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The Impact of Global Supply Chain Integration and Environmental Management Practices on Sustainable Technological Innovation Performance in Finnish born Global Companies

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ABSTRACT:

This study examined how environmental management practices (EMPs) and global supply chain integration (GSCI) influence sustainable technological innovation performance (STIP) in Finnish born global companies. This study focuses on how born global firms that rapidly internationalize can utilize EMP and GSCI to achieve STIP, helping them sustain themselves in a competitive global context by obtaining competitive advantage through environmental and operational strategies.

The theoretical foundation of this study is grounded in the Resource-Based View (RBV) and its ecological extension, the Natural Resource-Based View (NRBV). These frameworks were applied to explain how EMPs and GSCI together enhance firms' ability to innovate sustainably. Data were gathered using an online survey that was sent to Finnish-born global companies as part of a quantitative research approach. Responses from 100 companies were analysed using regression and mediation analysis in SPSS to test the developed hypotheses. To validate the results, the constructs of EMP, GSCI, and STIP were assessed using previously validated scales.

The findings demonstrate that EMPs are positively associated with STIP, indicating that firms adopting proactive environmental strategies achieve superior innovation outcomes that are both environmentally and economically beneficial. GSCI also shows a significant positive relationship with STIP, underscoring the importance of collaboration, information sharing, and joint problem-solving with global supply chain partners. Furthermore, GSCI mediates the relationship between EMPs and STIP, suggesting that supply chain integration amplifies the impact of internal environmental practices on sustainable innovation.

This study contributes to the literature by providing empirical evidence that environmental management and global supply chain integration jointly strengthen sustainable innovation in Finnish-born global firms. It also offers managerial implications by emphasizing that developing internal environmental capabilities alongside collaborative global supply chain networks is critical for strengthening sustainable competitiveness. The results conclude that when proactive environmental strategies are supported by strong supply chain integration, sustainability can evolve from a compliance-focused activity into a strategic driver of innovation and long-term growth.

KEYWORDS: Environmental management practices, Global supply chain integration, Sustainable technological innovation performance, Resource-based view, Natural resource-based view, Born global companies, Sustainability, Finland

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Abbreviations

EMP - Environmental Management Practices
GSCI - Global Supply Chain Integration
STIP - Sustainable Technological Innovation Performance
RBV - Resource Based View
NRBV- Natural Resource Based View

1 Introduction

Technological advancements have enabled small and medium firms to internationalize and enter the global market more rapidly than before (Madsen & Servais, 1997; Neubert, 2018). In the world, when it comes to corporate environmental management practices, much research has been done. Some scholars argue that implementing such practices can negatively impact a company's economic interests or reduce competitiveness (Yang et al., 2015). Likewise, some companies implement environmental management practices to follow the rules and regulations when processing the business (Cai et al., 2014). Nevertheless, there is research that demonstrates environmental management practices can help improve not only the environment but also the economic performance of organizations (Klassen & McLaughlin, 1996; Trumpp & Guenther, 2017). In various contexts, successful companies that have executed effective environmental management practices have achieved strong organizational performance, particularly in terms of sustainable innovation (Rivera et al., 2004; Gunarathne et al., 2021). Further, organizations have started to collaborate with supply chain partners by sharing resources, operating costs, and the benefits of environmental management. This study will examine how this collaborative approach can enhance the impact of environmental management practices through global supply chain integration.

1.1 Background

Environmental management practices have been elevated to a strategic level in many businesses, with an increased focus on green products and stocks. Furthermore, pollution standards are tightening, which leads firms to view proactive environmental management practices as an opportunity not only to comply with regulations but also to lower control risks, reduce operational costs, and respond to stakeholders regularly (Ervin et al., 2012). Likewise, as the contemporary world uses a lot of energy and generates pollution and waste, understanding environmental issues in international business management has never been more important. Due to competition and uncertainty in the business context, businesses seek the advantages of implementing

environmental management practices to obtain competitive advantages and survive in a highly volatile environment (Yang et al., 2015).

A review of the current global literature reveals ample research on environmental management practices in corporations, focusing not only on the motivations for implementation but also on the demotivating factors. Some scholars have argued that environmental management practices can negatively impact companies by creating externalities, damaging economic interests, and reducing power when implementing such practices. This highlights that while society benefits, the company must bear all the costs of EMPs (Chen et al., 2013). Jones (2010) and Masurel (2007) highlight that the cost of environmental management practices is the most significant obstacle preventing the implementation of such measures, especially in small and medium-sized organizations and service sector facilities.

Regulatory pressure is a key driver of environmental management practice adoption. Global firms are subject to numerous compliance requirements, and keeping up with frequent regulatory changes can be challenging (Masurel, 2007). This study focuses on Finnish-born global firms, which often experience a higher compliance burden, potentially restricting the resources available for environmental management initiatives (Marshall et al., 2005). Despite these challenges, evidence indicates that firms that implement robust environmental management practices can achieve strong organizational performance, particularly in terms of innovation outcomes (Portney, 2008).

When we look at the earlier implementations of environmental management practices, they have mainly focused on in production process and end treatment of after production, whereas currently environmental management practices expand the focal point to preventing the impact on the environment throughout the product life cycle stages (Curran, 2015; Danish EPA, 2003). According to Schroeder et al. (2002), at each stage of the product life cycle, sharing resources, operating costs, and the benefits of

environmental management with supply chain partners can enhance the impact of environmental management practices. Hence, this study will investigate the mediating impact of GSCI on EMPs toward technological innovation performance. According to resource-based view theory, cooperation between supply chain partners, referred to as global supply chain integration, can create firm networks for exchanging information and knowledge between partners in global business (Schroeder et al., 2002).

On the other hand, in the phase of globalization and with the technological changes we face rapidly, firms are now increasingly interested in Global supply chain integration (GSCI) in enhancing organizational performance. GSCI includes the strategic coordination as well as the collaboration with global partners, suppliers, manufacturers, distributors, and customers to facilitate a smooth exchange of technology, information, and resources throughout the international networks (Flynn et al., 2010). As per Shan et al. (2023), an effective collaboration in the supply chain enhances knowledge sharing, which is considered a critical mechanism that firms can access the external expertise and technological know-how. This learning is accessed through collaborative learning increases innovation and helps in strengthening the capacity of the firms to develop technologies sustainably. This study of Shan et al found that trust, commitment, and contractual collaboration among partners significantly enhance innovation performance, primarily through the mediation of knowledge sharing.

From the perspective of sustainability, global integration helps firms in leveraging the technologies that are environmentally friendly, sharing green product practices, and adapting to the international sustainability standards. When the global supply chain becomes much interdependent, such an integrated system helps firms in optimizing resource utilization, reducing waste, and implementing the eco-innovational strategies that comply with circular economy principles (Khan et al., 2022). Nevertheless, the knowledge distance among the global partners, differences in technological capabilities, condition in market conditions, and the organizational culture can weaken the benefits of global supply chain integration in the international market. Further, Shan et al. (2023)

show that the higher knowledge gaps decrease the effectiveness of shared knowledge in improving the innovation outcomes. Likewise, firms that mitigate these issues can achieve superior STIP.

Furthermore, the Global supply chain is very important in international business management, where it includes not only finished goods but also raw materials and other components in services and manufacturing industries among international organizations aiming to achieve better business performance (Gereffi and Lee, 2012). Due to this higher level of involvement in production, organizations have begun to collaborate with supply chain partners by sharing resources, operating costs, and the benefits of environmental management. This study will examine how this collaborative approach can enhance the impact of EMP through GSCI (Chen et al., 2013). The reason for investigating global supply chain integration is the recent developments in the supply chain management field. Particularly when it comes to the global supply chain integration, it talks about collaboration among trading partners, including different modes of integration (Johnston et al. 2004). These modes include cross-functional integration of the supply chain, connection of information systems of trading partners. promoting transparency and information flow, coordinated design of product, and sharing information to facilitate coordination of design throughout the trading partner networks (Sahin & Robinson, 2005; Uddin et al., 2024). In this research, knowledge sharing in Global supply chain integration is highlighted, which can be a mediating factor of impact in environmental management practices towards the organizational innovation performance.

This study adopts the Resource-Based View (RBV) and its ecological extension, the Natural Resource-Based View (NRBV), as key theoretical frameworks to understand how firms develop competitive advantages through valuable, rare, and hard-to-imitate internal resources (Barney, 1991; Wernerfelt, 1984). While RBV highlights the importance of tangible and intangible assets for firm performance, NRBV extends this perspective by emphasizing environmental capabilities and proactive environmental

strategies as critical drivers of sustainable innovation and competitive advantage (Hart, 1995; Poornima & Yadav, 2021). When it comes to the NRBV framework, it includes pollution prevention, product stewardship, and sustainable development strategies, which is particularly relevant for analysing how Finnish companies integrate sustainability into their operations and supply chains to foster innovation and long-term success (Dyllick & Hockerts, 2002; Sarkis, Zhu, & Lai, 2011). In this study, this framework is being utilized to explore how EMP and GSCI contribute to sustainable technological innovation performance in Finnish firms, considering both regulatory influences and the unique innovation ecosystem of Finland (Toppinen et al., 2013; European Commission, 2020).

Let's see how NRBV framework is utilized in building this study,

Table 1 Alignment of NRBV Components with Study Variables

NRBV Component	**Description (Theory)**	**Aligned Study Variable**	**Role in This Study**	**How It Drives Sustainable Technological Innovation Performance (STIP)**
Pollution Prevention	Reducing waste, emissions, and resource use to increase efficiency	**Environmental Management Practices (EMP)**	Internal environmental capability	Improves operational efficiency, lowers costs, and encourages cleaner technologies
Product Stewardship	Managing environmental impact across the product life cycle with partners	**EMP + GSCI (collaboration in design, information sharing)**	EMP extended through the supply chain	Joint environmental initiatives lead to eco-design and process innovation
Sustainable Development	Long-term integration of sustainability into strategy and networks	**Global Supply Chain Integration (GSCI)**	Inter-organizational capability that mobilizes EMP	Enables knowledge sharing, coordinated innovation, and systemic

				sustainability improvements
Environmental Capabilities → Competitive Advantage	NRBV states firms gain an advantage from rare, inimitable environmental capabilities	**EMP (internal) + GSCI (relational)**	EMP provides capability; GSCI enhances and scales it	Together, they generate sustainable technological innovation and long-term advantage
Strategic Outcome (NRBV Prediction)	Firms with strong environmental and collaborative capabilities outperform competitors	**Sustainable Technological Innovation Performance (STIP)**	Dependent variable/outcome	EMP and GSCI lead to innovation in products, processes, and technologies that are sustainable

(Hart, 1995; Poornima & Yadav, 2021).

The below table shows the summary of the background of studies,

Table 2 Background studies

Author(s) / Year	**Focus Area**	**Key Findings / Insights**	**Relevance to Current Study**
Ervin et al. (2012)	EMP as a strategic tool	EMP reduces risk, lowers costs, and improves stakeholder relations	EMP has strategic value beyond compliance
Yang et al. (2015)	EMP & competitive advantage	EMP helps firms survive in uncertain, competitive environments	EMP leads to competitive advantage and innovation
Chen et al. (2013)	Negative views on EMP	EMP may increase costs and reduce economic power	Highlights need to explore mediators (e.g., GSCI)
Johnstone & Labonne (2009); Masurel (2007); Bendell & Kearins (2005); Jones (2010)	Barriers to EMP	Cost is the biggest obstacle, especially in SMEs and service firms	EMP implementation challenges are important in Finland
Marshall et al. (2005)	Regulatory burden	Global compliance consumes resources, limits EMP investment	Finnish firms face a similar burden
Portney (2008)	EMP & performance	Firms with strong EMP achieve innovation benefits	EMP can positively impact innovation

Curran (2015); Danish EPA (2003)	EMP evolution	Shift from end-of-pipe to life-cycle environmental management	EMP is now integrated across the supply chain
Schroeder et al. (2002)	Supply chain collaboration	Sharing resources and knowledge improves EMP effectiveness	Introduces GSCI as the key mediator
Gereffi & Lee (2012)	Global supply chains	GSCI improves performance across production networks	GSCI is essential in international business
Johnston et al. (2004)	Modes of GSCI	Integration includes functional, information, and coordination	Defines GSCI dimensions
Sahin & Robinson (2005); Uddin et al. (2024)	GSCI mechanisms	Transparency, information flow, and product design coordination enhance performance	Knowledge sharing in GSCI increases innovation capability
Barney (1991); Wernerfelt (1984)	Resource-Based View (RBV)	Competitive advantage from valuable, rare, inimitable resources	GSCI and EMP are strategic internal capabilities
Hart (1995); Poornima & Yadav (2021)	Natural RBV	Environmental capabilities drive sustainable innovation	EMP is a strategic environmental capability
Dyllick & Hockerts (2002); Sarkis et al. (2011)	NRBV strategies	Pollution prevention, product stewardship, and sustainable development	EMP and sustainability strategies enable innovation
Toppinen et al. (2013); European Commission (2020)	Sustainability in Finland	Finland's innovation ecosystem supports green innovation	Contextual justification for focusing on Finnish firms

1.2 Research GAP

As discussed in, previous section, it is evident that there are numerous studies that sought to investigate the influence of EMP on STIP. While some research suggests that EMPs may harm organizations due to increased implementation costs (Chen et al., 2013), more recent studies highlight that EMPs can promote innovation and lead to sustained competitive advantage (Singh et al., 2021). Throughout the product life cycle, organizations are increasingly focused on minimizing or preventing negative environmental impacts. When it comes to the study of Yang et al. (2015), it investigated

how these EMP influence Sustainable Technological Innovation Performance, which highlights how EMP can be used to gain competitive advantages through GSCI and supply chain knowledge sharing.

likewise, in the contemporary business environment, the integration of EMPs with Global supply chain practices holds crucial relevance. Given the increasing pressures from regulatory bodies and a heightened concern for environmental sustainability, organizations have started to adopt environmentally responsible practices (Yang et al., 2015). Moreover, GSCI has emerged as a strategic initiative aimed at improving operational efficiency, competitiveness, and responsiveness (Chen et al., 2013). Thus, recognizing the relationship between EMPs and GSCI can offer valuable insights for born global organizations in Finland, as many international businesses in Finland strive for sustainable growth and competitive advantages through STIP. In the context of international business, this study focuses on born global firms that aim to compete with conventional international organizations that have already established their legacy globally.

