration plays an important role in improving environmental performance while maintaining supply continuity and product quality across a complex global supplier network.

4.2.2 Manufacturing Phase

4.2.2.1 Supplier Performance Management

The findings show that the telecommunications company manages manufacturing performance primarily through its global supplier network rather than through internal production facilities. Since manufacturing is outsourced to specialized suppliers, maintaining product quality and sustainability depends on monitoring supplier performance throughout the production process.

Interviewee F explained that the company does not operate its own production lines but relies on suppliers to manufacture different parts of its products. To maintain consistent quality, inspections and performance monitoring are carried out throughout the manufacturing process with the aim of identifying potential problems before products reach customers. According to Interviewee F, detecting problems during production is essential because failures discovered after product delivery can have significant operational and economic consequences.

The findings also show that supplier performance is monitored using standardized scorecards that include quality, delivery performance, compliance, and sustainability indicators. Interviewee F explained that suppliers are expected not only to deliver products that meet quality requirements but also to demonstrate progress towards greenhouse gas reduction targets. Company documentation supports these findings by showing that supplier audits, risk assessments, and performance reviews are used

to monitor both quality and sustainability throughout the supply chain.

Overall, the findings indicate that manufacturing performance is managed through an integrated supplier performance system where environmental requirements are monitored alongside traditional quality indicators.

4.2.2.2 Waste Reduction and Continuous Improvement

The findings indicate that reducing manufacturing waste is an important part of the company's continuous improvement activities. Material waste is viewed not only as a production loss but also as a source of unnecessary carbon emissions because resources have already been consumed during manufacturing.

Interviewee E explained that reducing waste contributes to several organizational objectives at the same time. Lower waste levels reduce production costs, inventory costs, and greenhouse gas emissions while improving overall manufacturing efficiency. Rather than treating environmental performance as a separate activity, waste reduction is managed as part of the company's existing quality improvement processes.

Company documentation also emphasizes improving operational efficiency throughout the supply chain as part of the organization's broader sustainability and Net Zero strategy. Together, the findings show that continuous improvement activities support both manufacturing performance and environmental objectives by reducing unnecessary resource consumption.

4.2.2.3 Cross-functional Quality and Sustainability Management

The findings show that the telecommunications company manages quality and sustainability through cross-functional collaboration rather than separate departmental responsibilities. Quality and environmental issues are addressed by bringing together employees with the knowledge required to solve each specific problem.

Interviewee F explained that improvement teams are formed according to the nature of the issue rather than organizational structure. Instead of assigning responsibility to a single department, specialists from different functions work together to identify problems and develop solutions. Interviewee E similarly described close collaboration between personnel responsible for different ISO management systems, explaining that quality and environmental audits are often coordinated to improve efficiency and avoid duplication.

Company documentation supports this collaborative approach by emphasizing teamwork, knowledge sharing, and integrated decision-making across the organization. The findings indicate that quality and sustainability are managed through coordinated organizational processes where different functions contribute to continuous improvement and compliance.

Overall, the findings show that the telecommunications company integrates quality and sustainability within manufacturing operations through supplier performance management, continuous improvement, and cross-functional collaboration across its global production network.

4.2.3 Product Phase

4.2.3.1 Product Design for Quality and Sustainability

The findings show that sustainability is integrated into product development while maintaining the high quality and reliability required for telecommunications equipment. Because products are expected to operate continuously for many years, environmental improvements are introduced only when they meet the same technical and quality standards as conventional solutions.

The findings show that the same challenge continues at the product level. Because telecommunications equipment must operate reliably for many years, sustainability-related material changes cannot be introduced solely on the basis of their environmental benefits. Interviewee F explained that recycled plastics used in radio equipment must undergo extensive testing because changes in material composition can affect signal transmission. The long validation process limits how quickly sustainable material alternatives can be introduced, as product reliability remains a fundamental requirement.

Company documentation supports these findings by emphasizing reliability, product performance, and long service life as key design objectives. Together, the findings show that sustainability is incorporated into product development while maintaining the quality standards expected for critical telecommunications infrastructure.

4.2.3.2 Energy Efficiency Throughout the Product Lifecycle

The findings indicate that improving energy efficiency during product use is one of the company's main sustainability priorities. Since most greenhouse gas emissions occur while telecommunications equipment is operating, reducing energy consumption has become an important part of product development.

Interviewee E explained that the operational phase represents the largest share of the product's environmental impact. To address this, the company focuses on improving both hardware and software to reduce energy consumption during operation. Interviewee G further described how products are designed to adjust their energy use according to demand, operating at full capacity when required while minimizing power consumption during periods of low activity.

Company documentation confirms that reducing energy consumption during product use is central to the company's sustainability strategy because emissions generated during operation account for most of the product's lifecycle carbon footprint. The findings therefore show that energy efficiency is integrated into product development as part of both environmental performance and long-term product quality.

4.2.3.3 Design for Circularity and Material Recovery

The findings show that circularity is also considered during product design by improving the recyclability and recoverability of materials at the end of the product's lifecycle. Rather than focusing only on product performance during use, the company also considers how products can be maintained, disassembled, and recycled

after their operational life.

Interviewees explained that Design for Environment principles are incorporated into product development to improve material selection, product durability, and end-of-life recovery. Company documentation similarly highlights requirements for material identification, ease of disassembly, and product durability to support maintenance, refurbishment, and recycling activities. These design principles also contribute to increasing the proportion of recyclable materials used throughout the product portfolio.

Overall, the findings show that the telecommunications company integrates sustainability throughout the product lifecycle by combining high product reliability with energy-efficient operation and product designs that support maintenance, recycling, and long-term resource use.

4.3 Construction Company

4.3.1 Material Phase

4.3.1.1 Supplier Selection and Sustainability Requirements

The findings show that sustainability is incorporated into supplier selection alongside traditional quality requirements. Because construction projects involve materials that remain in use for many decades, supplier selection considers both current product quality and the long-term environmental performance of construction materials.

Interviewee H explained that suppliers are evaluated not only according to cost, technical capability, and delivery performance but also based on environmental documentation, climate performance, and compliance with sustainability requirements. Materials are expected to satisfy both quality specifications and environmental standards before they are approved for use in projects.

The company's sustainability documentation supports these findings by highlighting supplier requirements related to Environmental Product Declarations (EPDs), responsible sourcing, and certified construction materials. Together, the interview and documentary evidence indicate that environmental performance forms an important part of supplier selection throughout construction projects.

Overall, the findings show that supplier selection combines quality and sustainability requirements to support long-term building performance.

4.3.1.2 Sustainable Material Selection

The findings indicate that material selection plays an important role in reducing the environmental impact of construction projects. Sustainability is considered during the planning stage by evaluating the environmental performance of alternative materials before construction begins.

Interviewee H explained that material decisions are guided by lifecycle assessments,

carbon calculations, and environmental documentation. Materials with lower climate impact are preferred when they satisfy the same technical and quality requirements as conventional alternatives. Particular attention is given to structural materials because these contribute significantly to the total carbon footprint of buildings.

The findings also show that environmental performance is evaluated throughout the design process rather than after construction has started. Company documentation similarly emphasizes climate calculations and environmental assessments during project planning to support more sustainable material choices.

The findings indicate that the use of reused and circular materials can also create challenges related to long-term quality and responsibility. Because construction projects result in buildings that remain in use for several decades, material decisions must consider durability, safety, regulatory compliance, and future performance. The use of reused materials can be limited by uncertainties concerning material history, warranties, insurance, and the possible presence of hazardous substances. As a result, the environmental benefits of reusing materials must be considered together with the need to ensure long-term building performance and compliance.

Overall, the findings indicate that material selection aims to balance quality, technical performance, and environmental impact during the early stages of project development.

4.3.1.3 Long-term Supplier Collaboration

The findings show that supplier relationships in construction are generally based on long-term collaboration rather than short-term purchasing decisions. Because projects often extend over several years and buildings remain operational for decades, maintaining stable relationships with suppliers supports both quality and sustainability objectives.

Interviewee H explained that suppliers are involved early in project planning to discuss technical solutions, environmental performance, and material availability. This collaboration allows project teams to identify opportunities for improving building performance while reducing environmental impacts before construction activities begin.

Company documentation also emphasizes collaboration with suppliers, designers, and contractors to achieve sustainability objectives throughout the project lifecycle. The findings indicate that close cooperation supports knowledge sharing, improves project planning, and facilitates the implementation of more sustainable construction solutions.

Overall, the findings show that long-term supplier collaboration contributes to both project quality and environmental performance throughout construction projects.

4.3.2 Manufacturing Phase

4.3.2.1 Project Performance and Quality Management

The findings show that quality and sustainability are managed together throughout project execution. Rather than treating environmental performance as a separate activity, project teams monitor quality, environmental requirements, cost, and project progress as part of the same management process.

Interviewee H explained that sustainability is considered during regular project meetings where teams review construction progress, technical quality, environmental targets, and compliance with project requirements. This allows project managers to identify potential issues early and coordinate improvement activities before they affect project delivery.

Company documentation supports these findings by showing that project performance is monitored using quality indicators together with environmental objectives, including climate performance, resource efficiency, and compliance with sustainability certifications. These findings indicate that sustainability forms part of the overall project management process rather than being managed independently.

Overall, the findings show that project performance is evaluated through an integrated approach that combines quality, environmental performance, and project delivery.

4.3.2.2 Preventive Planning and Continuous Improvement

The findings indicate that preventing problems during planning is considered more effective than correcting them after construction has started. As a result, quality and sustainability activities begin during the early stages of project development and continue throughout project execution.

Interviewee H explained that design reviews, technical assessments, and planning meetings are used to identify potential quality and environmental risks before construction activities begin. Early collaboration between project managers, engineers, architects, and suppliers allows the project team to improve construction solutions while reducing the need for later modifications.

The findings also show that experience gained from completed projects is transferred to future developments through continuous learning and standardized working methods. Lessons learned are discussed within project teams and incorporated into future planning activities to improve both project quality and environmental performance.

Company documentation similarly highlights continuous improvement as an important part of project management by encouraging knowledge sharing and the application of experience across different projects.

Overall, the findings indicate that preventive planning and continuous improvement support both quality and sustainability throughout the construction process.

4.3.2.3 Integrated Quality and Environmental Management

The findings show that quality and environmental management are coordinated through integrated management systems used across construction projects. Rather than operating separate systems for quality and sustainability, project teams work within common management processes that support multiple organizational objectives.

Interviewee H explained that project documentation, environmental requirements, quality controls, and regulatory compliance are managed through standardized procedures that apply throughout the construction process. Internal audits and project reviews assess both quality and environmental performance using the same management framework.

Company documentation also reports that the organization maintains certified management systems covering quality, environmental management, and occupational health and safety. These systems provide a common structure for monitoring project performance and supporting continuous improvement across construction activities.