The existing literature shows the significance of EMPs in mitigating environmental risks and enhancing competitiveness through innovation (Rennings et al., 2006). Similarly, GSCI is recognized as a catalyst for improving information exchange, collaboration, and efficient resource usage throughout the supply chain (Flynn et al., 2010). However, there is still a gap in examining the combined impact of EMPs and GSCI on sustainable technological innovation performance, particularly within Finnish born global companies. Previous literature has primarily focused on EMPs or GSCI separately, rather than investigating their combined influence on sustainable technological innovation performance. As mentioned before, Yang et al. (2015) highlighted the necessity of understanding the relationship among these concepts to derive implications for organizational performance, based on their study conducted in the Chinese industry. Hence, this study investigates how this relationship can be effective for born global companies in the Finnish context that seek sustainable development. Previous studies

have provided valuable insights into how environmental management practices (EMPs) and global supply chain integration (GSCI) individually impact organizational performance. Hart and Ahuja (1996) showed a positive correlation between EMPs and organizational performance, emphasizing EMPs' capability to increase economic benefits and gain competitive advantages. Similarly, Mentzer (2000) suggested that global supply chain integration enhances supply chain efficiency and customer satisfaction. Yang et al. (2015, p. 153) further confirmed the significant positive influence of EMPs on Sustainable Technological Innovation Performance (STIP) in Chinese manufacturing organizations, with GSCI playing a moderating role in this relationship.

While numerous studies explore the impact of GSCI and EMP on performance metrics, including innovation, there is a lack of integrative research examining how these two elements interact to influence Technological Innovation Performance, especially in born global firms originating from Finland. Thus, a contextual examination is necessary to understand the effects of GSCI and EMPs on STIP in this specific setting. When it comes to the focused context, Finland offers a good environment to study the objective of this study, as an innovation-driven economy that is oriented towards sustainability, it encourages the green transformation and digital innovation (OECD, 2023). Finnish-born global companies are considered firms that expand internationally soon after they are founded and depend heavily on global supply chain networks and external knowledge to maintain a competitive edge (Gabrielsson & Kirpalani, 2012). Hence, their limited resources plus strong commitment to environmental responsibility makes it ideal to examine how EMP and GSCI enhance the sustainable innovation performance. Understanding such an offer provides valuable insight into how firms can achieve STIP using both EMP and GSCI (Hautamäki & Oksanen, 2016).

1.3 Objectives and Limitations

The purpose of this study is to examine how EMPs and GSCI influence Sustainable Technological Innovation Performance (STIP) in Finnish born-global companies. Yang et

al. (2015, p. 15342) further confirm the significant positive influence of EMPs on Sustainable Technological Innovation Performance (STIP) in Chinese manufacturing organizations, with SCI playing a moderating role in this relationship. Hence, this study aims to examine how Environmental Management Practices (EMPs) and Global Supply Chain Integration (GSCI) each affect Sustainable Technological Innovation Performance (STIP), and whether GSCI influences (mediates or moderates) the relationship between EMPs and STIP.

Research Question:

What is the impact of Environmental Management Practices (EMP) and Global Supply Chain Integration (GSCI) on the Sustainable Technological Innovation Performance (STIP) of Finnish Born Global Companies?

Sub Research questions:

1. How do Environmental Management Practices affect Sustainable Technological Innovation Performance?
2. How does Global Supply Chain Integration affect Sustainable Technological Innovation Performance?
3. How does Global Supply Chain Integration mediate the Relationship between Environmental Management Practices (EMPs) and Sustainable Technological Innovation Performance (STIP)?

This study focuses on Finnish born global companies that internationalize rapidly from inception (Gabrielsson, 2005). In this study, born global companies from Finland are being included both from manufacturing and service-oriented sectors, but the specific industry will be further narrowed based on data availability and relevance. The plan for the data collection includes a structured questionnaire survey conducted with managers and decision-makers in relevant companies.

1.4 Definitions

Sustainable Technological Innovation Performance (STIP)

STIP explains as ability of a firm to design, develop, and implement technological innovations that simultaneously achieve economic, environmental, and social objectives, thereby integrating sustainability into the core of innovation success (Khan et al., 2021; Dangelico, Pujari, & Pontrandolfo, 2017). In contrast to traditional innovation performance measures, which predominantly focus on financial outcomes or market achievements, STIP represents an increased emphasis on addressing global environmental challenges, fulfilling regulatory obligations, and meeting stakeholder expectations for technologies that minimize adverse environmental impacts while promoting societal well-being (Long, Looijen, & Blok, 2023). To derive from the theoretical background, STIP is grounded in the Natural Resource-Based View (NRBV), which explains through the capabilities in pollution prevention, product stewardship, and sustainable development as sources of sustained competitive advantage (Hart, 1995; Hart & Dowell, 2011). Hence, in this framework, the dynamic capabilities framework highlights the need for firms to sense, seize, and reconfigure resources to address evolving environmental and market conditions, ensuring adaptability and competitiveness in sustainability-sensitive markets (Wu, Ding, & Chen, 2022). According to Yang et al. (2015), Hagedoorn and Cloodt (2003), and Chen and Chen (2006), STIP can be examined through several criteria: the launch of sustainable or green new products, growth in sales of environmentally sustainable products, speed in developing eco-innovative solutions, investment in sustainable R&D initiatives, and the success rate of projects aimed at sustainability-driven innovation. Together, these measures capture the multidimensional nature of STIP and its role in achieving long-term competitiveness while aligning with global sustainability goals.

Environmental Management Practices (EMP)

EMP is defined as a “set of organizational practices aimed at reducing resource consumption and improving waste disposal. This approach encompasses various aspects,

including technological possibilities, product design, manufacturing, and waste management" (Shrivastave & Hart, 1995, p. 32). Moreover, Bergmiller and McCright (2009, p. 24) define EMP, also called green practices, as a collection of actions to enhance environmental performance. These actions include increasing efficiency, reducing reaction time, minimizing energy consumption, and mitigating waste and hazardous material usage. Similarly, this study examines how these EMPs impact the Sustainable Technological Innovation Performance of Finnish Born Global companies.

Global Supply Chain Integration (GSCI)

When it comes to GSCI, as defined by Flynn et al. (2010, p. 60), it entails collaboration among supply chain members, spanning both intra-organizational and inter-organizational relationships. Its objective is to streamline the flow of products or services, information, financial transactions, and decisions to provide maximum value to customers efficiently and promptly (Jiang, 2023). Levary (2000) also introduces a similar definition of supply chain integration as the coordination and management of processes within and across organizations. This facilitates efficient outcomes through collaborative exchanges in product, information, capital, and service.

Resource-based view (RBV)

The Resource-Based View (RBV) theory, which was introduced by Wernerfelt in 1984, describes that a firm's success relies on its unique and valuable resources. This theory has evolved to incorporate relational theory, social network theory, and environmental considerations. Eventually there are two main branches have emerged in this theory: the Natural Resource-Based View (NRBV) and the Relational View (RV). The NRBV highlights three key strategies for competitive advantage, including pollution prevention, product stewardship, and sustainable development, where each relies on unique, hard-to-replicate resources. This paper focuses on pollution prevention and product stewardship, which involve essential knowledge and skills enhancing corporate competitiveness and performance, as well as driving technological innovation. The RV emphasizes that long-term business partnerships create valuable resources through shared knowledge and

collaboration, with Global supply chain integration fostering information exchange and joint problem-solving, thus providing another source of competitive advantage (Hart, 1995; Poornima & Yadav, 2021).

Finnish Born Global Companies

Born globals operate, develop, plan, grow, or internationalize differently than traditional firms. This is an emerging phenomenon compared to the traditional firms that international their operations. Likewise, born globals commence to start their international operations much earlier than conventional firms, which develop domestically before expanding their operations abroad. Hence, global companies are exporting quickly, given the international demand for unique products. In the existing literature, born globals are known differently by various scholars. These firms possess strong entrepreneurial skills, and they view the world as a single marketplace. They are planning their productions and operations globally from the start to reach global market leaders in the future. They usually employ innovative marketing strategies as well as operational strategies that enable them for rapid growth and support for their long-term vision for globalization (Luostarinen & Gabrielsson, 2006; Cavusgil and Knight,2015).

1.5 Structure of the Study

The Introduction, which is the first chapter of the thesis, will provide an introduction of the study topic, explain the research objectives, and summarize the thesis structure. It describes the research background, places the study in the perspective of current literature and industrial practices, and identifies the research challenge and specific objectives. It also discusses why the study is important and what it could contribute.

In the Literature Review, that chapter reflects on the theoretical underpinning of the Resource-Based View (RBV) and corporate strategy application. It reflects on the notion of global supply chain integration and its impact on innovation and performance, various

environmental management practices and their impact on technological innovation, and newly established global enterprises' characteristics, strategies, and patterns of growth. Under the same chapter, Theoretical Framework and Hypotheses Development will present the conceptual model from the literature review and develop hypotheses of the impact of environmental management practices and global supply chain integration on Sustainable Technological Innovation Performance and the moderating role of supply chain integration.

The research methodology chapter will describe the overall research design and approach, describe the techniques used to gather data, e.g., sampling methods and sources of data, and elaborate on the statistical methods and tools used in analysing data.

The Results and Analysis chapter presents an overview of the data obtained with descriptive statistics, states the results of hypothesis testing, and interprets the results on the grounds of the theoretical context and literature.

The Discussion chapter interprets theoretical implications of research findings, discusses practical implications in terms of policymakers and businesses, and mentions the study limitations and areas for future research.

The Conclusion section will summarize the most important research findings, present recommendations based on the study's findings, and suggest potential areas for future research.

The References section holds all the reference materials cited in the thesis in a consistent citation style.

The Appendices section holds supporting materials like questionnaires, large data tables, and other ancillary documents.

2 Literature review

This chapter reviews literature on global supply chain integration, environmental management, and their impact on sustainable innovation in Finnish-born global companies. It summarises existing conceptualizations, theories, and empirical research, examining how supply chain and sustainability practices affect innovation. Key findings, debates, and gaps in current research are discussed to contextualize the present study within sustainable business and innovation in international firms.

2.1 Resource-Based View

The Resource-Based View (RBV) is a major framework in strategic management. It explains how companies gain and sustain competitive advantages by utilizing internal resources and capabilities that are valuable, rare, inimitable, and non-substitutable (VRIN) (Barney, 1991). This framework was first introduced by Wernerfelt (1984) and later refined by Barney (1991). RBV shifts the focus from industry-level factors to firm-specific assets, demonstrating that the variety of internal resources plays a significant role in determining performance outcomes. According to the RBV framework, resources can be broadly categorized as tangible or intangible. Tangible resources include financial capital, physical technologies, and infrastructure, whereas intangible resources encompass human capital, organizational culture, intellectual property, and innovation capabilities (Barney, 1991). The RBV concept explains a firm's capacity to deploy and coordinate internal resources effectively and efficiently. According to Teece et al. (1997), the dynamic capabilities perspective extends RBV by measuring a firm's ability to adapt, integrate, and reconfigure resources in response to environmental changes, thereby enhancing long-term competitiveness.

With increased focus on sustainability and innovation, the Resource-Based View has evolved into the Natural Resource-Based View (NRBV), introduced by Hart (1995), which recognizes that environmental resources and capabilities can also serve as a foundation

for competitive advantage. The NRBV stresses that environmentally proactive firms can create value by integrating ecological considerations into strategic decision-making (Poornima & Yadav, 2021). According to Hart (1995), the determinants of environmental strategy are derived from a firm's organizational capabilities, as outlined in the NRBV, which is the theoretical perspective adopted in this research. The literature on NRBV explains that well-developed organizational capabilities serve as key drivers of environmental strategy, leading firms to adopt proactive environmental approaches (Albertini, 2019; Journeault, 2016). This view also explained that a Proactive environmental strategy has the potential to give cost and differential competitive advantages through the reduction of emissions, motivating productivity, and innovation through the resources which provide social legitimacy and increasing reputation (Fraj et al., 2015). Some other studies also validated this argument from developed countries as well (da Cunha Bezerra et al., 2020).

This research study will utilize NRBV to conceptualize and examine the effect of environmental management practices on the sustainable innovation performance of Finnish companies. According to Hart (1995), the three interconnected strategies of NRBV are pollution prevention, product stewardship, and sustainable development. These strategies can be tied to environmental performance, firms' competitiveness, and innovation performance. When it comes to pollution prevention, it includes the reduction of waste and emissions through increased operational efficiency (Barney, 1991). Porter and Linde (1995) also argue that **pollution prevention** can drive organizations into higher performance and profitability by supporting the link between ecological and economic benefits. Hence, this strategy strongly aligns with traditional RBV emphasis on internal cost reduction and optimization. For Finnish companies, such initiatives are not only internally driven but also shaped by the European Union's stringent environmental regulations and Finland's cultural predisposition toward sustainability. Finland has been a member of the European Union since 1995; the environmental policy has been integrated with the environmental policy of the EU to a larger extent. This was a historical change from then, as well as a challenge that is

demanding in the present context. This is not only challenging for the Ministry of the Environment but also for the whole national coordination system for environmental matters thus companies (European Commission, 2020). Firms such as Neste Finland and Outokumpu have shown how process innovations aimed at pollution control can enhance both ecological and economic benefits (Neste Corporation, 2023; Outokumpu, 2023).

When it comes to **Product Stewardship,** it represents an enhanced and holistic approach for corporate environmental responsibility by expanding the accountability throughout the entire product lifecycle. This includes every phase of the product, which starts with the sourcing of raw materials, continuing through the production and manufacturing processes, distribution and consumption, and concluding with the end of the life cycle of the product through recycling, reuse, and disposal (Baumann & Tillman, 2004). Rather than only viewing environmental responsibility as a cost centre or as a burden from regulatory compliance, product stewardship has reframed sustainability as a strategic opportunity that integrates focus on the ecological aspects as core business functions. A key feature of effective product stewardship can be identified as the facilitation of proactive collaboration with different stakeholders, particularly with their customers, suppliers, and regulatory bodies. This engagement is created to uplift the transparency, drive into the eco-innovation, and enhance the environmental performance across the value chain (Sarkis, Zhu, & Lai, 2011). To achieve these outcomes, it requires a high level of supply chain integration and information sharing, which enables organizations to track the flow of materials, predict environmental risks, and adopt much cleaner technologies in a timely manner (Lenox & Ehrenfeld, 1997). Such integrations not only enhance the operational efficiencies but also enable the firms to respond effectively to the regulatory bodies and customers for sustainable practices.

From a theoretical stance, this approach is grounded in NRBV of the firm, which is the extension of the conventional RBV by enhancing the capabilities that can contribute to environmental sustainability. In this research study, the NRBV framework is also

employed to analyse how GSCI influences STIP in Finnish organizations. The NRBV framework also suggests that organizations can build competitive advantages by developing unique capabilities that are sustainability-oriented, which will be difficult to imitate by competitors, particularly when those capabilities are included in collaboration with supply chain relationships (Dyllick & Hockerts, 2002). When it comes to Finnish corporations like KONE and VAISALA, they offer examples of how product stewardship helps firms in practice. When it comes to KONE, as a global leader in elevator and escalator solutions, they integrate lifecycle thinking into the product design and strategies in maintenance, as well as working closely with their suppliers to reduce material intensity and energy consumption through their offerings.

When to comes to **Sustainable Development,** it is a long-term strategic orientation which involves the integrated and balanced process of three core dimensions, namely, economic performance, environmental protection, and social equity (Dyllick & Hockerts, 2002). Not only being focused on the financial gains, but also this approach encourages the holistic perspective in which businesses are expected to generate value not only for shareholders but to the broader society and the environment. For example, from the given context, **Solar Foods** and **Sulapac** are Finnish firms leading in sustainable innovation. Solar Foods created a protein production process using air, water, and renewable electricity, reducing environmental impact and enhancing global food security (Solar Foods, 2023). Sulapac offers biodegradable, microplastic-free packaging from renewable materials as an eco-friendly plastic alternative (Sulapac, 2023). These companies exemplify Finnish leadership in the bioeconomy and circular economy, achieving competitive advantage while supporting global environmental and social objectives.

As collectively above-mentioned the strategies of NRBV explain the notion that environmental capabilities can be conceptualized as dynamic capabilities. According to

the present literature, these capabilities help firms to innovate continuously and, by engaging with stakeholder collaboration and adopting regulatory and market pressures, core competencies are significant for sustainable competitive advantage in global contexts (Poornima & Yadav, 2021). Empirical research has supported the relationship between environmental capabilities and the sustainable innovation outcomes, which can be proved through the work of Triguero et al. (2013), where their study demonstrates that practices from eco-oriented drives lead to both radical and incremental innovations. Further, the study of Dangelico and Vocalelli (2017) stressed the same by highlighting how sustainability-oriented innovations can enhance the market differentiation and satisfaction of the customer, hence, it reinforces the logic of RBV of leveraging inimitable resources. As explained by Toppinen et al. (2013) for born global companies in Finland, the RBV and NRBV frameworks provide and lens for understanding the interrelation between sustainability, innovation, and competitiveness. Such firms usually emerge from high-tech sectors and are established in a robust innovation ecosystem in Finland, which gets benefits through government supporting channels, university collaborations, and responsibility of culture and ecology as a system. Consequently, they are well-positioned to cultivate the kinds of rare and path-dependent capabilities emphasized in RBV and NRBV theory.

Furthermore, the integration of environmental management into the core strategy of the business facilitates the capability enhancement and organizational learning and development, which is further suggested by Albort-Morant et al. (2016), explaining practices from environmental management can catalyse new creations in knowledge, enhancing the absorption capacity and fostering the cross-functional collaboration. For Finnish firms operating globally, adapting to varied regulations and stakeholder expectations is crucial. The Resource-Based View (RBV) and its ecological extension, the Natural Resource-Based View (NRBV), influence supply chain management and knowledge integration. Integrating environmental criteria into supplier selection, logistics, and product design can improve operational sustainability and provide valuable external capabilities (Sarkis, Zhu, & Lai, 2011). From the perspective of RBV, such

integration can create complex and socially embedded interorganizational relationships, which will be difficult for competitors to imitate, hence can contribute to the development of sustained competitive advantage (Barney, 1991; Dyer & Singh, 1998).

Nevertheless, there are challenges that persist in operating these environmental capabilities, which can be explained briefly as below. When implementing strategies that are oriented in sustainability usually needs a significant amount of investment in technological infrastructure, human training, and process redesigning which is much comprehensive in nature (Russo & Fouts, 1997). When it comes to small and medium-sized Finnish enterprises or newly established organizations can have these resource constraints, which can limit the extent to which the practices aligned with RBV and NRBV are adopted or scaled (Klewitz & Hansen, 2014). Further, the dynamic nature of global markets, including fluctuations in environment-related regulations and higher expectations from stakeholders, makes it urge to continue such practices, and it requires the renewal of organizational learning, giving limitations to the strategic agility and innovation (Teece, Pisano, & Shuen, 1997).

Despite certain limitations, the NRBV View provides a rigorous theoretical framework for analysing how firms achieve and maintain competitive advantage through environmental and innovation capabilities. For globally operating companies originating from Finland, these models offer critical perspectives on transforming sustainability-oriented resources—such as environmental expertise, stakeholder trust, and green brand equity—into VRIN assets that foster technological advancement and long-term success (Barney, 1991; Hart & Dowell, 2011).

2.2 Environmental Management Practices

Environmental management practices (EMP) encompass organizational strategies and processes designed to minimize the impact of business operations on the natural environment. These practices include a wide range of actions, such as pollution prevention, resource conservation, waste management, environmental compliance, and

the integration of sustainability into product and process design. Adopting EMPs is highlighted both as a response to regulatory pressures and as a proactive approach to gaining competitive advantage through innovation and brand differentiation (Horbach et al., 2012; Lozano, 2015).

For Finnish Born Global companies, EMPs have become critical due to the high environmental standards imposed by the European Union and Finland's national sustainability policies. Likewise, Finnish firms tend to adopt advanced environmental technologies and integrate sustainability significantly into their corporate strategies (Hirvonen-Ere & Bask, 2023). These practices are guided and motivated by frameworks such as ISO 14001 environmental management systems, eco-design principles, and life cycle assessment (LCA) tools, which allow a firm to systematically reduce environmental impacts while increasing operational efficiency (Jabbour et al., 2013). EMPs include pollution prevention, product stewardship, sustainable development, waste management, energy efficiency, and compliance with environmental regulations (Srivastava, 2007; Lozano, 2015). In achieving sustainability goals, EMPs play a critical role for Finnish global companies and ultimately drive the enhancement of technological innovation performance, which contributes to Finland’s recognition as a pioneer in circular economy models (Ministry of Economic Affairs and Employment of Finland, 2021).

According to Hart (1995), adopting EMPs demonstrates the strategic orientation of an organization towards long-term sustainability. Organizations can integrate these environmental considerations into their core business strategy, which has come from internal motivations including corporate social responsibilities and ethical values, or from external pressures such as customer demands, regulatory compliance, and expectations from stakeholders (Zailani et al., 2012). When it comes to the capabilities of the EMPs, they can be grouped into three main capabilities using the Natural Resource-Based View (NRBV): pollution prevention, product stewardship, and sustainable development (Hart, 1995).

The first capability is pollution prevention, which is described as a proactive measure to minimize or eliminate the waste and emissions from their sources which different techniques are including process optimization, cleaner production technologies, and the adoption of renewable resources (Horbach, Rammer, & Rennings, 2012). Utilization of this capability helps in reducing the risk for the environment, and simultaneously, it reduces the operational costs by contributing to increased eco-efficiency. In the study of Hirvonen-Ere and Bask (2023), explained that Finnish companies leverage digitalization, advanced technological infrastructure, and the support from regulatory bodies to implement pollution prevention as a core perspective in their environmental strategies. For instance, the biorefinery innovations developed by UPM-Kymmene illustrate how implementing pollution prevention strategies can concurrently facilitate entry into emerging markets for bio-based alternatives (UPM, 2022).

The second capability of EMPs, product stewardship focuses on managing the entire lifecycle of the product from the designing of the product to the final disposal which ensure that the impact to the environment is minimized throughout the product lifecycle using, eco design, sourcing raw materials through sustainable sources and recycling or end of life product recovery(Albino, Balice, & Dangelico, 2009). In the context of Finnish organizations, sustainability standards are stringent as well, and consumer awareness is high; hence, product stewardship enables Finnish firms to differentiate in the international market globally (Kuivalainen et al., 2023). Fiskars applies cradle-to-grave design to lower environmental impact and enhance its brand (Fiskars Group, 2022).

The third capability of EMPs is Sustainable development, which is explained as the integration of economic, social, and environmental dimensions into the business operations, which promotes the long-term value creation by balancing profitability with the responsibility of the firm towards the people and the environment (Lozano, 2015). This is embedded in the corporate strategies of many Finnish global firms as a holistic approach that aligns with government policies, strategic goals, and their circular

economy. Organisations such as KONE integrate sustainability into their strategic objectives, aiming for carbon-neutral operations by 2030 and strengthening social sustainability through employee wellbeing programmes (KONE, 2022).

When practicing EMPs in Finnish contexts, there are drivers as well as barriers that can be seen. From one perspective, since Finland has stringent regulations for the environment, public awareness, and advanced technological infrastructure, which is explained in the study of Hirvonen-Ere and Bask (2023), these act as drivers. Furthermore, a higher level of environmental literacy among consumers and having a culture that values sustainability also creates market-based drivers for the adoption of EMPs (Luoma-aho & Vos, 2010). Externally, the global market also demands and recognizes interest in green products and ethical sourcing, which pushes firms to adopt EMPs to maintain competitiveness (Kuivalainen et al., 2023). International standards, including ISO 14001, establish frameworks for systematic environmental management and can impact credibility and market access (Zhu & Sarkis, 2007). Sustainability indices and investor requirements also play a role, as demonstrated by the focus Nordic institutional investors place on environmental performance disclosures (Nofsinger, Sulaeman, & Varma, 2019). Nevertheless, there are barriers as well, which include higher costs for green technologies, complexity in coordinating the multiple stakeholders, and uncertainty in return on investment in sustainability initiatives (Klewitz & Hansen, 2014). Therefore, small and medium-sized born global firms can face difficulties due to their limited resources and present capabilities. Furthermore, the knowledge gap is remarkable in implementing the advanced circular economy practices across international subsidiaries, which remains a challenge (Antikainen & Valkokari, 2016).

Adoption of EMP integrates with the innovations, especially sustainable technological innovations (Dangelico, Pujari, & Pontrandolfo, 2017). When firms leverage EMP tend to develop new products, processes as well as new business models to address environmental challenges which simultaneously open new market opportunities. When we have cleaner technologies for production, it reduces the emissions while it improves

the product quality and operational efficiency (Horbach et al., 2012). A Finnish born global company, Wärtsilä's hybrid marine propulsion systems exemplify how environmental compliance drives technological innovation (Wärtsilä, 2022). Furthermore, EMP stimulates the organizational learnings and accumulation of new knowledge about the challenges of environment and newer solutions which accompany them to new capabilities which is significant for innovations (Martínez-Martínez, Cegarra-Navarro, & García-Pérez, 2015). Product stewardship fosters advancements in eco-design, whereas sustainable development promotes comprehensive innovations that encompass social and economic dimensions. Organizations investing in environmental research and development enhance their absorptive capacity for sustainability-oriented innovation (Zahra & George, 2002).

In this study, the integration of EMPs with the supply chain has been analysed. Some studies have revealed that EMP can be more effective when it is extended across the supply chain (Srivastava, 2007). When firms act collaborative with suppliers, manufacturers, distributors, and customers, it enables them to address the impact of the environment holistically. It facilitates joint problem solving, resource sharing, and co-innovation in sustainability (Laari, 2016). In the Finnish context, born global companies operating in diverse and regulated as well as cultural environments which integration can be beneficial and essential to implement such consistent environmental standards and driving to the sustainable innovation globally (Vachon & Klassen, 2006). For instance, Nokia's Supplier Requirements for Environmental Management ensure first-tier suppliers uphold strong environmental standards across their operations (Nokia, 2023). Similarly, Fortum's circular economy partnerships with suppliers and municipalities promote waste-to-energy solutions, illustrating sustainable supply chain integration (Fortum, 2022).

When an organization adopting EMPs, the commitment from internal leadership and the organizational culture plays a significant role (Lo, Peters, & Kok, 2012). The transformational leadership fosters the organizational culture where environmental

management will view as a strategic opportunity than a mere compliance (Egri & Herman, 2000). Finnish corporate culture is distinguished by its flat hierarchies and emphasis on inclusivity, which fosters employee participation in environmental initiatives and enhances the effectiveness of their implementation (Hirvonen-Ere & Bask, 2023). To derive an example from the given context, KONE's sustainability programs led by employees illustrate how bottom-up innovation can complement established top-down environmental strategies (KONE, 2022). In a similar vein, Fortum's internal sustainability ambassador initiative promotes the dissemination of environmental knowledge across departments (Fortum, 2022).

As world is increasing the attention towards the climate change and the circular economy principles, EMPs shifting to the focus on renewable energy use, closed-loop supply chains, and social sustainability (Long et al., 2023). Digital technologies such as IoT, blockchain, and AI support environmental management by increasing data transparency and enabling more efficient resource management (Bag, Pretorius, & Gupta, 2020). For example, smart energy monitoring systems allow real-time optimization of resource utilization, which can lower carbon emissions during operations. There is also a trend toward regenerative sustainability, which aims to create positive environmental impacts, including the development of carbon-negative products and biodiversity initiatives that result in net-positive outcomes (Elkington, 2018).

2.3 Global Supply Chain Integration

Global supply chain integration (GSCI) refers to the strategic coordination and seamless connection of processes, activities, information, and resources across various firms and geographical locations within the supply chain. This enables firms to operate within interconnected ecosystems, rather than as isolated entities, thereby increasing efficiency, responsiveness, and innovation capacity (Min & Kim, 2012). The recent study from this discipline highlights the significant role of information technology and the data exchange in real time which enables the integration which fosters the transparency and the

collaborative decision making (Brown et al., 2025; Ning & Yao, 2024). In another study of Brown et al. (2025) explains GSCI as a multi-dimensional path to increase the cross functional and inter organizational coordination to optimize the information, material and financial flows. As well as Ning and Yao (2024) emphasize how the integrated information exchange system particularly increase the adaptability and the responsiveness to the dynamic market environments. This novel perspective builds upon earlier frameworks, such as Min and Kim (2012), by integrating digital capabilities and sustainability considerations into the overall integration process. In the context of Finland, born global companies often face the complex international markets and higher sustainability expectations which GSCI is significant for sustaining the competitive advantages and reaching the advanced innovation performance (Lehtimäki, Uusitalo, & Salonen, 2023).