Overall, the findings show that integrated management systems provide the operational framework for managing quality and sustainability together throughout project execution.

4.3.3 Product Phase

4.3.3.1 Building Performance Throughout the Lifecycle

The findings show that the construction company considers sustainability throughout the entire lifecycle of a building rather than focusing only on project completion. Building quality is evaluated not only by meeting technical specifications during construction but also by how well the building performs throughout its operational life.

Interviewee H explained that project decisions are made with a long-term perspective, considering future energy use, maintenance requirements, indoor environmental quality, and operational performance. Materials and technical systems are therefore selected based on their expected contribution to both building quality and environmental performance over many years.

Company documentation supports these findings by highlighting lifecycle performance as a central objective of sustainable building development. Environmental certifications, operational energy performance, and long-term building quality are monitored to ensure that projects continue to deliver value after construction has been completed.

Overall, the findings show that sustainability is integrated into project decisions by considering the long-term performance of buildings throughout their operational lifecycle.

4.3.3.2 Lifecycle Information and Building Documentation

The findings indicate that maintaining reliable project information is an important part of long-term building management. Quality and environmental documentation are preserved throughout the project to support future operation, maintenance, refurbishment, and renovation activities.

Interviewee H explained that project documentation includes technical specifications, material information, environmental declarations, and quality records that remain available after project completion. This information allows building owners and facility managers to make informed decisions throughout the building's operational life.

Company documentation similarly emphasizes the importance of Environmental Product Declarations (EPDs), material documentation, and digital project information to support sustainable asset management. The findings indicate that maintaining accurate information contributes to both long-term building quality and environmental performance.

Overall, the findings show that lifecycle documentation supports quality management by preserving reliable information for future decision-making.

4.3.3.3 Circular Construction and Future Resource Recovery

The findings show that circular economy principles are increasingly considered during building design and material selection. Rather than focusing only on the initial construction stage, project teams also consider how materials can be maintained, reused, refurbished, or recycled in the future.

Interviewee H explained that selecting durable materials and documenting their environmental characteristics improves opportunities for future renovation and resource recovery. Materials that can be disassembled and reused are preferred where project requirements allow, supporting more efficient use of resources throughout the building lifecycle.

Company documentation also highlights circular construction principles by encouraging responsible material selection, waste reduction, and improved resource efficiency during both construction and future redevelopment projects. These practices support the company's long-term sustainability objectives while maintaining the technical quality of completed buildings.

Overall, the findings indicate that circularity is considered from the early stages of project development by supporting future maintenance, refurbishment, material recovery, and efficient resource use throughout the building lifecycle.

5

Analysis

This chapter analyses how quality management and sustainability are integrated into supply chain operations across the three case companies. While Chapter 4 presented the findings from each company separately, this chapter compares the cases to identify common patterns, key differences, and the main factors that influence how this integration takes place in different industries.

The analysis is based on the theoretical framework presented in Chapter 2 and follows the three operational themes proposed by Bastas and Liyanage (2019). These themes are supplier evaluation, performance management, corrective action plans, and data quality and traceability. They represent practical activities that organizations use in their daily operations. Examining these themes makes it possible to understand how sustainability is incorporated into existing Quality Management Systems (QMS) instead of being managed as a separate function.

The purpose of this analysis is not to determine which company performs better in terms of sustainability. Instead, it focuses on understanding how differences in products, supply chains, and operational conditions influence the way quality and sustainability are integrated. To explain these differences, the findings are interpreted using the Product Time-Value Sensitivity (MVT) framework developed by Blackburn et al. (2004). According to this framework, products with a high level of time sensitivity require quick purchasing decisions, flexible supplier networks, and rapid operational responses. In contrast, products with longer life cycles allow organizations to build long-term supplier relationships, plan over longer periods, and integrate sustainability more systematically into their operations. This perspective helps explain why the companies use different approaches while working towards similar sustainability goals.

The analysis shows that all three organizations have moved beyond treating sustainability as a separate environmental initiative. Instead, sustainability has become part of their existing quality management practices. However, the way this integration is achieved differs between industries because each company operates under different business conditions and supply chain requirements. The hygiene company mainly integrates sustainability through supplier qualification, process improvement, and circular material flows to support fast and responsive operations. The telecommunications company focuses on supplier governance, compliance, and performance monitoring across a large global supplier network. In comparison, the construction company places greater emphasis on long-term supplier collaboration, lifecycle thinking, and preventive planning, reflecting the long lifespan of buildings and construction projects.

Across all three cases, quality management provides the foundation for integrating sustainability into everyday supply chain activities. Existing quality practices, such as supplier evaluations, performance measurement, audits, and continuous improvement, are expanded to include environmental and social considerations. Rather than creating separate systems for sustainability, the companies use their established quality management processes to manage quality and sustainability together.

The following sections analyse each of the three themes in detail. The first section examines how sustainability is considered during supplier evaluation and supplier development. The second section explores how organizations monitor and improve both quality and sustainability performance over time. The final section analyses how corrective action plans are used to address operational problems and support continuous improvement across the supply chain.

5.1 Supplier Evaluation

Supplier evaluation is the first stage where quality management and sustainability are integrated into supply chain operations. Traditionally, organizations selected suppliers mainly based on quality, cost, delivery reliability, and technical capability (Kaynak and Hartley, 2008). However, the findings of this study show that supplier evaluation has become broader. Along with these traditional criteria, companies now assess environmental and social performance when selecting and managing suppliers. Across all three case companies, sustainability is no longer treated as a separate purchasing requirement. Instead, it has become part of the existing supplier evaluation process. Although all three organizations follow this overall approach, they apply it differently because they operate in different industries with different products, supply chains, and operational priorities.

A common finding across the three companies is that supplier approval is no longer based only on product quality. Suppliers are also expected to meet environmental requirements, comply with regulations, and support long-term business continuity. This supports the work of Bastas and Liyanage (2018), who argue that sustainable supply chain management expands traditional quality management by including environmental and social considerations in supplier relationships. Rather than creating separate sustainability systems, organizations add these requirements to their existing supplier qualification processes.

Although the companies share this general approach, they differ in how supplier evaluation is carried out. These differences can largely be explained by Product Time-Value Sensitivity (MVT), which influences purchasing priorities and supplier relationship strategies.

The hygiene company follows a supplier evaluation approach that combines fast supplier qualification with continuous supplier development. As a company operating in the fast-moving consumer goods (FMCG) industry, it depends on a stable supply of large volumes of standardized raw materials while also working towards ambitious sustainability targets. For this reason, supplier evaluation has two main purposes. First, it ensures that suppliers meet the required quality, environmental, and ethical

standards before joining the supply chain. Second, it encourages existing suppliers to improve their sustainability performance over time.

Instead of immediately replacing suppliers that do not meet new sustainability expectations, the company first works with them to improve their performance. This reflects a move from traditional purchasing towards supplier development, which is consistent with Kaynak and Hartley (2008). They argue that quality management increasingly depends on collaboration with suppliers rather than relying only on inspections. In this case, sustainability becomes part of the continuous improvement process instead of simply being another compliance requirement.

However, collaboration has clear limits. Suppliers that fail to meet mandatory environmental or ethical requirements cannot enter or remain in the supplier base. This shows that sustainability is not only an improvement objective but also a minimum requirement for supplier approval. Environmental performance is therefore treated in the same way as other quality requirements, showing that sustainability has become part of the existing supplier qualification process.

The telecommunications company integrates sustainability differently. Unlike the hygiene company, which mainly purchases standardized raw materials, it manages a global network of highly specialized component suppliers. As a result, supplier evaluation focuses less on individual materials and more on managing the performance of suppliers across the entire supply network.

Supplier performance is monitored through formal scorecards that include quality, delivery, regulatory compliance, and sustainability indicators. This means that sustainability is assessed using the same performance management system that is already used for quality. Instead of evaluating suppliers only during the approval stage, supplier performance is monitored throughout the entire relationship.

This finding supports Seuring and Müller (2008), who explain that environmental impacts often occur upstream in global supply chains. Therefore, organizations need to extend quality management practices beyond first-tier suppliers. The telecommunications company demonstrates how sustainability depends not only on supplier selection but also on continuous monitoring and governance across an international supplier network.

Compared with the hygiene company, the telecommunications company also uses a more formal supplier management process. Supplier expectations are communicated through standardized documentation, contracts, codes of conduct, and regular performance reviews. These formal processes help ensure that quality, sustainability, and regulatory requirements are applied consistently across a large and complex supplier network. This finding agrees with Zhu et al. (2013), who argue that environmental requirements are increasingly integrated into formal procurement systems because of growing regulatory and stakeholder expectations.

The construction company represents a third approach to supplier evaluation. Compared with the other industries, construction projects have much longer product life cycles, unique project requirements, and more stable supplier relationships. As a result, supplier evaluation focuses less on rapid supplier qualification and more on

building long-term partnerships.

Because buildings remain in use for many decades, material selection has a lasting impact on maintenance needs, operational emissions, refurbishment opportunities, and overall building performance. Therefore, supplier evaluation considers not only current product quality but also the supplier's ability to contribute to long-term sustainability goals. Material certifications, environmental declarations, climate performance, and regulatory compliance become important because their effects continue throughout the building's lifecycle.

Unlike the hygiene company, where supplier flexibility is necessary to respond to changing market conditions, the construction company benefits from long-term supplier relationships. This makes it easier to introduce sustainability gradually through joint planning, collaboration, and innovation. These findings support Pagell et al. (2010), who argue that sustainable procurement often depends on strategic partnerships based on long-term cooperation and shared learning.

Comparing the three cases shows that supplier evaluation has developed from a quality control activity into a strategic process that connects quality management and sustainability. However, the role of supplier evaluation differs according to each industry's operational needs.

For the hygiene company, supplier evaluation mainly reduces operational risk while ensuring access to sustainable raw materials for high-volume production. Because products have high Time-Value Sensitivity, suppliers must respond quickly without compromising quality or sustainability. Continuous supplier development therefore becomes important for maintaining reliable supply while improving environmental performance.

For the telecommunications company, supplier evaluation mainly supports the management of a complex global supplier network. Sustainability is integrated into structured performance management systems that improve transparency, regulatory compliance, and risk management across multiple tiers of suppliers.

For the construction company, supplier evaluation mainly supports long-term lifecycle performance. Stable supplier relationships create opportunities for closer collaboration, allowing sustainability to influence material selection, building performance, and project planning from the beginning. Because products have longer life cycles, the company can invest more in supplier collaboration and innovation than industries with faster product turnover.

Overall, the findings show that supplier evaluation is an important mechanism for integrating quality management and sustainability, but its implementation depends on the operational context. While previous studies have identified supplier evaluation as a key element of sustainable supply chain management (Bastas and Liyanage, 2019; Seuring and Müller, 2008), this study shows that Product Time-Value Sensitivity influences how supplier evaluation is applied in practice. High-MVT industries prioritize rapid supplier qualification and flexibility. Medium-MVT industries focus on governance and structured performance monitoring. Low-MVT industries place greater emphasis on long-term collaboration and lifecycle value.

These differences should not be viewed as different levels of sustainability performance. Instead, they show that organizations adapt the same quality management principles to meet the needs of their own industries. Across all three cases, supplier evaluation provides the main process through which sustainability becomes part of existing Quality Management Systems. Rather than creating separate sustainability assessment systems, the companies build on their existing supplier management practices by including environmental and social performance alongside traditional quality requirements.

The comparison also shows that integrating sustainability into supplier evaluation creates trade-offs between sustainability requirements and supplier availability, technical capability, and supply continuity. In the hygiene company, suppliers may be reluctant to invest in environmental improvements when the buyer represents only a small share of their business. In such situations, the company must balance supplier development with the possibility of reducing purchases or replacing the supplier. In the telecommunications company, the challenge is different because some suppliers provide highly specialized components and cannot easily be replaced. The company may therefore continue working with a technically important supplier while allowing more time for environmental improvements. In construction, longer-term supplier relationships make collaboration easier, but material selection involves longer-term requirements related to durability, certification, and regulatory compliance. These findings show that sustainability criteria cannot be considered independently of supplier dependence and operational requirements.

5.2 Performance Management

Performance management is the process through which organizations monitor whether quality and sustainability objectives are being achieved in practice. While supplier evaluation focuses on selecting suitable suppliers, performance management ensures that suppliers, internal processes, and products continue to meet the required standards over time. Traditionally, Quality Management Systems (QMS) have measured performance using indicators such as product quality, process capability, delivery reliability, and customer satisfaction (Kaynak, 2003). However, the findings of this study show that organizations now monitor sustainability alongside these traditional quality measures. Indicators such as carbon emissions, waste reduction, circularity, and resource efficiency are increasingly included in existing performance management systems. Rather than introducing separate systems to measure sustainability, the three case companies integrate environmental objectives into their established quality management processes. This shows that sustainability has become part of daily operational management instead of being treated as a separate corporate initiative.

Across all three cases, performance management follows the principles of continuous improvement that are central to Quality Management Systems. Organizations establish performance objectives, monitor operational results, identify deviations, and implement improvement actions. This reflects the Plan–Do–Check–Act (PDCA) cycle introduced by Deming (1986) and adopted in ISO 9001. The findings indicate

that environmental performance is managed using the same approach as traditional quality performance. Carbon emissions, recycling rates, energy efficiency, supplier compliance, and material utilization are monitored alongside indicators such as defect rates, process variation, and delivery performance. As a result, sustainability becomes part of the same continuous improvement process that has traditionally been used to improve quality. Instead of creating additional management routines, organizations expand existing quality management practices to include environmental objectives.

The hygiene company provides a clear example of how sustainability can be integrated into daily operational management in a high-volume manufacturing environment. Because the company produces fast-moving consumer goods with short product life cycles, production efficiency has a direct impact on both quality performance and environmental performance. Material losses not only increase production costs but also create unnecessary waste and higher carbon emissions. For this reason, reducing waste and improving resource efficiency support both quality and sustainability objectives at the same time.

The findings show that waste reduction is mainly achieved through Statistical Process Control (SPC), standardized operating procedures, and machine capability management. These methods have traditionally been used in quality management to reduce process variation and improve product consistency (Montgomery, 2020). However, the empirical findings show that they also improve sustainability by reducing material consumption and production waste. Instead of introducing separate environmental controls, the company uses its existing quality management practices to improve environmental performance. This finding supports Florida's (1996) "Lean and Green" perspective, which suggests that eliminating operational waste can improve both economic and environmental performance.

The hygiene company also demonstrates a high level of integration through its management system. Rather than operating separate management systems for quality, environmental performance, and occupational health and safety, the company increasingly carries out integrated audits that cover several ISO standards at the same time. This approach reduces duplicated work while allowing managers to evaluate operational performance from different perspectives within a single management system. Instead of reviewing quality and sustainability separately, both areas are assessed together using the same audit process. This finding is consistent with Bernardo et al. (2015), who argue that Integrated Management Systems (IMS) improve organizational efficiency by reducing overlapping activities between ISO 9001 and ISO 14001.

Overall, the hygiene company shows that sustainability is closely linked to operational efficiency. Existing quality management tools are not replaced by new sustainability practices. Instead, they are expanded to address environmental objectives alongside traditional quality goals. In this way, continuous improvement supports better product quality while also reducing waste, improving resource efficiency, and lowering environmental impacts. The case demonstrates that in industries with high Product Time-Value Sensitivity (MVT), improvements in operational performance often create benefits for both quality and sustainability at the same time.

The telecommunications company demonstrates a different approach to performance management because of the nature of its global supply chain. Unlike the hygiene company, where manufacturing activities are the main focus, the telecommunications company depends heavily on external suppliers for production. As a result, performance management extends beyond internal operations and places greater emphasis on monitoring supplier performance throughout an international supply network.

A key finding is that supplier scorecards are the main tool used to monitor performance. These scorecards assess suppliers across several dimensions, including quality, delivery reliability, regulatory compliance, and sustainability performance. By including sustainability indicators within the same scorecards used to evaluate supplier quality, the company manages both objectives through a single performance management system. Supplier performance is therefore monitored continuously throughout the relationship rather than only during the initial qualification stage. This approach allows the company to identify performance issues early and work with suppliers to improve both quality and sustainability over time.

These findings support Seuring and Müller (2008), who argue that environmental impacts in global supply chains often occur upstream during raw material extraction, component manufacturing, and supplier operations. As a result, organizations need to extend quality management practices beyond their own facilities and monitor sustainability performance across the entire supply chain. The telecommunications company illustrates this approach by using supplier performance reviews to coordinate quality and sustainability across a large international supplier network. Rather than managing these objectives separately, both are incorporated into the same governance process.

Another important characteristic of the telecommunications company is its reliance on measurable sustainability data. Carbon emissions, circularity indicators, supplier compliance records, and environmental documentation are treated as standard performance measures alongside traditional quality indicators. Collecting and reviewing this information allows managers to monitor progress objectively while also responding to increasing regulatory and stakeholder expectations for environmental reporting. Instead of creating separate sustainability reports for operational decision-making, environmental performance becomes part of regular supplier reviews and procurement activities. This finding is consistent with Siva et al. (2016), who argue that sustainability integration is more effective when environmental indicators are included within existing organizational performance measurement systems.

Compared with the hygiene company, the telecommunications company uses a more structured and data-driven approach to performance management. This reflects the complexity of managing a global supplier network, where maintaining visibility across multiple suppliers is essential for ensuring quality, compliance, and sustainability. In this case, performance management focuses less on improving manufacturing processes and more on coordinating supplier performance across organizational boundaries.

The construction company represents a different approach because of the long lifecycle of its products. Unlike the other two industries, buildings remain in operation for many decades, meaning that performance cannot be evaluated only by the quality of construction or the successful completion of a project. Instead, performance management focuses on how well buildings continue to perform throughout their entire lifecycle.

The findings show that environmental performance is closely linked to building durability, operational efficiency, lifecycle emissions, and certification requirements. As a result, performance management extends beyond the construction phase and considers whether buildings continue to deliver environmental and functional value after they have been completed. Sustainability indicators therefore become closely connected with long-term quality performance rather than short-term project outcomes. This means that decisions made during the design and construction stages continue to influence environmental performance for many years.

This long-term perspective reflects the principles of sustainable asset management described by Bocken et al. (2014). Investing in higher-quality materials, energy-efficient building systems, and preventive maintenance may increase the complexity of a project at the beginning, but these investments reduce environmental impacts and operating costs throughout the building's lifecycle. Performance management therefore evaluates quality not only in terms of immediate project delivery but also according to the long-term value created by the building. Sustainability expands the focus of quality management from completing a successful project to ensuring that the building performs effectively over its entire operational life.

The findings also show that external certification systems play an important role in performance management within the construction company. Green building certifications and science-based climate targets provide recognized benchmarks that complement traditional quality measures. These frameworks help the company monitor environmental performance using standardized criteria while supporting continuous improvement. Rather than replacing existing quality requirements, they broaden the definition of project success by including environmental performance alongside traditional measures of quality, cost, and project delivery.

The comparison shows that combining quality and sustainability indicators does not remove the differences between these performance objectives. Quality indicators such as defects, reliability, and delivery performance are often directly linked to current operational requirements, while sustainability indicators may concern longer-term environmental outcomes. This difference becomes particularly visible across the three cases. The hygiene company needs to monitor sustainability while maintaining high-volume and responsive operations. The telecommunications company must coordinate sustainability indicators across a large international supplier network, where environmental data and supplier performance can be difficult to monitor consistently. In construction, performance is assessed over a much longer period, meaning that environmental benefits and quality outcomes may only become visible after the project has been completed. Thus, organizations need to balance immediate operational performance with longer-term sustainability objectives.

Overall, the construction company demonstrates that performance management is closely connected with lifecycle thinking. Because buildings have long operational lives, the company can evaluate quality and sustainability over an extended period and invest in improvements that provide long-term environmental and operational benefits. This differs from industries with shorter product lifecycles, where performance management is more closely linked to production efficiency and rapid operational improvements.

5.3 Corrective Action Plans (CAP)

Corrective Action Plans (CAP) are one of the core elements of Quality Management Systems (QMS). They help organizations identify problems, investigate their root causes, implement corrective measures, and prevent similar issues from occurring again. Traditionally, CAP has focused on product defects, process failures, customer complaints, and supplier quality issues through structured problem-solving and continuous improvement (ISO 9001:2015). However, the findings of this study show that corrective actions now cover a much broader range of issues. Environmental non-conformities, supplier sustainability performance, carbon reduction targets, and circular economy objectives are increasingly managed through the same corrective action plans that have traditionally been used for quality improvement. Rather than developing separate systems for sustainability, the three case companies extend their existing quality management practices to address both operational and environmental performance.

Across all three organizations, corrective actions follow the principles of continuous improvement that are central to Quality Management Systems. Deviations are identified through audits, supplier evaluations, or performance monitoring. The causes of these deviations are then investigated, improvement actions are implemented, and their effectiveness is reviewed. This process reflects the Plan–Do–Check–Act (PDCA) cycle embedded in ISO 9001 and demonstrates that sustainability is improved through structured learning and continuous improvement rather than isolated environmental initiatives. Although the overall process is similar across the three companies, the way corrective actions are applied differs according to industry characteristics and Product Time-Value Sensitivity (MVT).