From the perspective of organizational performance, GSCI contributes in various ways, including cost reduction, increased operational efficiency, quality improvement, and enhanced customer satisfaction (Zhang et al., 2015). Integrating the supply chain facilitates real-time data sharing, adjustment of production schedules, collaborative problem-solving, reduction of lead times, and improved responsiveness to market changes. This is significant for born global companies aiming to rapidly scale innovations across markets (Luostarinen & Gabrielsson, 2006). The recent studies further shows that adoption of enhances digital technologies such as AI, blockchain, and IoT in supply chain integration significantly enhances visibility and traceability, thereby supporting faster decision-making and reducing inefficiencies (Kähkönen & Lintukangas, 2023; Zhou, Wang, & Wang, 2021). Such advancements significantly influential in intensive economies from high tech and manufacturing sectors such as Finland where firms leverage digital supply chain capacities to keep the global competitiveness (Hirvonen-Ere & Bask, 2023).

When it comes to the sustainability GSCI improves the environmental performance by making firm to coordinate with efforts for pollution prevention, reduction of waste and

optimization of the resources beyond the own operations of the firm (Vachon & Klassen, 2006). This approach is holistic which can minimize the risk for environment and enhance the processes within the international regulations and improving the corporate social responsibility credentials all were contributed to the advanced and stronger bran reputation and the differentiation in the market (Laari, 2016). Furthermore, some scholars argue that, integrating sustainability practices in the supply chain management can directs to the sound improvements in carbon emission, efficiency in water usage and outcomes from the circular economy when supplies by real time data analytics and inter organizational transparency (Schliemann, Reuter, & Foerstl, 2022; Wichmann, Kaufmann, & Carter, 2022). These kinds of benefits can be increased when supply chain partners share a collaborative commitment towards the sustainability goals and maintaining the long-term relationship build upon the trust which is common as a characteristic in the business context of Finland (Hirvonen-Ere & Bask, 2023).

Furthermore, some scholars also argue that GSCI can be acted as a mediator in the relationship between EMP and STIP. Implementing EMPs in singular firm is significant yet it is not enough for achieving broader sustainable goals which to integrate throughout the supply chain can magnify their effectiveness (Srivastava, 2007). For an instance pollution prevention as an effort in manufacturing can be reached in higher level if the raw material suppliers also comply with the sustainable sourcing practices. Likewise, when it comes to the product stewardship requires the coordination with the customers and distributors to make sure that there is environmentally considered end of life management (Gualandris & Kalchschmidt, 2016). Recent studies have explained that GSCI can increase the scalability and consistency of EMPs across the borders and creating synergistic effects that can improve the sustainable innovation performance (Wichmann et al., 2022). Collaborated and integrated EMPs as a system which is supported by the shared platform and real time communication tools helps to align with goals, track the sustainability metrics and foster the join accountability across the supply chain (Cai, Jun, & Yang, 2010; Schliemann et al., 2022).

According to the study of Cai, Jun, and Yang (2010) utilizing integrated and shared information system, GSCI enable the distribution of environmental knowledge and green technology throughout the organizational boundaries. This collaborative effort enables the join problem solving and innovation by reducing the redundancy and increasing the development of green products and processes (Laari, 2016). Hence it opens the door for complementary capabilities and resources as a core part of the resource-based view (RBV). Further, digital enablers play significant role in the knowledge diffusion process specially in the European context which there is high pressure from legislation and stakeholders who make it essential to have traceable and transparent environmental practices (Kähkönen & Lintukangas, 2023). As Finnish born global firms act as a leading sector in global value chain GSCI serves as a significant and critical mechanism in aligning the sustainability and innovation across their ample partners, different locations and regulatory environments (Kuivalainen et al., 2023).

GSCI functions as a strategic asset, generating relational rents by integrating firm-specific resources with partner competencies to establish complex, inter-organizational routines that are challenging for competitors to replicate (Dyer & Singh, 1998). Recent empirical research also demonstrate that global supply chain integration strengthens firms' dynamic capabilities by cultivating a learning environment and facilitating the recombination of internal and external knowledge to drive sustainable innovation (Kähkönen & Lintukangas, 2023).

Nevertheless, despites their advantages, to have effective GSCI it must overcome obstacles such as misaligned objectives, cultural differences, and technological incompatibilities (Lee & Kim, 2009). When it comes to the Finnish firms they are been benefited from institutional environments, digital infrastructures and strong trust-based relationship which can helps in facilitating smoother integration of knowledge exchange (Hirvonen-Ere & Bask, 2023). Even though there are such favourable contexts, integration can be still challenging specially aligning with data standards, balancing power dynamics and managing complexity of multiple supplier networks (Schliemann et

al., 2022). To overcome these barriers, it is required to companies implement advanced supply chain governance mechanisms, invest in interoperable digital technologies, and establish enduring, capability-driven partnerships that extend beyond mere transactional relationships (Wichmann et al., 2022). By taking such measures, organizations not only address traditional limitations but also strategically position themselves to achieve sustained competitive advantage through impactful supply chain collaboration.

2.3.1 Supply Chain Knowledge Sharing

In the Global supply chain integration, Supply Chain Knowledge Sharing (SCKS) acts as a sub-dimension which involves the exchanging the relevant information, expertise and best practices among supply chain partners to increase operational efficiency and innovation capacity (Zailani et al., 2012). In the context of EMPs and sustainable innovation performance, knowledge sharing is beneficial to a firm in collectively identifying risk for environment, co-development of eco friendly solutions and harmonizing the sustainability standards for throughout the supply chain. SCKS beneficial in facilitating transparency, collaboration and trust which are necessary for integrating environmental management practices which beyond the boundaries of organization (Gualandris & Kalchschmidt, 2016). Finnish global companies use digital platforms, strong networks, and a culture of learning to facilitate knowledge sharing (Kuivalainen et al., 2023). They exchange environmental knowledge such as regulations, green technologies, resource efficiency, and life cycle data. This ongoing collaboration drives improvements in pollution prevention, product stewardship, and sustainability (Martínez-Martínez, Cegarra-Navarro, & García-Pérez, 2015).

Furthermore, SCKS acts as mediating agent in the relationship between EMPs and STIP by magnifying the diffusion of green innovations by reducing the innovation costs (Laari, 2016). Sharing the best practices helps firms in avoiding the repetition or duplication of efforts and it will leverage the complementary resources and capabilities. Nevertheless,

there are barriers for the existence of effective knowledge sharing such as issues related to intellectual property, cultural differences, and technological incompatibilities (Lee & Kim, 2009). Finnish companies generally address these barriers by fostering trust, establishing formal agreements, and investing in interoperable information systems. In conclusion, Supply Chain Knowledge Sharing serves as a critical facilitator of sustainable supply chain integration and innovation, strengthening the capacity of globally operating Finnish enterprises to collaboratively develop and implement effective environmental management strategies throughout international supply networks (Kaipia & Tanskanen, 2020).

2.4 Sustainable Technological Innovation Performance

Sustainable technological innovation performance (STIP) refers to firms developing and implementing technologies that simultaneously advance economic, environmental, and social goals, which differs from conventional innovation metrics that focus solely on financial outcomes or market success. STIP integrates sustainability as a crucial factor in innovation success (Klewitz & Hansen, 2014). This dimension aligns with global sustainability imperatives and demonstrates the increasing demands of stakeholders, consumers, and regulators for technologies that reduce negative externalities and enhance well-being (Dangelico & Vocalelli, 2017). The relevance of STIP is increased as the commitments for global climate and environmental regulations increase. Further, there is a need to build resilience against the ecological risks (Long, Looijen, & Blok, 2023).

STIP has become particularly salient in Finland, where strong environmental policies, high societal awareness of ecological issues, and an innovation-oriented environment drive firms to systematically incorporate sustainability into their innovation processes (Hirvonen-Ere & Bask, 2023). Finnish companies such as Neste, KONE, and Wärtsilä exemplify STIP through their leadership in renewable fuels, energy-efficient elevators, and hybrid marine propulsion technologies—innovations that align with decarbonization

objectives and enhance market competitiveness (Neste, 2023; Wärtsilä, 2022; KONE, 2023). The achievements of these firms illustrate that embedding sustainability within technological advancements fosters strategic differentiation in international markets (Kuivalainen et al., 2023).

When it comes to the theory, STIP is grounded in the NRBV as well as in the dynamic capabilities' framework. The NRBV framework explains that organizations reach sustained competitive advantage by deriving cultivation from the capabilities that address the environmental challenges and are rare, difficult to imitate, and path dependent (Hart, 1995). Those involve pollution prevention, product stewardship, and sustainable development capabilities, which motivate the eco innovations and advanced sustainability performance (Hart & Dowell, 2011). Further, this is stressed by dynamic capabilities theory as well by highlighting that organizations should continuously sense, size, and reconfigure the resources for responding to changes in the environmental and market conditions (Teece, 2007). Altogether, using these perspectives can further explain the adaptation of Finnish global firms to the global sustainability transitions while keeping their competitive agility (Wu, Ding, & Chen, 2022).

When it comes to the indicators of the STIP, they include the environmentally related patents, eco innovations, resources, and energy efficiency improvements, reductions in pollution emissions, and successful commercialization in the market with sustainable technologies (Horbach et al., 2012). According to the study of Triguero, Moreno-Mondéjar, and Davia (2013) reveals that, firms that are innovating in environmental research and development and that are collaborating closely with their supply chain partners are reported to have advanced innovation and likewise the financial returns. Empirical research conducted in Finland explains that organizations with advanced environmental management practices show a higher eco-innovation level and stronger international market positions (Hirvonen-Ere & Bask, 2023; Kuivalainen et al., 2023). These findings show the importance of STIP at the strategic level in born global companies that are aiming at competing in sustainability-sensitive markets.

Further, the digitalization is highlighted as it helps in enhancing STIP by enabling firms to have data-driven environmental management. Advanced and emerging technologies like Internet of Things, Artificial Intelligence, and blockchain pave the path for real-time monitoring of emissions to track down the materials and help in optimizing the energy and resource usage (Bag, Pretorius, & Gupta, 2020). Finnish firms are increasingly using these digital tools to make improvements in environmental transparency and to achieve innovation in sustainable business models (Hirvonen-Ere & Bask, 2023). For an instant, integrating AI into the industrial processes allows firms to optimize energy consumption, reducing the operational cost and impact to the environment simultaneously (Long et al., 2023). Further, in the contemporary business context, STIP aligns with technological innovation with global sustainability goals such as the United Nations Sustainable Development Goals (SDGs). According to this, organizations are expected to develop and implement technologies that enable renewable energy transitions, closed-loop production, and decarbonized value chains (Dangelico et al., 2017). When it comes to Finland, their national policies like “Carbon Neutral Finland 2035” accelerate these transformations by setting up clear targets for the firms to comply their innovation efforts (Ministry of Economic Affairs and Employment of Finland, 2021).

Hence, it is evident that, STIP is a multidimensional construct which is significant to the long-term maintenance of competitiveness and keeping social legitimacy in the global firms. The integration of environmental management practices, dynamic capabilities, and supply chain competencies is associated with Finnish-based global companies developing technologies that address sustainability concerns and firm performance. As sustainability challenges become more prominent, the capacity to achieve strong STIP may distinguish market participants and contribute to firms' strategic relevance in a global economy that increasingly emphasizes environmental issues (Hart & Dowell, 2011; Long et al. 2023).

2.5 Finnish Born Global Companies

Born global companies are defined as firms that begin international operations very soon after the inception, which is usually within the first three years of the foundation, which is contrasts with the conventional Uppsala model where internationalization is gradual (Knight & Cavusgil, 2004; Gabrielsson & Gabrielsson, 2009). Born global companies have been studied in European international business literature widely in the context of the Nordic. Finnish born global companies have a distinctive subset in the discipline of new ventures (INVs) which usually start the international operations within three years of founding and generate a significant amount of share in their revenue from foreign markets (Gabrielsson & Gabrielsson, 2009; Räty, Kuivalainen, & Sundqvist, 2023). These firms are well recognized for their early global orientation, which is more proactive, and there are high level of innovation happens as well as the capability to recognize and explore niche opportunities within the international market from the inception (Kuivalainen, Saarenketo, & Puumalainen, 2020). The criteria for identifying born global companies in Finland is used as (a) be of Finnish origin, (b) commence international operations within its initial years of operation, and (c) derive at least 25% of its total revenue from two or more international markets (Laanti, Gabrielsson, & Gabrielsson, 2007; Gabrielsson & Gabrielsson, 2009). These definitional parameters remain a solid foundation for empirical research and comparative analysis within the European born global literature (Räty et al., 2023).

According to the existing literature Finnish born global companies emerges typically from high technology and knowledge intensive industries including ICT, cleantech, life science and advanced manufacturing (Luostarinen & Gabrielsson, 2006; Kuivalainen et al., 2023). Finland's innovation ecosystem benefits from coordinated support, particularly through Business Finland (formerly Tekes), which funds technology, supports internationalization, and connects businesses to global networks (Gabrielsson, Darling, & Seristö, 2016; Kuivalainen et al., 2023). Form a system like this with the given policies which is closely comply with European Union priorities on green growth, eco-innovation, and the digital

transition, give the path to the competitive position in international markets (European Commission, 2022).

One of the emphasised characteristics of Finnish born global firm is about their integration of environmental management and sustainability systematically into their core business strategies (Laari, Töyli, & Ojala, 2016; Kuivalainen et al., 2023). This is shaped by societal values, environmental regulations and policy frameworks to some extent which promotes sustainable innovations (Pätäri et al., 2017). Numerous born global firms in Finland have developed enhanced green technologies, low carbon solutions and circular economy innovations which address the ever-growing demand in the global for sustainable products and services (Kuivalainen et al., 2023). In this context, sustainability is treated as an embedded element in their value proposition and competitive advantages rather than a mere add-on on This approach aligns with the climate-neutrality goals set by the European Commission and demonstrates Finland's ongoing commitment to incorporating sustainability within its national economic policies. Apart from their innovation focus driven by sustainability, Finnish born global companies show strong global value chain capabilities. Likewise, they have engaged in closely with internal suppliers, customers, and distribution partners frequently to integrate sustainability across all the operational stages (Laari et al., 2016).