The hygiene company demonstrates a highly collaborative approach to corrective actions. Instead of immediately replacing suppliers that do not meet new sustainability expectations, the company focuses on supplier development and continuous improvement. Environmental shortcomings are generally viewed as opportunities to work with suppliers and improve their capabilities rather than as automatic reasons for ending the business relationship. This reflects the company's understanding that achieving long-term sustainability goals depends on developing supplier capabilities across the supply chain instead of relying only on supplier replacement.

This finding is consistent with the supplier development literature, which suggests that collaborative improvement often creates more sustainable long-term results than purely transactional purchasing relationships (Krause et al., 2000). Rather

than focusing only on compliance, the company works with suppliers through regular communication, technical support, and the gradual introduction of cleaner production methods. As a result, sustainability becomes part of the same continuous improvement philosophy that has traditionally guided quality management.

However, collaboration has clear limits. The findings show that suppliers are expected to demonstrate both commitment and the ability to improve. If suppliers repeatedly fail to correct significant environmental issues or do not meet mandatory sustainability requirements, corrective actions become more restrictive. The company may reduce purchasing volumes or eventually remove the supplier from its supply base. This shows that environmental performance is treated in the same way as critical quality failures. Sustainability is therefore no longer considered an optional objective but has become an important requirement within supplier quality management.

Another important finding is the close connection between corrective actions and the company's circular supply chain activities. Within its closed-loop recycling system, contamination of recycled materials creates both a quality problem and a sustainability challenge. Instead of focusing only on correcting defects after production, the company increasingly addresses the causes of these problems earlier in the supply chain. Corrective actions therefore include improving waste sorting practices, encouraging customer participation, and providing clear guidance on material collection. These activities help improve the quality of recycled materials before they return to the production process.

This finding extends the traditional role of CAP beyond internal manufacturing operations. Corrective actions are no longer limited to solving problems inside the factory but also involve suppliers, logistics partners, and even customers. This broader approach supports the circular economy perspective proposed by Bocken et al. (2014), which argues that maintaining material quality across multiple product life cycles requires cooperation between different stakeholders throughout the supply chain.

Overall, the hygiene company shows that corrective actions have developed from a process for solving quality problems into a broader improvement mechanism that supports both operational performance and sustainability. Existing CAP procedures are not replaced by separate environmental processes. Instead, they are expanded to include sustainability objectives while maintaining the same structured approach to continuous improvement. This allows the company to improve supplier performance, support circular material flows, and strengthen environmental performance without creating additional management systems.

The telecommunications company demonstrates a different approach to corrective actions because of the complexity of its global supplier network. Since most manufacturing activities are carried out by external suppliers, corrective actions focus less on internal production processes and more on supplier performance and governance. When deviations are identified through supplier evaluations or performance reviews, the company initiates structured improvement plans to restore compliance with quality, delivery, and sustainability requirements.

Supplier scorecards play a central role in this process. Suppliers with unsatisfactory performance are expected to develop and implement corrective action plans that address the identified problems. Their progress is monitored over time to ensure that the required improvements are achieved. If suppliers repeatedly fail to improve, the company may reduce future business opportunities or replace them. Corrective actions therefore become an important mechanism for ensuring that quality and sustainability expectations are maintained throughout the supplier relationship rather than only during supplier qualification.

Compared with the hygiene company, the telecommunications company relies more on standardized procedures and formal governance. This reflects the challenges of managing a large international supplier network where suppliers operate in different countries and under different regulatory conditions. As suggested by Seuring and Müller (2008), sustainable supply chain management increasingly depends on governance systems that can monitor environmental performance across organizational boundaries. The telecommunications company demonstrates this by using corrective actions not only to solve operational problems but also to strengthen supplier accountability, regulatory compliance, and sustainability performance throughout the supply chain.

Another important finding is the growing role of data verification in the corrective action plan. Environmental reports, emissions data, supplier declarations, and compliance records are regularly reviewed to identify inconsistencies or missing information that require further investigation. As a result, corrective actions increasingly address the quality of sustainability data as well as the quality of products and processes. This reflects the increasing importance of reliable environmental information as organizations respond to growing stakeholder expectations and regulatory requirements related to sustainability reporting.

The construction company applies a different corrective action approach because of the long operational life of its products. Since buildings remain in use for many decades, decisions made during planning and construction can have environmental and financial consequences long after a project has been completed. For this reason, corrective actions focus more on preventing problems than on correcting them after they occur. Many improvement activities take place during project planning, material selection, and design reviews before construction begins.

This preventive approach is closely aligned with the principles of Total Quality Management (TQM), which emphasize preventing defects rather than correcting failures after they occur (Oakland, 2014). The findings show that sustainability further strengthens this preventive philosophy because decisions related to construction materials, energy systems, and building design determine much of a building's environmental performance throughout its lifecycle. As a result, corrective actions are integrated into planning activities, supplier collaboration, lifecycle assessments, and design reviews instead of relying mainly on inspections after construction has been completed.

The findings also show that long-term supplier relationships support continuous organizational learning. Because many suppliers work with the company on multiple

projects, the knowledge gained from one project can be applied to future developments. Lessons learned from previous corrective actions are incorporated into procurement decisions, design standards, and sustainability requirements. In this way, corrective actions improve not only the current project but also the organization's capabilities over time. This demonstrates that CAP contributes to long-term learning and continuous improvement rather than simply solving individual operational problems.

Comparing the three companies reveals several common patterns. First, corrective actions are no longer limited to traditional quality problems such as product defects or process failures. Environmental non-conformities, supplier sustainability performance, carbon reduction targets, and circular economy objectives now trigger the same structured improvement processes used for quality management. This supports the findings of Siva et al. (2016), who argue that sustainability is more effectively managed when environmental issues are incorporated into existing management systems rather than handled separately.

Second, all three organizations place greater emphasis on preventing problems instead of only correcting them after they occur. Corrective actions increasingly focus on identifying the root causes of quality and sustainability issues and eliminating them before they affect future performance. Whether through supplier development, governance systems, preventive planning, or improved stakeholder collaboration, the companies use CAP to strengthen both operational performance and sustainability. This reflects the continuous improvement philosophy that forms the foundation of modern Quality Management Systems.

Although the companies share these common principles, the implementation of corrective actions differs according to Product Time-Value Sensitivity (MVT). In the hygiene company, which represents a high-MVT industry, corrective actions focus on improving supplier performance while maintaining production continuity. Because production depends on a reliable supply of raw materials, developing existing suppliers is often more effective than replacing them. Corrective actions therefore balance operational responsiveness with long-term environmental improvement.

The telecommunications company represents a medium-MVT industry, where corrective actions primarily strengthen governance across a complex international supplier network. Standardized procedures, supplier scorecards, and structured improvement programmes ensure that quality, sustainability, and compliance requirements are applied consistently across multiple suppliers and countries. In this context, corrective actions mainly support supply chain transparency, accountability, and regulatory compliance.

The construction company represents the lowest level of Product Time-Value Sensitivity. Because buildings have long operational lifecycles, corrective actions focus on preventive planning, lifecycle thinking, and continuous organizational learning. Sustainability is therefore integrated into project planning, supplier collaboration, and design decisions rather than relying on rapid corrective interventions after construction has started.

The findings also show that corrective actions can become more complex when

sustainability issues are added to traditional quality problems. In the hygiene company, corrective actions may require supplier development rather than immediate supplier replacement because maintaining supply continuity is important. In the telecommunications company, corrective actions often depend on cooperation with suppliers across different countries and organizational contexts, which can make implementation and follow-up more complex. In construction, many sustainability-related decisions need to be addressed before problems occur because changes after construction can be costly and difficult to implement. Corrective action therefore involves a balance between immediate problem solving, preventive planning, supplier relationships, and long-term sustainability objectives.

Overall, the findings show that Corrective Action Plans have developed into one of the main mechanisms for integrating sustainability into Quality Management Systems. Environmental issues are increasingly managed using the same structured problem-solving methods that have traditionally been used to improve quality. This enables organizations to improve operational performance and sustainability at the same time without creating separate management systems. The comparison of the three cases also shows that while the principles of CAP remain consistent across industries, their practical implementation depends on product lifecycle characteristics and operational context. Product Time-Value Sensitivity provides a useful explanation for these differences by showing how organizations adapt the same quality management principles to meet the specific requirements of their industries while pursuing the shared goal of integrating quality management and sustainability throughout the supply chain.

5.4 Data Quality and Traceability Systems

Data quality and traceability have become increasingly important for integrating quality management and sustainability within modern supply chains. Traditionally, Quality Management Systems (QMS) have used traceability, document control, and process verification to ensure product quality, regulatory compliance, and consistent operations. However, the findings of this study show that traceability now covers much more than product quality. Organizations increasingly collect and manage environmental information throughout the product lifecycle, including supplier sustainability performance, carbon emissions, recycled material content, lifecycle data, and circular material flows. Rather than developing separate systems for sustainability information, the three case companies extend their existing quality management systems to ensure that environmental data is accurate, consistent, and traceable. This allows sustainability information to support operational decision-making in the same way as traditional quality data.

This finding supports the integration perspective proposed by Siva et al. (2016), who argue that quality management provides the organizational structure needed to support sustainability initiatives. Collecting environmental information alone is not enough. Organizations must also ensure that the data is reliable, standardized, and available throughout the supply chain. Without accurate information, companies cannot evaluate supplier performance, monitor environmental targets, or demon-

strate compliance with increasingly demanding reporting requirements. Therefore, high-quality data is not simply an administrative requirement but an important condition for successfully integrating sustainability into supply chain management.

The hygiene company demonstrates how traceability supports sustainability within a circular supply chain. Unlike traditional linear supply chains, where raw materials are purchased from certified suppliers, the company's recycling system introduces a different material flow in which end-users become suppliers of secondary raw materials. As a result, traceability extends beyond monitoring supplier production processes and also includes the collection, transportation, and recycling of recovered materials. Maintaining material quality throughout these activities becomes essential for both product quality and environmental performance.

The findings show that the company manages this challenge through standardized collection procedures, visual inspections, and process controls that ensure recycled materials meet the required quality standards before entering production. These activities extend traditional quality traceability beyond manufacturing and into reverse logistics. Instead of monitoring material quality only during production, the company follows materials throughout the circular supply chain. This approach supports the circular economy framework proposed by Bocken et al. (2014), which emphasizes that maintaining material value across multiple product life cycles requires continuous information sharing between all participants in the recovery process.

Another important finding is that traceability helps the company verify the environmental benefits of its circular initiatives. The organization monitors recycled material content, evaluates alternative raw materials, and uses Life Cycle Assessment (LCA) to measure the environmental impact of recycled materials. These measurements provide evidence that environmental improvements are achieved while maintaining product quality. Reliable data therefore supports both operational decision-making and long-term sustainability objectives.

Overall, the hygiene company demonstrates that data quality and traceability have become essential for managing circular supply chains. Existing quality management systems are expanded to monitor environmental information alongside traditional quality data. This allows the company to maintain product quality, improve resource efficiency, and verify the environmental performance of recycled materials through a single, integrated information system.

The telecommunications company demonstrates the highest level of formalization in managing data quality and traceability among the three case companies. Because it operates through a large global supplier network, the company depends heavily on standardized documentation and supplier reporting to monitor sustainability performance. Environmental information, including carbon emissions, supplier compliance records, responsible sourcing data, and circularity indicators, is integrated into procurement processes and supplier management systems. This allows managers to evaluate quality and sustainability using the same information infrastructure.

The extensive use of data reflects the complexity of global electronics supply chains. Unlike organizations that mainly monitor internal manufacturing processes, the telecommunications company depends on information provided by suppliers across

different countries and organizational levels. As a result, the quality of sustainability data becomes as important as the quality of the products themselves. Supplier declarations, audit reports, compliance documents, and environmental disclosures all become essential sources of information for monitoring supplier performance and supporting decision-making.

The findings also show that traceability plays an important role in risk management. Reliable supplier information allows the company to identify environmental risks, verify compliance with internal requirements, and monitor progress towards sustainability objectives. This finding supports Seuring and Müller (2008), who argue that transparency across the supply chain is essential for sustainable supply chain management. The case demonstrates that high-quality information supports not only operational quality but also environmental governance and supplier accountability across a complex international network.

Compared with the hygiene and telecommunications companies, the construction company applies traceability from a long-term lifecycle perspective. Buildings remain in operation for many decades, meaning that quality and environmental information must remain available long after construction has been completed. Material specifications, Environmental Product Declarations (EPDs), certification documents, and building performance records therefore become important sources of information throughout the building's lifecycle.

Rather than supporting rapid production decisions, traceability enables informed decision-making during maintenance, refurbishment, renovation, and eventual demolition. Reliable documentation helps future stakeholders understand the environmental characteristics of construction materials and supports decisions related to reuse, recycling, or replacement. In this way, traceability contributes directly to circular construction by preserving information that allows materials to be managed more effectively throughout the building's life.

The findings also show that sustainability information has become an important addition to traditional quality documentation. Historically, construction records focused mainly on structural quality, technical specifications, and regulatory compliance. However, environmental information is now given similar importance because organizations increasingly need to monitor lifecycle carbon emissions, green building certifications, and long-term environmental performance. As a result, traceability systems now support both quality assurance and sustainable asset management.

Comparing the three companies reveals several common patterns. First, traceability has expanded beyond its traditional role of ensuring product quality and regulatory compliance. The companies now collect environmental, social, and circular economy information alongside traditional quality records. This shows that sustainability requires the same level of documentation, standardization, and process control that has traditionally supported quality management.

Second, the findings demonstrate that data quality is essential for effective decision-making. Organizations cannot monitor carbon emissions, recycled material use, supplier sustainability performance, or other environmental objectives without reliable and standardized information. Existing quality management practices, including

document control, auditing, verification, and standardized reporting, provide the structure needed to ensure that sustainability information is accurate, consistent, and comparable over time. Instead of creating new information systems, the companies strengthen their existing quality management processes to support both quality and sustainability.

The comparative analysis also shows that Product Time-Value Sensitivity (MVT) influences how traceability is applied in different industries. In the hygiene company, which represents a high-MVT industry, traceability focuses on maintaining material quality within fast-moving circular material flows while supporting quick operational decisions. The telecommunications company represents a medium-MVT industry, where traceability mainly improves transparency across a complex international supplier network through standardized documentation and reporting. In contrast, the construction company represents a low-MVT industry, where traceability focuses on preserving information that supports lifecycle management over many decades.

These findings extend the existing literature by showing that traceability should no longer be viewed only as a quality assurance tool. Instead, it has become an important mechanism for integrating quality management and sustainability within supply chain operations. As organizations increasingly adopt circular economy practices and respond to growing ESG reporting requirements, reliable information becomes essential for supporting both operational performance and environmental credibility. Rather than developing separate sustainability databases, the three case companies demonstrate that existing Quality Management Systems provide a strong foundation for managing environmental information alongside traditional quality data.

The findings also indicate that integrating sustainability into existing data and traceability systems creates challenges related to the availability, consistency, and verification of information. This is particularly evident in the telecommunications company, where sustainability information must be collected from a large and geographically distributed supplier network. Supplier declarations, environmental reports, compliance records, and emissions data may come from different sources and therefore require verification. In the hygiene company's circular supply chain, traceability also depends on the quality of materials collected from customers, making information and material quality partly dependent on actors outside the company's direct control. In construction, the challenge is maintaining reliable material and environmental information over a much longer period. These differences show that data quality is not only a supporting mechanism for integration but also a practical challenge that organizations need to manage.

Overall, the findings suggest that data quality and traceability support all the analytical themes discussed in this chapter. Supplier evaluation depends on reliable sustainability information when selecting and developing suppliers. Performance management requires accurate environmental data to monitor progress and measure improvement. Corrective Action Plans rely on trustworthy information to identify the root causes of operational and environmental problems. Together, these findings show that traceability provides the information foundation that allows quality management and sustainability to be integrated consistently throughout supply chain

operations.

5.5 Cross-case Synthesis

The cross-case analysis shows that although the three case companies operate in different industries with different products, supply chain structures, and sustainability challenges, they share a common approach to integrating sustainability into Quality Management Systems (QMS). Rather than developing separate sustainability management systems, all three companies build on their existing quality management practices to support environmental and social objectives. Supplier evaluation, performance management, corrective action plans, and data quality and traceability work together as complementary mechanisms that integrate sustainability into everyday supply chain activities.

This finding supports previous research suggesting that quality management and sustainability should be viewed as complementary rather than separate management approaches (Bastas and Liyanage, 2018). Across all three organizations, sustainability is managed through existing quality management practices, including supplier audits, performance measurement, continuous improvement, corrective actions, and integrated management systems. Instead of replacing traditional quality management, sustainability expands its scope by including environmental and social performance alongside traditional quality objectives.

Although the companies follow similar quality management principles, the findings show that they apply these principles differently depending on their operational context. Product Time-Value Sensitivity (MVT) provides a useful explanation for these differences and represents one of the main theoretical contributions of this study. Previous research has established that quality management supports sustainability, but less attention has been given to how product characteristics influence the way this integration is implemented. The findings suggest that MVT helps explain why organizations adopt different approaches while working towards similar sustainability goals.

The hygiene company, representing a high-MVT industry, prioritizes speed, flexibility, and operational responsiveness. Because production depends on a continuous supply of materials and products have relatively short lifecycles, quality and sustainability are integrated through rapid supplier qualification, continuous supplier development, waste reduction, and efficient circular material flows. In this context, environmental improvements must support operational efficiency without disrupting production. As a result, sustainability becomes closely linked to lean operations and continuous improvement.

The telecommunications company represents a medium-MVT industry, where products require long operational reliability while the supply chain is globally distributed and technologically complex. In this case, sustainability integration focuses on governance, transparency, and supplier coordination. Supplier evaluation, performance management, corrective actions, and traceability systems are used to monitor quality and sustainability across multiple suppliers and organizational boundaries. Rather

than emphasizing manufacturing efficiency alone, the company prioritizes structured management systems that improve visibility, regulatory compliance, and supplier accountability throughout the supply chain.

The construction company, representing a low-MVT industry, follows a different integration strategy because of the long lifecycle of its products. Since buildings remain in operation for many decades, sustainability is integrated through lifecycle planning, preventive management, long-term supplier collaboration, and continuous organizational learning. Decisions made during design and construction affect environmental performance throughout the building's operational life. As a result, quality management and sustainability are closely connected through long-term planning, durable asset performance, and lifecycle thinking.

Together, these findings show that Product Time-Value Sensitivity influences not only supply chain design but also the way quality management and sustainability are integrated. High-MVT industries emphasize operational flexibility and fast decision-making. Medium-MVT industries focus on governance, coordination, and transparency across complex supplier networks. Low-MVT industries prioritize long-term value creation, preventive planning, and lifecycle optimization. Although these operational priorities differ, all three companies rely on the same quality management principles, including continuous improvement, standardized processes, evidence-based decision-making, supplier collaboration, and systematic problem-solving.

Another important finding is that the role of Quality Management Systems has expanded. Traditionally, QMS focused on product quality, customer satisfaction, and process control. The findings of this study suggest that QMS now plays a broader strategic role by supporting multiple organizational objectives at the same time. Environmental performance, carbon reduction, circular economy initiatives, supplier responsibility, and regulatory compliance are increasingly managed through existing quality management processes rather than through separate sustainability systems. This demonstrates how QMS has evolved from a quality assurance tool into a broader management platform that supports sustainable business development.

The analysis also shows that successful sustainability integration depends less on introducing new management tools and more on adapting existing organizational capabilities. Across all three companies, sustainability is incorporated into familiar quality management activities rather than supported by completely new organizational structures (Siva et al., 2016). Supplier audits include environmental criteria, performance measurement systems monitor sustainability indicators, corrective action plans address environmental issues, and traceability systems capture lifecycle information alongside traditional quality records. These findings suggest that organizations can strengthen sustainability performance by building on established quality management practices instead of creating parallel management systems.

From a managerial perspective, the findings indicate that organizations should avoid applying the same sustainability approach across different industries without considering their operational context. Although the four integration mechanisms identified in this study are relevant across all three cases, their implementation should reflect

product characteristics and supply chain requirements. High-MVT industries benefit from flexible supplier development and rapid process improvement. Medium-MVT industries require strong governance, standardized reporting, and transparent supplier performance management. Low-MVT industries gain greater benefits from long-term supplier collaboration, preventive planning, and lifecycle management. Managers should therefore view sustainability integration as an extension of existing quality management practices that must be adapted to the needs of their industry.

Overall, the cross-case synthesis shows that integrating quality management and sustainability involves both common principles and industry-specific practices. Continuous improvement, supplier collaboration, standardized performance measurement, and evidence-based decision-making provide a common foundation across all three organizations. At the same time, the way these principles are applied depends on product lifecycle characteristics and Product Time-Value Sensitivity. By introducing MVT as an explanatory perspective, this study extends existing research on sustainable quality management and provides a clearer understanding of why organizations use different integration strategies while pursuing similar sustainability objectives.

The findings presented in this chapter provide the basis for answering the research questions introduced in Chapter 1. Building on the cross-case analysis, the next chapter discusses the theoretical and practical implications of the findings, outlines the limitations of the study, and suggests directions for future research.