2.6 Theoretical framework and hypotheses

This research is grounded in the RBV and its ecological extension, the NRBV, to explain how Finnish-born global companies can enhance STIP through EMPs and GSCI. (Barney, 1991; Wernerfelt, 1984). In this research, EMPs and GSCI are viewed as strategic resources and capabilities that can improve environmental performance while simultaneously driving innovation. The NRBV expands upon the RBV by recognizing environmental capabilities, including pollution prevention, product stewardship, and sustainable development as potential sources of competitive advantage (Hart, 1995). These capabilities are associated with reducing environmental impacts and enabling eco-

innovation, which may influence market differentiation in industries focused on sustainability.

Given from the NRBV framework, EMPs includes practices such as, pollution prevention, product stewardship, and sustainable development are essential strategic resources that increase the capacity of a firm to generate STIP and as per the NRBV, capabilities related to the EMP considered as competitive advantages since they are difficult to imitate and contributing to the long term efficiency including learning (Hart, 1995). Pollution prevention, product stewardship, and sustainable development initiatives each drive firms toward greater innovation and sustainability. Pollution prevention minimizes waste and uncovers process improvements, product stewardship leads to eco-friendly product redesign and collaboration, and sustainable development promotes long-term strategies and integration for cleaner technologies and new sustainable business models. Empirical studies confirm that firms with advanced EMPs achieve higher levels of eco-innovation and stronger competitive positions (Yang et al., 2015; Triguero et al., 2013). Therefore, Environmental Management Practices are expected to positively influence Sustainable Technological Innovation Performance, and below hypothesis is set:

H1: Environmental Management Practices have a positive effect on Sustainable Technological Innovation Performance

GSCI enables firms to coordinate knowledge, information, and resources with partners in the global supply chain, thereby helping to enhance the ability of the firm to generate STIP. The extension of RBV framework to interorganizational relationships explains that firms create relational rent by integrating and sharing resources across the network which can enhance the Innovation performance (Dyer & Singh, 1998). From the perspective of dynamic capabilities, GSCI strengthens the ability of the firm to sense the environmental opportunities, keep sustainable technologies and reconfigure process in response to environmental pressures (Teece et al., 1997). Digital supply chain tools like IoT, blockchain, and analytics improve transparency by allowing firms to monitor emissions, resource use, and waste—key factors for sustainable product development

(Kähkönen & Lintukangas, 2023). Research shows that GSCI boosts innovation through better coordination, responsiveness, and support for environmental technologies (Flynn et al., 2010; Zhou et al., 2021). Evidence from Finnish manufacturing and born-global firms also links GSCI with sustainability-driven innovation (Lehtimäki et al., 2023). Thus, Global Supply Chain Integration is expected to enhance Sustainable Technological Innovation Performance below hypothesis is set:

H2: Global Supply Chain Integration has a positive effect on Sustainable Technological Innovation Performance.

The integration of EMP to firm internal processes must extend to the external network to produce meaningful STIP. EMPs require firm to align environmental goals and technological specification with the supply chain partners particularly in pollution prevention and product stewardship activities (Sarkis et al., 2011; Horbach et al., 2012). Implementing EMP creates environmental requirement including, cleaner inputs, reduced emission and eco design standards that can't be fully achieved without cross border and cross functional coordination (Laari, 2016). According to the existing literature, GSCI helps partners meet these requirements by letting them share environmental data, work together on eco-friendly innovations, and develop cleaner technologies (Gualandris & Kalchschmidt, 2016). Better coordination embeds EMPs throughout the supply chain, making it easier to expand and advance environmental efforts. GSCI is contributing from various dimensions including reduction of cost, increasing operational efficiency, quality improvement and the customer satisfaction (Zhang, Lettice, & Zhao, 2015). In this way, GSCI converts internal environmental strengths into sustainable technological innovations that work outside the organization. Thus, Global Supply Chain Integration is suggested as mediator between Environmental Management Practices with Sustainable Technological Innovation Performance and below hypothesis is set:

H3: Global Supply Chain Integration mediates the relationship between Environmental Management Practices and Sustainable Technological Innovation Performance.

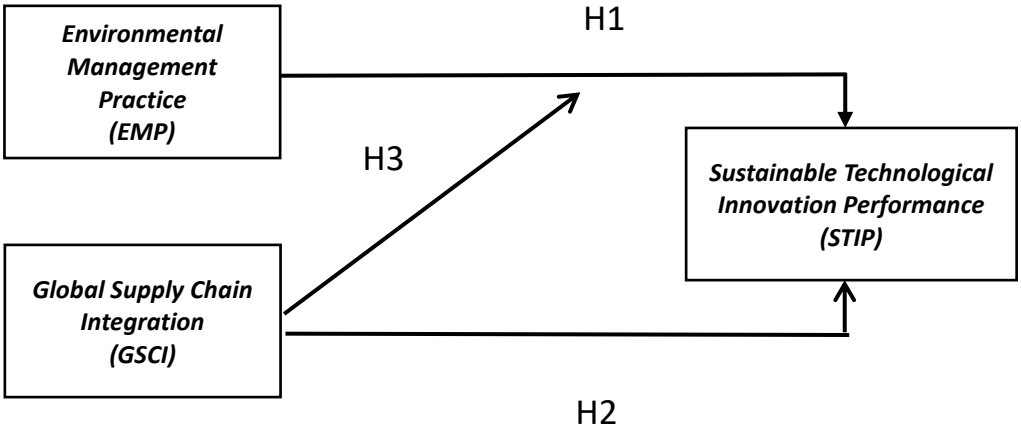

Figure 1 Conceptual model

3 Research Methodology

This chapter described the research methodology of the study, which is expected to examine the influence of GSCI and EMPs on STIP in Finnish born global companies. This study is founded on the established theories of international business management, environmental management, and innovation performance, which employs a quantitative design with structured data collection through statistical analysis. This chapter is structured as follows: research approach, research design, measurements, data collection and sampling, and the reliability and validity of the instruments.

3.1 Research Approach

This research study has adopted a deductive approach, which goes with the research philosophy of Positivism, which explains the hypothesis testing based on the existing theories through the objectives and quantifiable data (Saunders, Lewis, & Thornhill, 2019). Positivism assumes that reality is observable and can be measured, and it is applied in this study to derive the formulation of a structured hypothesis to test the theoretical relationship between variables by using empirical data. This deductive approach starts with the review of the relevant literature about environmental management, global supply chain integration, and sustainable innovation performance in born global firms, particularly in the Finnish and then European context. With the foundation of this theoretical framework, hypotheses were developed and tested by using statistical analysis of survey data. This approach includes and consistent with the previous research studies in international business management and operation management which seek to buildup casual relationship between the variables (Creswell & Creswell, 2018). When it comes to the deductive research approach it is particularly useful in structured and theory driven research study like this. As explained by Sekaran and Bougie (2019), this method allows researchers to draw on previous knowledge to derive experimental propositions. The said relationship between EMP, GSCI and TIP were

analysed using regression and mediation analysis providing both explanatory and predictive insights.

3.2 Research Design

This research has used a quantitative, cross sectional survey design, which is more suited in collecting data at a single point of time and establishing the association between the variables. Also, quantitative methods use for precise measurement, statistical analysis and extrapolation of the results to the similar contexts (Bryman & Bell, 2015). This research has used a structured electronic questionnaire as the primary data collection instrument. It was built and developed based on the validated scales of previous research and it is adapted to fit the Finnish born global firms' environment. A questionnaire is appropriate for the deductive approach since it enables the collection of large amounts of the data relatively inexpensively (Saunders et al. 2009: 144). This questionnaire consists of closed questions with five-point Likert scaled which can be used for the collection of quantifiable responses while the control and demographic questions used to collect the other firm level characteristics (Bryman & Bell, 2015). A cross-sectional design was used due to its capacity to collect data efficiently within a limited timeframe. While longitudinal studies provide more robust evidence for causality, cross-sectional surveys can identify relationships and examine theoretical frameworks, especially in initial or exploratory phases of theory testing (Hair et al., 2020). There are advantageous from survey-based research in business studies such as their scalability and the standardization. Nevertheless, it has own limitations like response bias, overs implication of the complex construct and the limited contextual depth (Ghauri & Grønhaug, 2010). To mitigate and minimize the risks rigorous questionnaire development process, pilot testing, and bilingual distribution in English and Finnish has been done.

3.3 Measurements

There are three constructs that were measure in this study: Environmental Management Practices (EMP), Global Supply Chain Integration (GSCI), and Sustainable Technological Innovation Performance (TIP). And the questionnaire was divided into four sections as demographic data, EMP, GSCI, and TIP.

Dependent Variable: Sustainable Technological Innovation Performance (TIP)

The dependent variable of this study is the firm's sustainable technological innovation performance. This was measured using five items (TIP1–TIP5) adapted from Yang et al. (2015), Hagedoorn & Cloodt (2003), and Chen & Chen (2006). Respondents evaluated their firms' performance in launching sustainable products, growing sales of green products, the speed of eco-innovative solutions, investment in sustainable R&D, and the success rate of sustainability-driven projects.

Responses were collected on a five-point Likert-type scale ranging from 1 = Very Low to 5 = Very High. Similar indicators of sustainable innovation performance have been used in prior studies on innovation outcomes. To ensure reliability, Cronbach's α was calculated, and the results exceeded the recommended threshold of 0.70, supporting the internal consistency of the scale.

Independent Variable 1: Environmental Management Practices (EMP)

This construct was measured with eight items (EMP1–EMP8), adapted from Xue & Gao (2004), Shrivastava & Hart (1995), and Yang et al. (2015). Items cover areas such as environmental training, pollution prevention investment, compliance with international standards, use of eco-friendly raw materials, and integration of environmental goals into corporate strategy.

Responses were recorded on a five-point Likert-type scale ranging from 1 = No consideration to 5 = Fully implemented successfully. Cronbach's α confirmed the reliability of this measurement scale (above 0.70).

Independent Variable 2: Global Supply Chain Integration (GSCI)

This was measured using nine items (GSCI1–GSCI9) developed from Flynn et al. (2010) and Frohlich & Westbrook (2001). The items capture integration in planning, logistics, IT platforms, product development, sustainability data sharing, and joint decision-making with supply chain partners.

The scale used a five-point Likert-type format, where 1 = Not at all and 5 = To a great extent. Previous studies have validated these measures as reliable indicators of supply chain integration in international contexts. Cronbach's α confirmed internal consistency, exceeding the 0.70 cutoff.

Control Variable: Enterprise Size

Enterprise size, measured by the **number of employees**, was included as a control variable. Respondents categorized their firms into one of four groups: (1) ≤50 employees, (2) 51–300, (3) 301–1000, and (4) >1000 employees. Enterprise size is considered an important control factor as it may affect the implementation of sustainability practices and innovation performance.

Table 3 Variables

Variable	Code Range	Scale	Source
Sustainable Technological Innovation Performance (TIP)	TIP1–TIP5	1–5 Likert (Very Low → Very High)	Yang et al. (2015); Hagedoorn & Cloodt (2003); Chen & Chen (2006)
Environmental Management Practices (EMP)	EMP1–EMP8	1–5 Likert (No consideration → Fully implemented)	Xue & Gao (2004); Shrivastava & Hart (1995); Yang et al. (2015)

Global Supply Chain Integration (GSCI)	GSCI1–GSCI9	1–5 Likert (Not at all → To a great extent)	Flynn et al. (2010); Frohlich & Westbrook (2001)
Enterprise Size (Control)	D5	Ordinal categories (≤50; 51–300; 301–1000; >1000)	Questionnaire Item D5

3.4 Data Collection and Sample

The data for this study was collected between May and October 2025 through an online survey. The purposive sampling method has been used to identify the Finnish born global firms the data bases including Orbis and Business Finland. Those firms further evaluated using the criteria proposed by Gabrielsson and Gabrielsson (2009), which defines born global firms as such firms that internationalize rapidly from its establishment and consist significant portion of their revenue from the foreign markets shortly after the founding. The initial sample frame consisted of 200 companies which 130 did not responded or could not be reached despite repeated contact effort. Data collection time is critical and limited with the period hence a total 70 companies were successfully contacted and screened for eligibility. The following questions were asked for the verification via phone or email directly aligned with the born global framework which is established by Gabrielsson (2009):

1. Did the company initiate international operations within three years of its founding?
   This question reflects the rapid internationalization timeline typical of born global firms (Gabrielsson & Gabrielsson, 2009).
2. Does at least 25% of the company's revenue come from international markets?
   This revenue threshold indicates a significant level of international business activity (Gabrielsson & Gabrielsson, 2009).
3. Is the company active in at least two foreign markets?
   Multi-market activity is a key indicator of a global orientation (Gabrielsson & Gabrielsson, 2009).
4. Was the intent to internationalize embedded in the company's strategy from the beginning?

> An early global mindset is a defining characteristic of born globals (Gabrielsson & Gabrielsson, 2009).

After the verification, the online questionnaire was sent which consist of 30 closed ended questions. After several follow ups, 70 companies have submitted the answers. Further, an additional 30 firms were joined through the referrals from the participating companies, followed by snowball sampling approach (Saunders et al. 2009). These firms also evaluated through the same four criteria in total 100 valid responses were collected resulting the response rate as 50%. Responders of the survey were senior decision makers in the operational departments (CEO / Senior Manager / Middle Manager), which ensure that they have in-depth knowledge about their firm's internationalization strategies and environmental practices. The questionnaire was distributed from both Finnish and English language to ensure the clarity and the accessibility. Even though the sample size is modest, prior research supports the adequacy of 30 or more observations for regression and mediation analyses when effect sizes are moderate and validated instruments are employed (VanVoorhis & Morgan, 2007; Hill, 2023).

Summary

This study employed a deductive, positivist research methodology, using a quantitative cross-sectional design and structured online survey to examione the relationship between EMP, GSCI, and STIP in Finnish born global companies. Despite limitations in sample size, rigorous data collection procedures and validated instruments ensure that the findings are both reliable and valid.

4 Data Analysis, Presentation and Discussion

4.1 Introduction

This study is grounded in the Resource-Based View (RBV) and its ecological extension, the Natural Resource-Based View (NRBV), to explain how Finnish born global companies can enhance STIP through EMP and GSCI This chapter covers Descriptive Data Analysis, Validity and Reliability of Data, Preliminary Statistical Analysis, Hypothesis Testing, Discussion, and Summary. The descriptive data analysis encompasses frequency distribution analysis of respondents based on their personal traits and frequency distribution analysis of variables. The frequency distribution analysis of responses indicates that the demographic profile represents the general information of the participants. All appears inside graphs and tables. This section also emphasizes the reliability and validity of each variable, then hypothesis will be tested and followed by the comprehensive discussion.