6

Discussion and Conclusion

This study aimed to investigate how quality management and sustainability are integrated within supply chain operations and how this integration differs across industries with different levels of Product Time-Value Sensitivity (MVT). Using a comparative multiple-case study of a hygiene company, a telecommunications company, and a construction company, the findings show that sustainability is increasingly incorporated into existing Quality Management Systems (QMS) rather than being managed through separate organizational structures. Although the three companies operate in different industries with different operational conditions, they share a common approach by using established quality management practices to support sustainability. At the same time, the study shows that the way these practices are applied depends on product characteristics, supply chain complexity, and product lifecycle requirements.

This chapter discusses the findings in relation to the literature and the theoretical framework presented in Chapter 2. It explains how the findings answer the research questions, highlights the study's theoretical contributions, and discusses the practical implications for organizations seeking to integrate sustainability into quality management.

6.1 Integration of Quality Management and Sustainability within Supply Chain Operations

One of the main findings of this study is that Quality Management Systems provide the operational foundation for integrating sustainability into supply chain operations. Instead of creating separate sustainability management systems, all three case companies incorporate environmental and social objectives into existing quality management practices, including supplier audits, performance measurement, continuous improvement, corrective actions, and standardized operating procedures. This shows that sustainability is managed through familiar organizational processes rather than through independent structures.

This finding supports previous research suggesting that Quality Management Systems provide an effective platform for sustainability integration (Siva et al., 2016; Bastas and Liyanage, 2018). Traditionally, quality management has focused on process control, customer satisfaction, evidence-based decision-making, and continuous improvement. The findings of this study suggest that these same principles can also support environmental and social objectives. Rather than replacing quality

management, sustainability extends its scope by broadening the definition of organizational performance to include environmental and social outcomes alongside traditional quality objectives.

The findings also show that integration takes place throughout the supply chain rather than only within internal operations. Sustainability considerations influence supplier selection, supplier development, manufacturing activities, product design, reverse logistics, and lifecycle management. This supports the sustainable supply chain management perspective proposed by Seuring and Müller (2008), which argues that environmental performance depends on effective coordination across organizational boundaries. In this study, quality management extends beyond internal process control and becomes a mechanism for coordinating sustainability throughout the supply chain.

Another important finding is the changing role of quality itself. Traditionally, quality has been associated with meeting customer requirements, product conformity, and process consistency. However, the findings suggest that organizations increasingly define quality more broadly by including environmental responsibility, resource efficiency, circularity, and lifecycle performance. This indicates that sustainability is no longer viewed as a separate organizational objective but as an important aspect of delivering high-quality products, processes, and supplier relationships.

The results also demonstrate that integrating sustainability into existing Quality Management Systems offers practical advantages for organizations. Instead of introducing new management structures, companies build on processes that employees already understand and use in their daily work. Supplier evaluations, performance reviews, corrective action procedures, and traceability systems are expanded to include environmental and social considerations without changing their overall purpose. This allows organizations to manage quality and sustainability together while reducing unnecessary duplication of activities and management systems.

Although the three case companies apply these practices differently, they all demonstrate the same underlying principle. Sustainability is integrated by extending existing quality management routines rather than replacing them with separate sustainability initiatives. This suggests that mature Quality Management Systems provide organizations with a strong foundation for responding to increasing environmental expectations while maintaining operational efficiency and continuous improvement.

Overall, the findings reinforce the view that quality management and sustainability should not be considered separate management philosophies. Instead, they complement one another by using the same organizational principles to achieve broader operational objectives. Continuous improvement, standardized processes, evidence-based decision-making, and supplier collaboration support not only product quality but also environmental and social performance. The findings therefore strengthen the argument that Quality Management Systems can play a central role in supporting sustainable supply chain management across different industries.

6.2 Integration Challenges and Trade-offs

Addressing the second research question, the findings show that integrating quality management and sustainability is not always a straightforward process. Instead, organizations must continuously balance environmental ambitions with established quality requirements. Across all three case companies, managers described situations where sustainability initiatives introduced new operational and technical challenges that required careful decision-making. These findings support Hahn et al. (2010), who argue that organizations frequently face trade-offs between economic, environmental, and social objectives, as well as Wu and Pagell (2011), who emphasize that sustainable supply chain decisions often involve balancing competing priorities rather than optimizing a single objective.

One of the main challenges identified in this study concerns the use of recycled and alternative materials. While these materials contribute to sustainability objectives, they may not always perform in the same way as conventional materials. This creates tensions with established quality requirements related to reliability, functionality, and product performance (Gimenez and Tachizawa, 2012). The telecommunications company provides a clear example of this challenge. The findings show that recycled plastics are being introduced into radio equipment; however, any change in material composition must first satisfy strict technical requirements because the material directly affects signal transmission. As a result, new materials undergo extensive testing and validation before they can be implemented in commercial products. These findings indicate that sustainability initiatives are introduced gradually to ensure that product reliability and performance are maintained.

A similar challenge was observed in the hygiene company, where increasing the use of recycled plastics required adjustments to existing production processes. The findings showed that recycled materials differed from virgin materials in terms of purity and consistency, which could influence both product appearance and physical performance. To address these challenges, production parameters were adjusted to maintain the required quality while increasing recycled material content. This illustrates that achieving sustainability objectives often depends not only on introducing new materials but also on adapting manufacturing processes to maintain consistent product quality. These observations are consistent with Bastas and Liyanage (2018), who argue that environmental objectives may create tensions with traditional quality measures such as defect rates, product consistency, and production efficiency.

The construction company demonstrates a different type of integration challenge. Because buildings remain in use for several decades, decisions regarding recycled or reused materials must also consider long-term quality, safety, and regulatory requirements. The findings indicate that uncertainty regarding warranties, insurance, material history, and potential hazardous substances may limit the use of reused construction materials. In this context, managers must balance the environmental benefits of extending material lifecycles with the responsibility to ensure long-term structural performance and regulatory compliance. This reflects the circular economy perspective proposed by Bocken et al. (2014), where slowing resource loops contributes to sustainability but requires careful management to maintain product

quality and long-term performance.

Across all three case companies, the findings suggest that quality requirements continue to provide the baseline for operational decision-making. Sustainability initiatives are not implemented at the expense of product safety, functionality, or reliability. Instead, organizations seek ways to achieve environmental improvements while maintaining established quality standards. This often involves adapting production processes, extending material validation activities, strengthening supplier collaboration, or introducing additional quality controls before sustainable alternatives are implemented.

These findings also provide a broader insight into the relationship between quality management and sustainability. Rather than representing competing management approaches, the findings suggest that quality management provides the operational discipline needed to implement sustainability in a controlled and systematic way. Existing quality management practices—including testing, validation, supplier development, process control, and continuous improvement—allow organizations to introduce sustainability initiatives while reducing operational risks. This supports Carter and Rogers' (2008) argument that sustainability becomes more effective when it is integrated into existing operational processes rather than managed as a separate organizational initiative.

6.3 The Influence of Product Time-Value Sensitivity

Although all three case companies integrate sustainability into their Quality Management Systems, the findings show that they do so in different ways. The comparative analysis suggests that these differences can largely be explained by Product Time-Value Sensitivity (MVT). This represents one of the main theoretical contributions of the study. While previous research has examined the relationship between quality management and sustainability, less attention has been given to how product characteristics influence the practical implementation of this integration. The findings indicate that MVT provides a useful perspective for understanding why organizations adopt different approaches while pursuing similar sustainability objectives.

The hygiene company represents a high-MVT industry, where products have short lifecycles and production depends on a continuous flow of materials. Under these conditions, sustainability initiatives need to be implemented without reducing production speed or operational flexibility. As a result, the company focuses on rapid supplier qualification, supplier development, waste reduction, and efficient circular material flows. Improving resource efficiency not only supports environmental objectives but also improves production performance by reducing material waste and increasing process efficiency. This shows that sustainability and operational performance can be improved simultaneously when environmental initiatives are closely connected to existing quality management practices.

The telecommunications company represents a medium-MVT industry. Although its products are expected to perform reliably over a long period, the company operates in a rapidly changing technological environment with a complex global supplier network. Consequently, sustainability integration focuses less on internal production processes and more on supplier governance, standardized performance measurement, and traceability. These management practices improve visibility across the supply chain and help ensure that quality, environmental requirements, and regulatory standards are consistently applied throughout the supplier network. In this context, sustainability depends on effective coordination and information sharing across multiple organizational boundaries.

The construction company represents a low-MVT industry, where products remain in use for many decades. Because of these long product lifecycles, organizations can adopt a much longer planning horizon when integrating sustainability into their operations. The findings show that sustainability is mainly supported through lifecycle planning, preventive management, careful material selection, and long-term collaboration with suppliers. Rather than focusing on rapid operational improvements, the company emphasizes decisions that improve building performance and reduce environmental impacts throughout the asset's entire lifecycle.

These findings extend Blackburn et al.'s (2004) Product Time-Value Sensitivity framework beyond its original application in supply chain design. Previous studies mainly used the framework to explain differences in logistics, inventory management, and operational responsiveness. The findings of this study suggest that MVT also influences how organizations design and apply their management systems. Product characteristics shape not only operational decisions but also the mechanisms used to integrate sustainability into Quality Management Systems. This provides a broader understanding of how operational context influences sustainability integration across different industries.

6.4 Theoretical Contributions

The findings of this study suggest that the integration of quality management and sustainability cannot be understood independently of the operational context in which organizations operate. While previous research has emphasized the benefits of integrated management systems (Siva et al., 2016) and the importance of buyer power in Sustainable Supply Chain Management (Touboulic et al., 2014), the empirical findings indicate that both management system integration and supplier relationships are influenced by product characteristics, operational requirements, and supply chain context.

Previous studies generally argue that integrating Quality Management Systems (QMS) and Environmental Management Systems (EMS) reduces administrative duplication and improves organizational coordination (Siva et al., 2016). The findings of this study support this argument in the hygiene company, where multiple ISO standards are integrated into a common management system to support continuous, high-volume production. However, the telecommunications and construction

companies demonstrate that formal integration is not always considered the most appropriate solution. Instead, these organizations rely on shared quality management practices, cross-functional collaboration, and common improvement methods while maintaining greater flexibility in how quality and sustainability are managed. This suggests that successful integration depends less on the formal combination of management system standards and more on how organizations apply quality management practices within their operational context.

The findings also extend previous research on power relationships within sustainable supply chains. Touboulic et al. (2014) argue that powerful buying organizations can encourage sustainability improvements by imposing supplier requirements and monitoring compliance. While this perspective is supported by the findings, the study also shows that the ability to influence suppliers depends on the technical characteristics of the products being supplied. In the telecommunications company, highly specialized components and strict technical performance requirements reduce the organization's flexibility to replace suppliers or rapidly introduce alternative materials. Similarly, the construction company depends on long-term collaboration with contractors and material suppliers because technical expertise, warranties, and long-term asset performance create strong interdependencies between supply chain partners. In these contexts, collaboration becomes more important than coercive supplier management.

Together, these findings suggest that Product Time-Value Sensitivity and product characteristics influence not only operational decisions but also how organizations integrate quality management and sustainability throughout the supply chain. Industries characterized by short product lifecycles and standardized production benefit from greater management system integration and standardized operational processes. In contrast, industries producing highly specialized or long-lifecycle products require greater flexibility, long-term collaboration, and context-specific management practices. This extends existing literature by demonstrating that operational context influences both management system design and supplier governance when organizations seek to integrate quality management and sustainability.

The findings therefore contribute to theory by suggesting that quality management and sustainability should not be viewed as universally applicable management models. Instead, their integration should be understood as context dependent, where product characteristics, lifecycle requirements, and operational conditions shape how organizations apply management systems, collaborate with suppliers, and balance quality and sustainability objectives across the supply chain.

6.5 Management Practices for Integrating Quality Management and Sustainability

The findings of this study identified four management practices that consistently support the integration of quality management and sustainability across the three case companies: supplier evaluation, performance management, corrective action plans, and data quality and traceability systems. Although these mechanisms are

applied differently depending on the operational context, together they provide a practical framework for embedding sustainability into everyday supply chain operations.

The findings show that organizations integrate sustainability primarily by expanding existing quality management practices rather than introducing separate sustainability management systems. Supplier evaluation incorporates environmental and social requirements, performance management combines quality and sustainability indicators, corrective action plans address both operational and environmental issues, and data quality and traceability provide reliable information to support decision-making across the supply chain. Together, these mechanisms enable organizations to coordinate quality and sustainability through established Quality Management Systems.

From a managerial perspective, the findings suggest that organizations should build on existing quality management capabilities when implementing sustainability initiatives. Rather than adopting a universal approach, managers should adapt these mechanisms to the characteristics of their products and supply chains. The findings also highlight the importance of reliable sustainability data and traceability for supporting supplier management, regulatory compliance, and continuous improvement. Overall, embedding sustainability into existing quality management processes allows organizations to improve operational performance while responding more effectively to increasing environmental and stakeholder expectations.

6.6 Limitations and Future Research

As with any research, this study has several limitations that should be considered when interpreting the findings.

First, the study is based on a multiple-case study of three organizations. Although this approach provides rich insights into how quality management and sustainability are integrated in different industries, the findings are intended for analytical rather than statistical generalization. The results provide an in-depth understanding of the integration process, but they cannot be assumed to represent all industries or organizations. Future research involving a larger number of companies from different sectors would help evaluate whether the patterns identified in this study are observed more broadly.

Second, this research adopts a qualitative approach based mainly on interviews and document analysis. This method was appropriate for exploring how organizations integrate quality management and sustainability and for understanding the reasoning behind management practices. However, future studies could complement these findings with quantitative research, such as surveys or statistical analyses, to examine whether the four management practices identified in this study are consistently applied across larger groups of organizations. Combining qualitative and quantitative methods could also provide a more comprehensive understanding of sustainability integration.

Another limitation is that the study mainly focuses on the environmental dimension of sustainability. Although environmental performance was highly relevant across

all three case companies, sustainability also includes important social and economic dimensions. Future research could examine how issues such as labour conditions, human rights, diversity, employee well-being, and responsible sourcing are integrated into Quality Management Systems through similar management practices. Such studies would provide a broader understanding of sustainability integration within supply chain operations.

Finally, the relationship between Product Time-Value Sensitivity (MVT) and sustainability integration requires further investigation. The findings suggest that MVT influences how organizations implement quality management practices to support sustainability, but this relationship has only been explored across three industries. Future studies could test the proposed framework in other industrial contexts with different product characteristics and supply chain structures. This would help refine the theoretical framework developed in this research and further evaluate its applicability across a wider range of industries.

6.7 Conclusion

This study examined how quality management and sustainability are integrated within supply chain operations by comparing three companies operating in different industries. The findings show that sustainability is increasingly incorporated into existing Quality Management Systems through established management practices rather than through separate sustainability initiatives. Supplier evaluation, performance management, corrective action plans, and data quality and traceability systems were identified as the main mechanisms supporting this integration across all three case companies.

Although the same management practices were observed in each organization, their implementation differed according to Product Time-Value Sensitivity, product lifecycle characteristics, and supply chain context. The hygiene company emphasized operational responsiveness and supplier development, the telecommunications company focused on governance and supply chain transparency, while the construction company prioritized lifecycle planning and long-term collaboration. These differences demonstrate that organizations pursue similar sustainability objectives while adapting their quality management practices to the operational requirements of their industries.

The findings also show that Quality Management Systems provide a strong foundation for integrating sustainability into everyday supply chain operations. Instead of introducing completely new management structures, organizations can strengthen environmental performance by expanding existing quality management practices. This approach allows sustainability to become part of routine operational activities while maintaining the principles of continuous improvement, evidence-based decision-making, supplier collaboration, and standardized management.

From a theoretical perspective, the study contributes to the literature by providing empirical evidence that quality management and sustainability are complementary management approaches. It also identifies four operational mechanisms that sup-

port this integration and extends the Product Time-Value Sensitivity framework by demonstrating its influence on the implementation of management systems. These contributions provide a deeper understanding of how organizations integrate sustainability into Quality Management Systems across different industrial contexts.

From a practical perspective, the findings suggest that organizations can achieve sustainability objectives more effectively by building on mature quality management practices instead of creating separate sustainability systems. At the same time, managers should recognize that the implementation of these practices should reflect the characteristics of their products, supply chains, and operational environment rather than following a single approach for every industry.

Overall, this study demonstrates that quality management can serve as the operational foundation for sustainable supply chain management. As organizations face increasing expectations to improve both quality and sustainability performance, integrating these two management approaches provides a practical and structured way to support long-term operational excellence, environmental responsibility, and sustainable business development.

Bibliography

[1] Akao, Y. (1990). *Quality function deployment: Integrating customer requirements into product design*. Productivity Press.

[2] Alvesson, M. (2003). Beyond neopositivists, romantics, and localists: A reflexive approach to interviews in organizational research. *Academy of Management Review*, 28(1), 13–33.

[3] Bastas, A., and Liyanage, K. (2018). Sustainable supply chain quality management: A systematic review. *Journal of Cleaner Production*, 181, 726–744.

[4] Bastas, A., and Liyanage, K. (2019). Integrated quality and supply chain management business diagnostics for organizational sustainability. *Sustainable Production and Consumption*, 17, 11–30.

[5] Bernardo, M., Simon, A., Tarí, J. J., and Molina-Azorín, J. F. (2015). Benefits of management systems integration: A literature review. *Journal of Cleaner Production*, 94, 260–267.

[6] Blackburn, J. D., Guide, V. D. R., Jr., Souza, G. C., and Van Wassenhove, L. N. (2004). Reverse supply chains for commercial returns. *California Management Review*, 46(2), 6–22.

[7] Bocken, N. M. P., Short, S. W., Rana, P., and Evans, S. (2014). A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production*, 65, 42–56.

[8] Boiral, O. (2011). Managing with ISO systems: Lessons from practice. *Long Range Planning*, 44(3), 197–220.

[9] Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101.

[10] Brinkmann, S., and Kvale, S. (2015). *InterViews: Learning the craft of qualitative research interviewing* (3rd ed.). SAGE Publications.

[11] Bryman, A. (2016). *Social research methods* (5th ed.). Oxford University Press.

[12] Carter, C. R., and Rogers, D. S. (2008). A framework of sustainable supply chain management: Moving toward new theory. *International Journal of Physical Distribution & Logistics Management*, 38(5), 360–387.

[13] Castillo-Montoya, M. (2016). Preparing for interview research: The interview protocol refinement framework. *The Qualitative Report*, 21(5), 811–831.

[14] Castro, C. G., Trevisan, A. H., Pigosso, D. C. A., and Mascarenhas, J. (2022). The rebound effect of circular economy: Definitions, mechanisms and a research agenda. *Journal of Cleaner Production*, 345, 131136.

[15] Cherrafi, A., Elfezazi, S., Chiarini, A., Mokhlis, A., and Benhida, K. (2016). The integration of lean manufacturing, Six Sigma and sustainability: A literature

review and future research directions for developing a specific model. *Journal of Cleaner Production*, 139, 828–846.

[16] Cherrafi, A., Elfezazi, S., Govindan, K., Garza-Reyes, J. A., Benhida, K., and Mokhlis, A. (2017). A framework for the integration of Green and Lean Six Sigma for superior sustainability performance. *International Journal of Production Research*, 55(15), 4481–4515.

[17] Christopher, M. (2016). *Logistics & supply chain management* (5th ed.). Pearson UK.

[18] Construction Company. (2024). *Construction company annual report 2024*.

[19] Creswell, J. W., and Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

[20] De Menezes, L. M., Escrig-Tena, A. B., and Bou-Llusar, J. C. (2022). Sustainability and quality management: Has EFQM fostered a sustainability orientation? *Quality Management Journal*, 34(2), 24–41.

[21] Dean, J. W., and Bowen, D. E. (1994). Management theory and total quality: Improving research and practice through theory development. *Academy of Management Review*, 19(3), 392–418.

[22] Deming, W. E. (1986). *Out of the crisis*. MIT Press.

[23] Downie, J., and Stubbs, W. (2013). Evaluation of Australian companies' scope 3 greenhouse gas emissions assessments. *Journal of Cleaner Production*, 56, 156–163.

[24] Duflou, J. R., Sutherland, J. W., Dornfeld, D., Herrmann, C., Jeswiet, J., Kara, S., Hauschild, M., and Kellens, K. (2012). Towards energy and resource efficient manufacturing: A processes and systems approach. *CIRP Annals*, 61(2), 587–609.

[25] Elkington, J. (1998). *Cannibals with forks: The triple bottom line of 21st century business*. New Society Publishers.

[26] Ferdows, K., and De Meyer, A. (1990). Lasting improvements in manufacturing performance: In search of a new theory. *Journal of Operations Management*, 9(2), 168–184.

[27] Fisher, M. L. (1997). What is the right supply chain for your product? *Harvard Business Review*, 75(2), 105–117.

[28] Florida, R. (1996). Lean and green: The move to environmentally conscious manufacturing. *California Management Review*, 39(1), 80–105.

[29] Flynn, B. B., Schroeder, R. G., and Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, 11(4), 339–366.

[30] Galletta, A., and Cross, W. E. (2013). *Mastering the semi-structured interview and beyond: From research design to analysis and publication*. NYU Press.