4.2 Missing Values

Missing Values are values that are completely absent from the data set. They are shown as periods in data view (Malhotra & Birks, 2007). Researchers have used IBM SPSS Statistics Version 23 to analyze data and frequency tables to treat missing values. This data set has not missed value. Table 4.2 shows missing value table.

Table 4 Missing values

Univariate Statistics							
	N	Mean	Std. Deviation	Missing		No. of Extremes[a]	
				Count	Percent	Low	High
EMP1	100	3.7400	1.11573	0	.0	7	0
EMP2	100	3.5700	1.10330	0	.0	7	0

EMP3	100	3.6600	1.11210	0	.0	7	0
EMP4	100	3.8500	1.19236	0	.0	18	0
EMP5	100	3.4100	1.12002	0	.0	8	0
EMP6	100	3.3600	1.16792	0	.0	0	0
EMP7	100	3.6100	1.09078	0	.0	7	0
EMP8	100	3.6800	1.21339	0	.0	11	0
SCI1	100	3.6100	.88643	0	.0	0	0
SCI2	100	3.3600	1.25142	0	.0	0	0
SCI3	100	3.6100	.95235	0	.0	0	0
SCI4	100	3.6800	.85138	0	.0	0	0
SCI5	100	3.9300	.81965	0	.0	.	.
SCI6	100	4.1200	.76910	0	.0	5	0
SCI7	100	3.4600	1.19274	0	.0	11	0
SCI8	100	3.5300	1.19304	0	.0	10	0
SCI9	100	3.4900	1.15027	0	.0	9	0
TIP1	100	3.6700	.87681	0	.0	0	0
TIP2	100	3.6300	.94980	0	.0	0	0
TIP3	100	3.8200	.92529	0	.0	.	.
TIP4	100	3.7200	.84184	0	.0	0	0
TIP5	100	3.7700	.98324	0	.0	3	0
JOB_POSITION	100			0	.0		
YEARS	100			0	.0		
PRIMARY_INDUSTRY	100			0	.0		
MARKET	100			0	.0		

NO_OF_EMPLOYEES	100			0	.0		
FORMAL_SUSTANABILITY_POLICY	100			0	.0		
a. Number of cases outside the range (Q1 - 1.5*IQR, Q3 + 1.5*IQR).							

4.3 Descriptive Data Analysis

Descriptive data analysis is used to gather, organize, summarize, display and analyze the data from a population (Malhotra & Birks, 2007). In this study descriptive analysis is applied to examine the demographic factors, independent variables, and dependent variables in this study. Graphs, charts and tables are used to demonstrate the data that has been studied. The results of the descriptive analysis are presented in tabular form by the researcher.

4.3.1 Frequency distribution analysis of respondents by their personal characteristics

Table 5 Job Position

D1. What is your job position?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CEO	3	3.0	3.0	3.0
	Middle Manager	20	20.0	20.0	23.0
	Other	3	3.0	3.0	26.0
	Senior Manager	74	74.0	74.0	100.0
	Total	100	100.0	100.0	

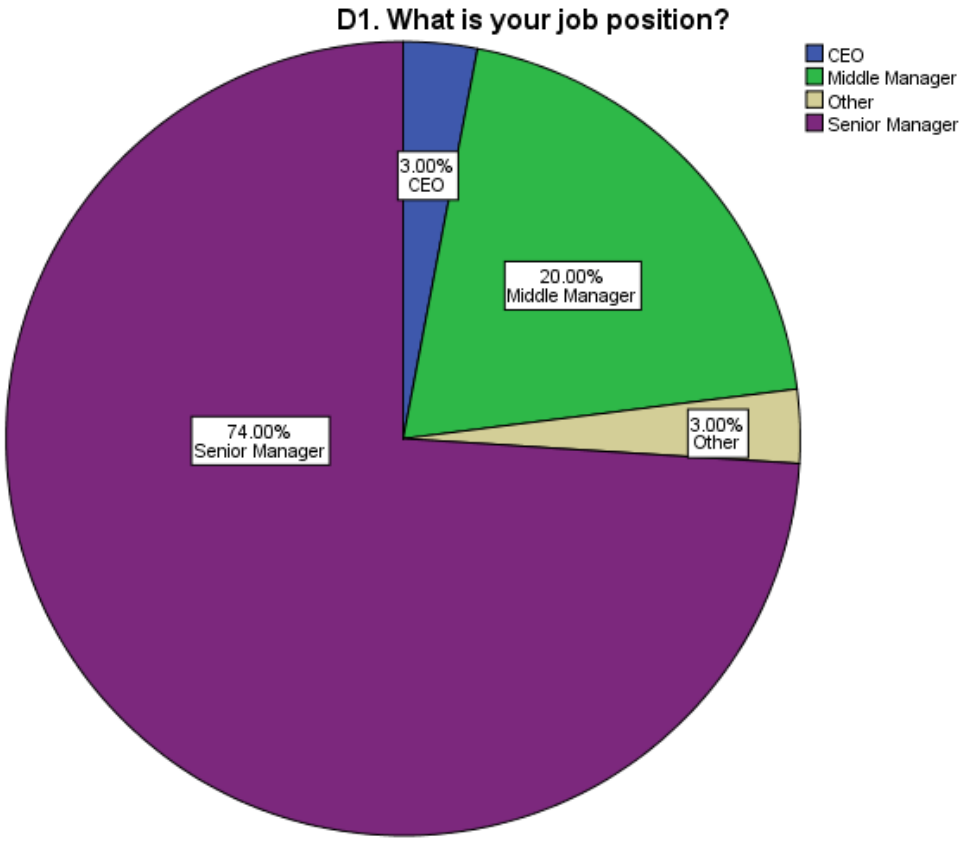

Figure 2 Frequency distribution analysis of respondents by their personal characteristics

The above table shows that, majority of the respondents (74%) were Senior Managers working in the company, followed by 20% Middle Managers working in the company, and the remaining 6% were CEOs and other executives working in the company. This shows that most of the respondents are reliable in the source of information as they hold position of power and are informed about their organizations' environmental and innovative strategies, which lend credibility to their responses. They are people who take decisions and known about the decisions in the company (Zhu et al., 2008).

4.3.1.1 How many years has the company been in operation

How many years has your company been in operation?				
	Frequency	Percent	Valid Percent	Cumulative Percent

Valid	<1	6	6.0	6.0	6.0
	>20	16	16.0	16.0	22.0
	1–5	17	17.0	17.0	39.0
	11–	33	33.0	33.0	72.0
	6–1	28	28.0	28.0	100.0
	Total	100	100.0	100.0	

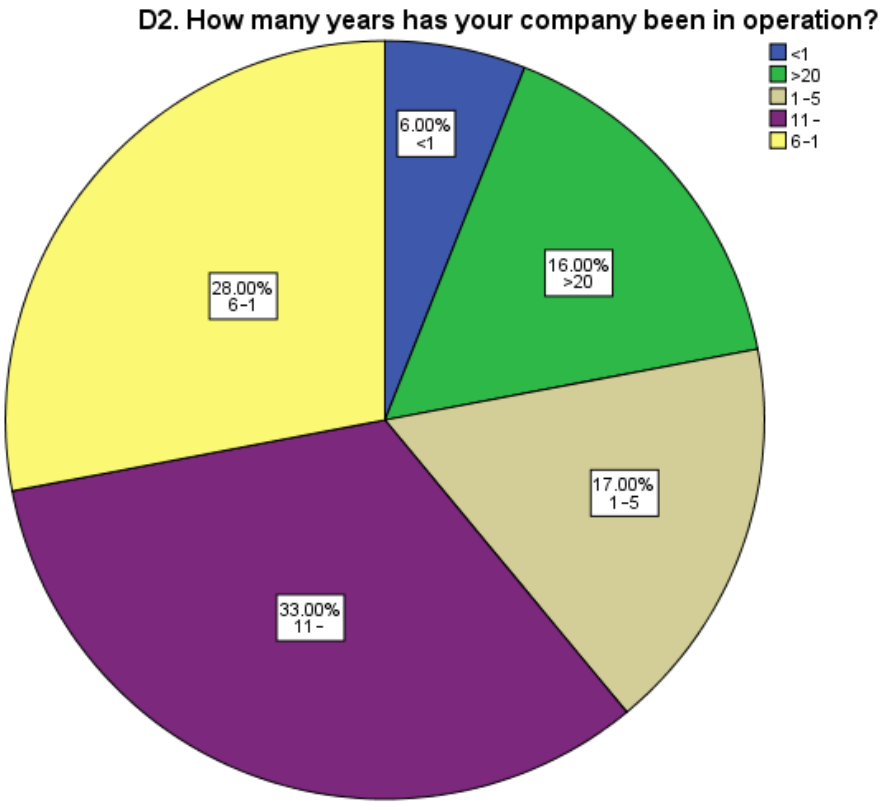

Figure 3 How many years has the company been in operation

According to the responses, 33% of respondents had between 11 and 20 years in the industry, 28% had between 6 and 10 years, and the rest of the respondents had less than 5 years in the industry. The age of the organization is associated with the maturity of the organization, availability of resources and learning capabilities. These factors can also influence the capability of the organization to implement environmental practices and

integrating supply chain (Flynn et al., 2010). according to the results, majority has experience in their industry.

4.3.1.2 The primary industry of the company

What is the primary industry of your company?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Manufacturing	25	25.0	25.0	25.0
	Other	8	8.0	8.0	33.0
	Services	1	1.0	1.0	34.0
	Technology	66	66.0	66.0	100.0
	Total	100	100.0	100.0	

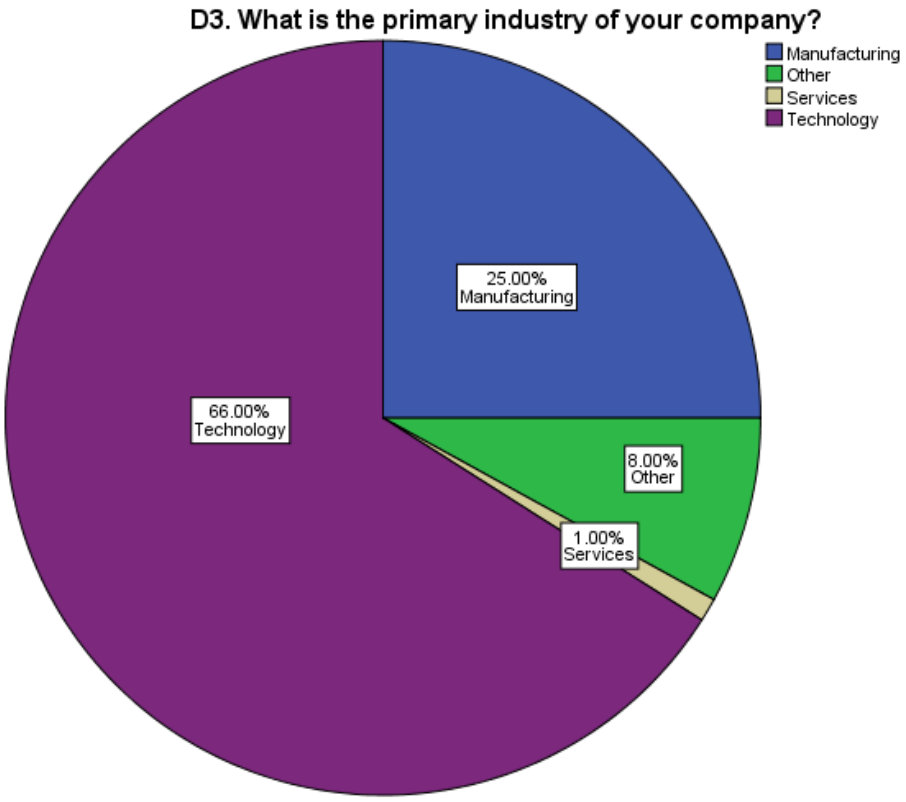

Figure 4 The primary industry of the company

The above table shows that 66% of respondents belonged to technology firms, 25% to manufacturing, and 1% to services. The predominance of technology-intensive firms aligns with the study's focus on Sustainable technological innovation performance. The column for others refers to the companies who do not belong to the main three categories, and it is used to ensure that every respondent can select a relevant option (Dillman et al., 2014; Fink, 2013; Fowler, 2014).

When it comes to the manufacturing industry it focuses on the production of a tangible product through the process of transforming raw materials utilizing capital intensive processes (OECD, 2017) whereas, service industry deliver an intangible output with signifying customer experience, interaction as well as the expertise contrast to the physical product (Lovelock & Wirtz, 2016; Zeithaml, Bitner, & Gremler, 2018). Further, when it comes to the technology industry, it centres the innovation and knowledge-intensive activities by adopting and building digital products and solutions, including software and IT systems that often support both manufacturing and service sectors (Bresnahan & Trajtenberg, 1995; OECD, 2019).

4.3.1.3 Market

D4. What markets does your company serve?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EU	7	7.0	7.0	7.0
	Global	93	93.0	93.0	100.0
	Total	100	100.0	100.0	

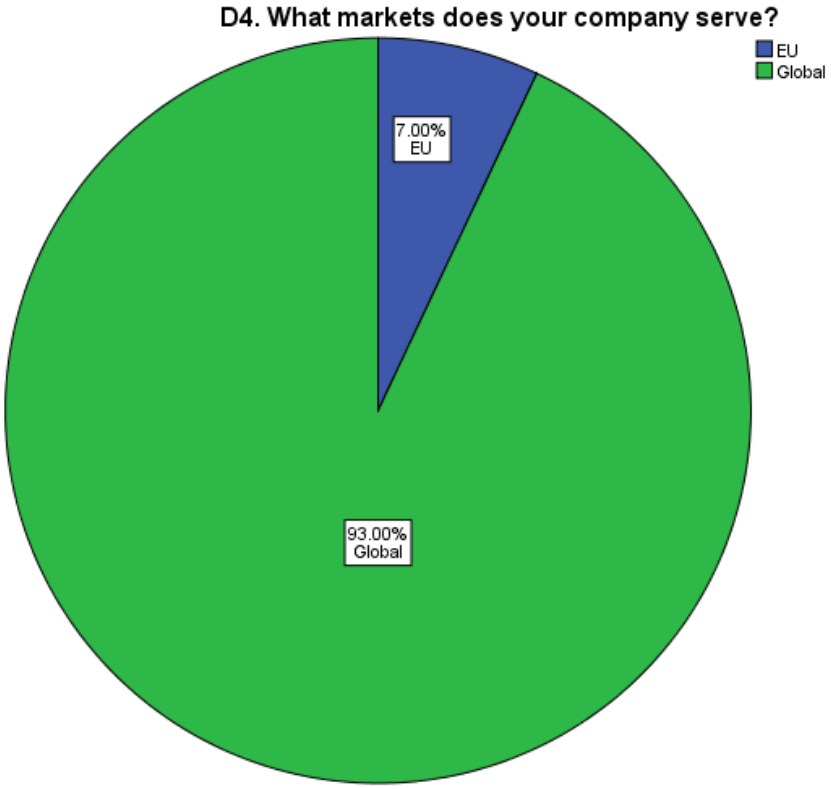

Figure 5 Market

According to the above table shows that 93% of firms operate globally, confirming their "born global" nature & only 7% serves only EU countries still EU is also a part of global area thus those firms are globally distributed (Knight & Cavusgil, 2004; Rennie, 1993).