[31] Garvin, D. A. (1987). Competing on the eight dimensions of quality. *Harvard Business Review*, 65(6), 101–109.

[32] Genovese, A., Acquaye, A. A., Figueroa, A., and Koh, S. C. L. (2017). Sustainable supply chain management and the transition towards a circular economy: Evidence and some applications. *Omega*, 66, 344–357.

[33] Gimenez, C., and Tachizawa, E. M. (2012). Extending sustainability to suppliers: A systematic literature review. *Supply Chain Management: An International Journal*, 17(5), 531–543.

[34] Giunta, M. (2023). Life cycle cost and sustainability in rail transit. *Transportation Research Part D: Transport and Environment*.

[35] Gremyr, I., Lenning, J., Elg, M., and Martin, J. (2021). Increasing the value of quality management systems. *International Journal of Quality and Service Sciences*, 13(3), 381–394.

[36] Guide, V. D. R., Jr., and Van Wassenhove, L. N. (2009). OR FORUM—The evolution of closed-loop supply chain research. *Operations Research*, 57(1), 10–18.

[37] Hahn, T., Figge, F., Pinkse, J., and Preuss, L. (2010). Trade-offs in corporate sustainability: You can't have your cake and eat it. *Business Strategy and the Environment*, 19(4), 217–229.

[38] Hajmohammad, S., and Shevchenko, A. (2024). Procurement for social sustainability: Manoeuvring tensions and enabling systemic interventions in supply networks. *Journal of Supply Chain Management*.

[39] Hariyani, D., Mishra, S., Hariyani, P., and Sharma, M. K. (2024). Quality management and sustainability drivers for manufacturing systems. *Innovation and Green Development*, 2(1), 100030.

[40] Hygiene Company. (2025). *Hygiene company annual report 2025*.

[41] International Organization for Standardization. (2015). *ISO 14001:2015 Environmental management systems – Requirements with guidance for use*.

[42] International Organization for Standardization. (2015). *ISO 9001:2015 Quality management systems – Requirements*.

[43] Kano, N., Seraku, N., Takahashi, F., and Tsuji, S. (1984). Attractive quality and must-be quality. *Hinshitsu (Quality, The Journal of the Japanese Society for Quality Control)*, 14(2), 39–48.

[44] Kaynak, H. (2003). The relationship between total quality management practices and their effects on firm performance. *Journal of Operations Management*, 21(4), 405–435.

[45] Kaynak, H., and Hartley, J. L. (2008). A replication and extension of quality management into the supply chain. *Journal of Operations Management*, 26(4), 468–489.

[46] Kirchherr, J., Reike, D., and Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling*, 127, 221–232.

[47] Krause, D. R., Vachon, S., and Klassen, R. D. (2009). Special topic forum on sustainable supply chain management: Introduction and reflections on the role of purchasing management. *Journal of Supply Chain Management*, 45(4), 18–25.

[48] Libby, A. (2025). SHEIN and the environmental price of fast fashion: An emissions analysis.

[49] Lincoln, Y. S., and Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.

[50] Linton, T. D., Klassen, R., and Jayaraman, V. (2007). Sustainable supply chains: An introduction. *Journal of Operations Management*, 25(6), 1075–1082.

[51] Liu, Y. (2025). The impact of supply chain quality management on firm performance in manufacturing business: The moderating role of digital intelligence. *Sustainability*, 17(9), 4165.

[52] Lorek, S., and Spangenberg, J. H. (2014). Sustainable consumption within a sustainable economy–beyond green growth and green economies. *Journal of Cleaner Production*, 63, 33–44.

[53] Lüdeke-Freund, F., Gold, S., and Bocken, N. M. P. (2018). A review and typology of circular economy business model patterns. *Journal of Industrial Ecology*, 23(1), 36–61.

[54] Matthews, H. S., Hendrickson, C. T., and Weber, C. L. (2008). The importance of carbon footprint estimation boundaries. *Environmental Science & Technology*, 42(15), 5839–5842.

[55] Niinimäki, K., Peters, G., Dahlbo, H., Perry, P., Rissanen, T., and Gwilt, A. (2020). The environmental price of fast fashion. *Nature Reviews Earth & Environment*, 1(4), 189–200.

[56] Pagell, M., and Wu, Z. (2009). Building a more complete theory of sustainable supply chain management using case studies of 10 exemplars. *Journal of Supply Chain Management*, 45(2), 37–56.

[57] Pagell, M., Wu, Z., and Wasserman, M. E. (2010). Thinking differently about purchasing portfolios: An assessment of sustainable sourcing. *Journal of Supply Chain Management*, 46(1), 57–73.

[58] Pande, P. S., Neuman, R. P., and Cavanagh, R. R. (2000). *The Six Sigma way: How GE, Motorola, and other top companies are honing their performance.* McGraw-Hill.

[59] Piercy, N., and Rich, N. (2015). The relationship between lean operations and sustainable operations. *International Journal of Operations & Production Management*, 35(2), 282–315.

[60] Pietrzak, P., Fandrejewska-Nowakowska, A., and Kwiatkowski, B. (2025). A conceptual integration of the EFQM model and sustainable development. *Scientific Papers of Silesian University of Technology*, 2025(10), 437–452.

[61] Sarkis, J. (2012). A boundaries and flows perspective of green supply chain management. *Supply Chain Management: An International Journal*, 17(2), 202–216.

[62] Schaltegger, S., and Burritt, R. L. (2014). Measuring and managing sustainability performance of supply chains: Review and sustainability supply chain management framework. *Supply Chain Management: An International Journal*, 19(3), 232–241.

[63] Seuring, S., and Müller, M. (2008). From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*, 16(15), 1699–1710.

[64] Siems, E., Land, A., and Seuring, S. (2021). Dynamic capabilities in sustainable supply chain management: An inter-temporal comparison of the food and automotive industries. *International Journal of Production Economics*, 236, 108128.

[65] Siva, V., Gremyr, I., Bergquist, B., Garvare, R., Zobel, T., and Isaksson, R. (2016). The support of quality management to sustainable development: A literature review. *Journal of Cleaner Production*, 138, 148–157.

[66] Slack, N., and Lewis, M. (2019). *Operations strategy* (6th ed.). Pearson UK.

[67] Sousa, R., and Voss, C. A. (2002). Quality management re-visited: A reflective review and agenda for future research. *Journal of Operations Management*, 20(1), 91–109.

[68] Sousa, R., and Voss, C. A. (2008). Contingency research in operations management practices. *Journal of Operations Management*, 26(4), 697–713.

[69] Srivastava, S. K. (2007). Green supply-chain management: A state-of-the-art literature review. *International Journal of Management Reviews*, 9(1), 53–80.

[70] Sroufe, R., and Curkovic, S. (2008). An examination of ISO 9000:2000 and supply chain quality assurance. *Journal of Operations Management*, 26(4), 503–520.

[71] Tachizawa, E. M., and Wong, C. Y. (2014). Towards a theory of multi-tier sustainable supply chains: A systematic literature review. *Supply Chain Management: An International Journal*, 19(5/6), 643–663.

[72] Telecommunication Company. (2025). *Telecommunication Company annual report 2025*.

[73] Touboulic, A., Chicksand, D., and Walker, H. (2014). Managing imbalanced supply chain relationships for sustainability: A power perspective. *Decision Sciences*, 45(4), 577–619.

[74] Wang, C. H., Zhang, Q., Zhang, W., Lu, J., and Zhang, Y. (2023). Integrating lean and sustainability: The role of total quality management and supply chain practices. *Journal of Cleaner Production*.

[75] Wu, Z., and Pagell, M. (2011). Balancing priorities: Decision-making in sustainable supply chain management. *Journal of Operations Management*, 29(6), 577–590.

[76] Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications.

[77] Zhu, Q., and Sarkis, J. (2004). Relationships between operational practices and performance among early adopters of green supply chain management practices in Chinese manufacturing enterprises. *Journal of Operations Management*, 22(3), 265–289.

[78] Zhu, Q., Sarkis, J., and Lai, K. H. (2013). Institutional-based antecedents and performance outcomes of internal and external green supply chain management practices. *Journal of Purchasing and Supply Management*, 19(2), 106–117.

A

Interview Design

As Galletta and Cross (2013) note, semi-structured interviews offer researchers a robust "repertoire of possibilities," providing enough structure to explore specific research dimensions while leaving ample space for participants to assign new meanings to the topics. Consequently, the initial semi-structured interviews have been meticulously designed into three progressive segments to guide the conversation naturally from concrete experiences to theoretical reflections. The opening segment serves as a warm-up, focusing on establishing trust and rapport. During this phase, this study has introduced the general research direction and core objectives of the paper, inviting interviewees to share their personal backgrounds and specific roles within the company. Galletta and Cross (2013) emphasize that the core of this stage is to create a space for interviewees to narrate their authentic experiences, allowing them to spontaneously depict their work environment without the interference of excessive theoretical presuppositions, thereby laying a rich empirical foundation for subsequent questions.

As mutual trust is established, the questioning in the middle segment has transitioned to a higher level of specificity, focusing heavily on the information disclosed in the companies' annual reports. This study has systematically asked questions closely tied to the three previously established supply chain operation modules.

According to the methodology of Galletta and Cross (2013), this middle stage has aimed to address the nuances in the interviewees' opening narratives, using probing questions to steer the dialogue toward the core theoretical dimensions of the research.

In the concluding segment of the initial interview, this study has introduced more abstract and reflective questions. This phase has primarily involved follow-up inquiries on key points previously mentioned by the interviewee, exploring their theoretical implications, and jointly looking ahead to the company's future strategic directions in sustainability. During the follow-up interviews with the same participants, this study has continued to adhere to this three-segment logic. However, in the opening phase of the follow-up, this study has first summarized the key takeaways from the initial interview and any emerging themes discovered during subsequent cross-case comparisons, inviting the interviewee to engage in a deeper discussion based on this established context.

Beyond the structured design, this study has highly valued interactional flexibility during the interview process. Alvesson (2003) profoundly points out that researchers should not view interviews merely as a "pipeline for transmitting knowledge" to ex-

tract data, but rather as a complex social and linguistic interactive situation. Based on this reflexive approach, this study has maintained a high degree of openness. When interesting or unexpected insights have emerged during the conversation, this study has deviated from the predetermined sequence of questions and flexibly posed follow-up inquiries to ensure a natural flow of dialogue. As Alvesson suggests, by rejecting rigid questioning patterns and fostering an empathetic atmosphere of "give and take," this study has encouraged interviewees to express their views more honestly, thereby allowing the interview to present a much deeper and more vivid "realistic" picture.

Department of Technology Management and Economics
CHALMERS UNIVERSITY OF TECHNOLOGY
Gothenburg, Sweden
www.chalmers.se

CHALMERS
UNIVERSITY OF TECHNOLOGY