4.3.1.4 Number of Employees

D5. Number of employees (Enterprise Size)					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	>1000	26	26.0	26.0	26.0
	≤50	26	26.0	26.0	52.0
	300–1000	15	15.0	15.0	67.0
	51–300	33	33.0	33.0	100.0
	Total	100	100.0	100.0	

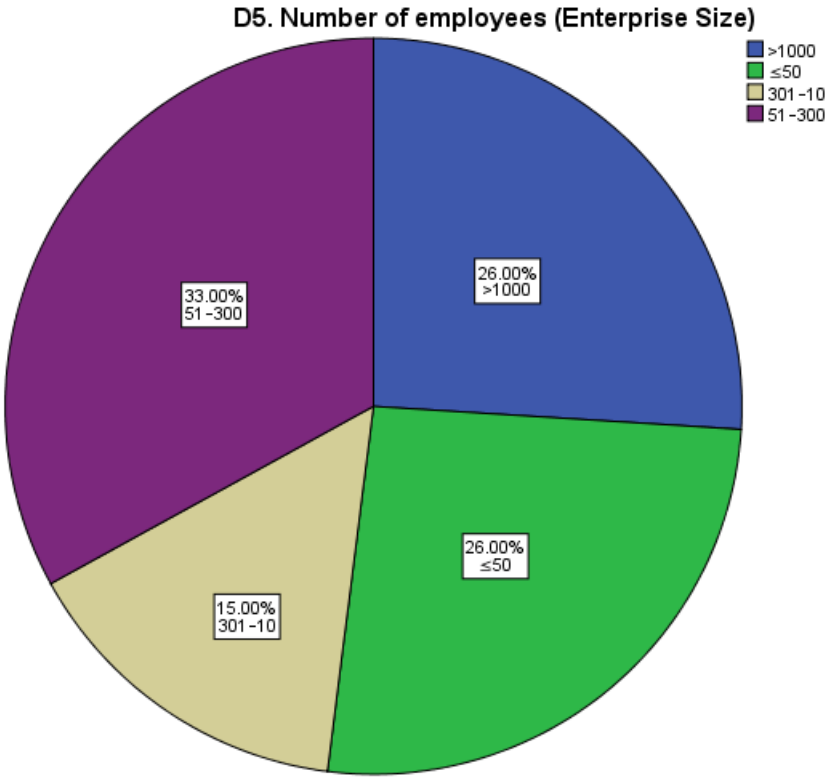

Figure 6 Enterprise size

4.3.1.5 Availability of formal sustainability policy

D6. Does your company have a formal sustainability policy?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	28	28.0	28.0	28.0
	Yes	72	72.0	72.0	100.0
	Total	100	100.0	100.0	

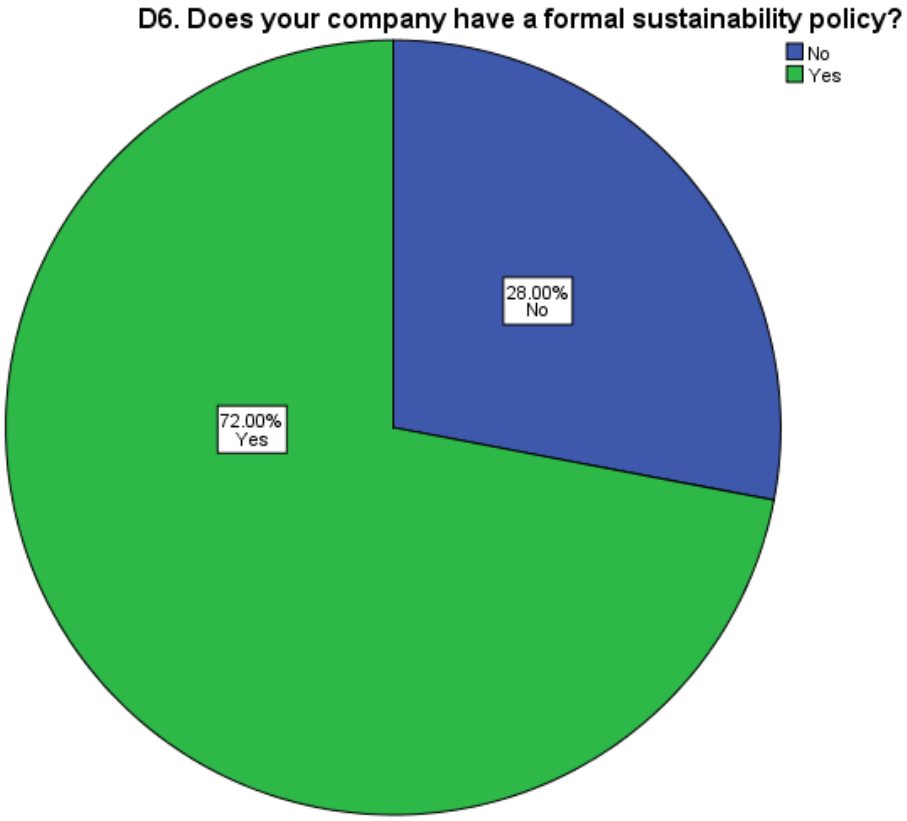

Figure 7 Availability of formal sustainability policy

The above table shows that 72% of firms have formal sustainability policies, indicating institutionalized environmental management practices (Hart & Dowell, 2011).

4.3.2 Frequency distribution analysis for variables

4.3.2.1 Frequency distribution of Environmental Management Practices (EMP):

Statistics							
	N		Mean	Median	Mode	Std. Deviation	Variance
	Valid	Missing					
EMP1. We have established clear green/environmental management goals.	100	0	3.7400	4.0000	4.00	1.11573	1.245

EMP2. We train employees in environmental awareness.	100	0	3.5700	4.0000	4.00	1.10330	1.217
EMP3. We invest in pollution prevention and eco-efficiency.	100	0	3.6600	4.0000	4.00	1.11210	1.237
EMP4. We comply with local and international environmental standards.	100	0	3.8500	4.0000	4.00	1.19236	1.422
EMP5. We use sustainable/eco-friendly raw materials.	100	0	3.4100	4.0000	4.00	1.12002	1.254
EMP6. We adopt green packaging and logistics practices.	100	0	3.3600	4.0000	4.00	1.16792	1.364
EMP7. We measure and monitor environmental performance.	100	0	3.6100	4.0000	4.00	1.09078	1.190
EMP8. We integrate environmental sustainability into corporate strategy.	100	0	3.6800	4.0000	4.00	1.21339	1.472

Mean scores ranged from 3.36 to 3.85 on a 5-point Likert scale, indicating moderate-to-high engagement in sustainability initiatives such as eco-training, green goal-setting, and sustainable corporate strategy integration.

4.3.2.2 Frequency distribution of Global Supply Chain Integration (GSCI)

Statistics							
	N		Mean	Median	Mode	Std. Deviation	Variance
	Valid	Missing					
SCI1. We integrate planning and forecasting with our supply chain partners.	100	0	3.6100	4.0000	4.00	.88643	.786
SCI2. We share logistics and inventory systems with partners.	100	0	3.3600	4.0000	4.00	1.25142	1.566

SCI3. We share product demand and production data across the supply chain.	100	0	3.6100	4.0000	4.00	.95235	.907
SCI4. We use joint IT platforms with suppliers/customers.	100	0	3.6800	4.0000	4.00	.85138	.725
SCI5. We maintain strong communication and trust with partners.	100	0	3.9300	4.0000	4.00	.81965	.672
SCI6. We collaborate on product development with supply chain partners.	100	0	4.1200	4.0000	4.00	.76910	.592
SCI7. We share real-time environmental or sustainability data with partners.	100	0	3.4600	4.0000	4.00	1.19274	1.423
SCI8. We make joint decisions regarding production and sourcing.	100	0	3.5300	4.0000	4.00	1.19304	1.423
SCI9. We engage in sustainable practices jointly across our supply chain.	100	0	3.4900	4.0000	4.00	1.15027	1.323

Mean scores ranged between 3.36 and 4.12, reflecting substantial collaborative integration with suppliers and partners in areas such as eco-product development and environmental communication.

4.3.2.3 Frequency distribution of Sustainable Technological Innovation Performance (STIP)

Statistics							
	N		Mean	Median	Mode	Std. Deviation	Variance
	Valid	Missing					

TIP1. Our company has actively launched new sustainable or green products.	100	0	3.6700	4.0000	4.00	.87681	.769
TIP2. We have achieved notable growth in sales of environmentally sustainable products.	100	0	3.6300	4.0000	4.00	.94980	.902
TIP3. We rapidly develop eco-innovative solutions compared to peers.	100	0	3.8200	4.0000	4.00	.92529	.856
TIP4. We have made significant investments in sustainable R&D initiatives.	100	0	3.7200	4.0000	4.00	.84184	.709
TIP5. Our sustainability-driven innovation projects have a high success rate.	100	0	3.7700	4.0000	4.00	.98324	.967

Mean values ranged from 3.63 to 3.82, suggesting strong performance in eco-innovation, sustainable R&D, and environmentally responsible technological advancements.

Descriptive analysis summaries the respondents' perceptions regarding the key constructs. These descriptive statistics highlight that Finnish-born global firms actively engage in environmental management and supply chain integration, which is consistent with prior studies demonstrating that proactive environmental practices support innovation performance (Chen et al., 2006; Srivastava, 2007).

4.4 Validity and Reliability of Data

4.4.1 Reliability

Reliability describes "how far the survey will produce similar results in different circumstances assuming nothing else has changed" (Roberts and Priest, 2006, p.41) A

reliability analysis was carried out to determine the amount of internal consistency of the data collected. Using Cronbach's Alpha, it was determined whether the items included in the questionnaire under each variable in the research were internally consistent with one another. In the following tables, the Cronbach's alpha values derived by reliability analysis are shown for each variable.

4.4.1.1 Reliability of Environmental Management Practices (EMP)

Reliability Statistics	
Cronbach's Alpha	N of Items
.961	8

4.4.1.2 Reliability of Global Supply Chain Integration (GSCI):

Reliability Statistics	
Cronbach's Alpha	N of Items
.956	9

4.4.1.3 Reliability of Sustainable Technological Innovation Performance (STIP):

Reliability Statistics	
Cronbach's Alpha	N of Items
.958	5

Cronbach’s Alpha was used to assess the internal consistency of each construct. A value of 0.70 or higher is considered acceptable (Nunnally, 1978).

Construct	**Cronbach’s Alpha**	**No. of Items**
EMP	0.961	8

Construct	Cronbach's Alpha	No. of Items
GSCI	0.956	9
STIP	0.958	5

All constructions demonstrated high reliability, confirming that the measurement items consistently reflect the underlying theoretical constructions. High reliability supports the validity of subsequent regression and mediation analyses (Hair et al., 2010).

4.4.2 Validity

The validity was assessed through factor analysis. Validity is the second essential element to ensure the quality of the derived data (Crowther & Lancaster, 2012), as well as it ensure the value of the research in overall (Hartas, 2015). The KMO and Bartlett's Test table shows that the sample size is adequate for the measurement of the variables. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was above 0.5, and the significant value was less than 0.05, indicating that the sample is adequate for measuring the variable.

4.4.2.1 Validity of Environmental Management Practices (EMP)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.895
Bartlett's Test of Sphericity	Approx. Chi-Square	1106.322
	df	28
	Sig.	.000

The above table shows that validity of the **Environmental Management Practices** variable, The Kaiser-Meyer-Olkin Measure of Sampling Adequacy score was.895, while the significance level was.000. In this variable, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was more than 0.5, while the significance value was less than 0. 05.. Therefore, **Environmental Management Practices** variable satisfied the condition, and the sample is adequate to measure the variable. (Kaiser, 1974).

4.4.2.2 Validity of Global Supply Chain Integration (GSCI):

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.878
Bartlett's Test of Sphericity	Approx. Chi-Square	1079.015
	df	36
	Sig.	.000

The table above presents the validity results for the Global Supply Chain Integration variable. The Kaiser–Meyer–Olkin (KMO) Measure of Sampling Adequacy was .878, and the significance level was .000. Since the KMO value exceeds the recommended threshold of 0.5 and the significance level is below 0.05, the Global Supply Chain Integration variable meets the required conditions, indicating that the sample is adequate for measuring this construct (Kaiser, 1974).

4.4.2.3 Validity of Sustainable Technological Innovation Performance (STIP)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.883
Bartlett's Test of Sphericity	Approx. Chi-Square	588.538
	df	10
	Sig.	.000

The above table shows that validity of the **Sustainable Technological Innovation Performance** variable, Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was .883 and significance value was .000. In this variable, Kaiser-Meyer-Olkin Measure of Sampling Adequacy value was higher than the 0.5 and significance value was less than the 0.05. Therefore, **Sustainable Technological Innovation Performa variable** satisfied the condition, and the sample is adequate to measure the variable (Kaiser, 1974).

4.5 Correlation Analysis

correlation analysis was conducted to examine the relationships between Global Supply Chain Integration (GSCI), Environmental Management Practices (EMP), and Sustainable Technological Innovation Performance (TIP). Using Pearson's correlation coefficient, the results showed that all variables are positively and significantly related at the 0.01 level (Sekaran & Bougie, 2020; Field, 2018). Both environmental management and supply chain integration are closely connected to sustainable innovation performance. Operational strategies focused on sustainability significantly enhance a firm's innovation outcomes.

Table 6 Correlation Analysis of EMP, GSCI, and Sustainable Technological Innovation Performance (STIP)

Variables	Correlation (r)	Significance (p-value)	Interpretation
EMP & STIP	0.911	< 0.01	Strong positive correlation: firms with advanced environmental management practices tend to achieve higher levels of sustainable technological innovation. Effective environmental strategies are linked to long-term innovation success.
EMP & GSCI	0.899	< 0.01	Substantial positive correlation: firms with robust environmental practices are more likely to be well-integrated into global supply chains, possibly due to increased sustainability expectations from international partners.
GSCI & STIP	0,856	< 0.01	Strong positive correlation: higher levels of global supply chain integration are associated with improved sustainable technological innovation performance.

4.6 Regression Analysis

Regression analysis is a collection of statistical procedures for estimating relationships between variables. Regression analysis is used to determine whether independent variables are connected to the dependent variable (Sekaran & Bougie, 2020; Field, 2018).

4.6.1 Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.931[a]	.867	.865	.31242
a. Predictors: (Constant), Global Supply Chain Integration (GSCI), Environmental Management Practices (EMP)				

The "R Square" column displays the R square value, which represents the proportion of variance in the dependent variable that is explained by the independent variables. In this case, the R square value is 0.867 with a significance level of $P < 0.05$. This means that 86.7% of the variation in Sustainable Technological Innovation Performance can be attributed to the independent variables (Field, 2018).

4.6.2 Anova Table

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61.884	2	30.942	316.997	.000[b]
	Residual	9.468	97	.098		
	Total	71.352	99			
a. Dependent Variable: Sustainable Technological Innovation Performance (TIP)						
b. Predictors: (Constant), Global Supply Chain Integration (GSCI), Environmental Management Practices (EMP)						

The F-ratio in the ANOVA table tests whether the overall regression model is a good fit for the data. In the analysis above table shows that the table significance column is a score obtained by .000[b], a score smaller than 0.05 (Sig 0.000 < 0.05) (Field, 2018).

4.6.3 Coefficient table

Coefficients						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.610	.134		4.540	.000
	Environmental Management Practices (EMP)	.436	.071	.518	6.141	.000
	Global Supply Chain Integration (GSCI)	.423	.082	.437	5.180	.000
a. Dependent Variable: Sustainable Technological Innovation Performance (TIP)						

The beta value indicates the average rise in the dependent variable corresponding to an increase in the independent variable. Considering the above Table, the unstandardized coefficient, Beta for Environmental Management Practices, is equal to .436. This means that for each one-unit increase in Environmental Management Practices, there is an increase in Sustainable Technological Innovation Performance of .436 times the number of units (Sekaran & Bougie, 2020).

Independent variable increases. Considering the above Table, the unstandardized coefficient, Beta for Global Supply Chain Integration, is equal to .423. This means that for each one-unit increase in Global Supply Chain Integration, there is an increase in Sustainable Technological Innovation Performance of .423 units. These findings corroborate the NRBV perspective, suggesting that environmental capabilities and supply chain integration are critical drivers of sustainable technological innovation (Hart & Dowell, 2011; Sarkis & Zhu, 2018).

4.6.4 Mediation Analysis (H3)

In this study, it is hypothesized that GSCI mediates the relationship between EMP and Sustainable Technological Innovation Performance STIP (H3). To test this hypothesis, a mediation analysis was performed using the PROCESS macro (Model 4) with 5,000 bootstrap samples at 95% confidence intervals (CI) (Hayes, 2013). The independent variable was EMP (X = EMPM), the dependent variable was STIP (Y = TIPM), and the mediator was GSCI (M = SCIM). The sample size was N = 100 (Preacher & Hayes, 2004; Hayes, 2013).

1. Path A: Effect of EMP on GSCI (Mediator)

Outcome Variable: SCIM

R	R^2	MSE	F	df1	df2	p
0.8989	0.8080	0.1497	412.4693	1	98	0.000

Predictor	Coefficient	SE	t	p	LLCI	ULCI
Constant	0.8215	0.1442	5.6962	0.000	0.5353	1.1078
EMPM	0.7817	0.0385	20.3093	0.000	0.7053	0.8580

Interpretation: EMP has a strong, positive, and significant effect on GSCI ($\beta = 0.899$, $p < 0.001$), supporting Path A.

2. Path B and Direct Effect: Effect of EMP and GSCI on STIP

Outcome Variable: TIPM

R	R^2	MSE	F	df1	df2	p
0.9313	0.8673	0.0976	316.9974	2	97	0.000

Predictor	Coefficient	SE	t	p	LLCI	ULCI
Constant	0.6101	0.1344	4.5403	0.000	0.3434	0.8768
EMPM	0.4356	0.0709	6.1406	0.000	0.2948	0.5764
SCIM	0.4225	0.0816	5.1795	0.000	0.2606	0.5844

Interpretation: GSCI significantly predicts STIP when controlling for EMP (β = 0.423, p < 0.001), supporting Path B. EMP remains significant (β = 0.436, p < 0.001), indicating partial mediation.

3. Total Effect of EMP on STIP (Without Mediator)

Outcome Variable: TIPM

R	R^2	MSE	F	df1	df2	p
0.9114	0.8306	0.1233	480.5264	1	98	0.000

Predictor	Coefficient	SE	t	p	LLCI	ULCI
Constant	0.9572	0.1309	7.3114	0.000	0.6974	1.2170
EMPM	0.7659	0.0349	21.9209	0.000	0.6965	0.8352

Interpretation: EMP has a strong, positive, and significant total effect on STIP.

4. Direct, Indirect, and Total Effects

Effect Type	Effect	SE	t	p	LLCI	ULCI
Total	0.7659	0.0349	21.9209	0.000	0.6965	0.8352
Direct	0.4356	0.0709	6.1406	0.000	0.2948	0.5764

Indirect Effect (Bootstrapped):

Mediator	Effect	BootSE	BootLLCI	BootULCI
SCIM	0.3303	0.0761	0.1887	0.4923

Interpretation: The indirect effect is significant because the 95% CI does not include zero.

Summary of Mediation Paths

- **Path A (EMP → GSCI):** β = 0.899, p < 0.001
- **Path B (GSCI → STIP | controlling for EMP):** β = 0.423, p < 0.001
- **Direct effect of EMP → STIP |controlling for GSCI):** β = 0.436, p < 0.001

- **Indirect effect of EMP → GSCI → STIP:** β = 0.3303, 95% CI [0.1887, 0.4923], significant

According to the above results, it supports the partial mediation of GSCI to the EMP towards STIP, thus even though EMP has a direct positive impact on STIP, a significant part of this effect occurs indirectly through GSCI. This means that companies achieve greater sustainable technological innovation not only by implementing internal environmental practices, but even more so when these practices are extended and integrated throughout their supply chain. This can be further supported by previous studies, which it suggests that supply chain integration serves as a dynamic capability, turning internal sustainability initiatives into tangible innovation outcomes (Lee, 2015; Dubey et al., 2017). Thus, the mediation analysis validates hypothesis H3 and highlights the strategic importance of GSCI in enhancing the innovation benefits derived from environmental management practices

Further to validate the results, the Sobel test, which provides an analytic Z test for the indirect effect which can be used in this study to examine the indirect effect of EMP towards STIP through GSCI. This test has a long history in mediation analysis, yet the Sobel test assumes that product *a·b is* approximately normally distributed; hence, when samples are small or *a*nd/or *b* are not normally distributed, the Sobel test can have reduced accuracy (Type I and II error problems). Since the sample of this study is N-100 Sobel test is also being examined (Sobel, 1982; Baron & Kenny, 1986).

Table 7 Regression coefficients and Sobel mediation test for the effect of EMP on STIP via GSCI (N = 100)

Path / Effect	**Predictor(s)**	**Dependent Variable**	**b**	**SE**	**t**	**p**	**95% CI (approx.)**	**Notes**
Path a	EMP	SCIM	0.7817	0.0385	20.30	<.001	[0.705, 0.859]	X → M
Path b	GSCI	TIPM (controls	0.4225	0.0816	5.18	<.001	[0.261, 0.584]	M → Y

		for EMPM)						
Path c′	EMP	TIPM (controls for SCIM)	0.4356	0.0709	6.14	<.001	[0.295, 0.576]	Direct effect
Path c (total)	EMP	TIPM	0.7659	0.0349	21.93	<.001	[0.696, 0.836]	Total effect
Indirect effect (a·b)	—	—	0.3303	0.0658	—	—	—	Computed product
Sobel z	—	—	5.02	—	<.001	—	—	Sobel test[(1)]
Proportion mediated	—	—	0.4312	—	—	—	—	≈43 % of total effect

EMP - Environmental Management Practices
SCIM - Global Supply Chain Integration
TIPM- Sustainable Technological Innovation Performance.
Coefficients are unstandardized. Significance evaluated at α = .05 (two-tailed). Indirect effect tested using the Sobel product-of-coefficients method (Sobel, 1982).

Sobel test calculation as below,

$$a = 0.7817, \quad s_a = 0.0385$$

$$b = 0.4225, \quad s\_b = 0.0816$$

$$\text{Indirect Effect} = a \times b = 0.3303$$

$$Z = (a \times b) / \sqrt{(b^2 s_a^2 + a^2 s\_b^2)}$$

$$Z = 0.3303 / \sqrt{((0.4225)^2 (0.0385)^2 + (0.7817)^2 (0.0816)^2)} = 5.0189$$

$$p < 0.001$$

According to the calculations, the Sobel test value (Z = 5.0189, p < 0.001) demonstrates that, there is an indirect effect of EMP on STIP through the GSCI is statistically significant and it confirm the presence of the partial mediation (Sobel, 1982; Preacher & Hayes, 2004).

4.7 Testing Hypothesis

Let's test the hypothesis developed in the literature review with the above-mentioned results and further we can discuss it accordingly under discussion.

4.7.1 Result of testing hypothesis

The hypothesis criteria (H) are accepted when it is sign. <0.05.

Table 8 Results of Hypothesis testing

Hypothesis	Statement	β (Beta)	p-value / CI	Result
H1	Environmental Management Practices positively influence Sustainable Technological Innovation Performance.	0.436	p = 0.000 (< 0.05)	Supported
H2	Global Supply Chain Integration positively influences Sustainable Technological Innovation Performance.	0.423	p = 0.000 (< 0.05)	Supported
H3	Global Supply Chain Integration mediates the relationship between Environmental Management Practices and Sustainable Technological Innovation Performance.	Indirect effect = 0.3303	95% CI [0.1887, 0.4923] (no zero in CI)	Supported

To summarize this section before the discussion the results presented include comprehensive data analysis. All constructions were reliable and valid. EMP, GSCI, and STIP exhibited strong positive relationships. Regression results confirmed direct positive effects of EMP and GSCI on STIP. Mediation analysis revealed that GSCI partially mediates the relationship between EMP and STIP, highlighting the strategic role of global supply chain integration.

4.8 Discussion of the key findings

Environmental Management Practices and Sustainable Technological Innovation

According to the results, it is evident that there is a strong positive relationship between EMP and STIP ($\beta = .436$, $p < .001$). This gives the explanation that implementations like setting green objectives, adopting eco-friendly purchasing, preventing pollution, and training employees play a significant role in increasing a company's ability to innovate. Previous studies have presented evidence to prove that environmental strategies enhance competitiveness by promoting eco-efficiency and green innovation (Chen et al., 2006; Fernando et al., 2019). Recent findings continue to support this relationship. For instance, Chang (2022) reported that EMPs in manufacturing firms led to noticeable improvements in eco-innovation, especially among globally oriented companies. Likewise, Martins et al. (2023) found that integrating environmental management into research and development resulted in better sustainability-focused outcomes. These findings support the Natural Resource-Based View (NRBV), which considers environmental resources to be valuable, rare, and hard to replicate, thereby providing lasting competitive advantages (Hart & Dowell, 2011). Further, these results are also consistent with Zhu et al. (2018) and Lee and Kim (2020), who argued that proactive environmental management boosts eco-innovation and competitiveness internationally. Most recently, Garad and Khalifa (2024) offered empirical proof that EMPs significantly enhance green innovation and business performance, further highlighting the importance of environmental management in innovation-driven strategies.

Global Supply Chain Integration and Sustainable Technological Innovation

Furthermore, the results also proved the direct positive impact of GSCI on the STIP proving that, when companies work together with their global supply chain partners, they become more innovative and successful at creating sustainable technologies ($\beta = .423$, $p < .001$). To further elaborate, when businesses use shared IT systems, develop products jointly, and openly exchange sustainability data, they can see better results in eco-innovation. Bag and Pretorius (2022) found that new digital technologies, like those in Industry 4.0, help companies innovate sustainably by making things more transparent and resilient. Similarly, Kamble et al. (2022) showed that using digital twin technology makes supply chains more sustainable and improves teamwork for eco-innovation. In

addition, supply chain integration is a valuable skill for companies. It allows them to spot opportunities, act quickly, and adjust their resources to meet sustainability challenges (Tachizawa & Wong, 2015). For born-global firms, this kind of integration is especially important because managing sustainability across many countries can be complex.

Mediation Role of GSCI

The third subobjective of this research study is to know the mediation role of GSCI in EMP towards the STIP. According to the results, GSCI partially mediates the EMPs in the relationship towards sustainable innovation performance (STIP) (β_indirect = .330, $p < .001$). This means that environmental actions help companies innovate not only on their own, but also by working together with partners across the world. This matches the idea that environmental strategies work better when working collaboratively with outside networks (Hart & Dowell, 2011). This explains that environmental practices influence innovation performance both directly and indirectly through collaborative integration across global supply chains. This is also relevant with the NRBV's proposition that environmental strategies gain greater effectiveness when diffused through external networks (Hart & Dowell, 2011). The results also comply with previous research showing that collaborative supply chain structures facilitate knowledge sharing, joint problem-solving, and eco-innovation (Lee, 2015; Dubey et al., 2017). So, while EMPs directly improve innovation, their effect is even stronger when companies are connected through global supply chains. It also shows that companies get more innovation benefits from environmental efforts when they work closely with others (Lee, 2015). Further according to the Wang et al. (2021) supply chain networks amplify sustainability and innovation, and Jabbour et al. (2020) pointed out that working together in the supply chain is key for making green practices stick. This also fits with dynamic capabilities theory, which says that supply chain integration helps companies adjust to sustainability challenges (Teece, 2018).

Theoretical Implications

The findings advance the RBV and NRBV perspectives by demonstrating how resource complementarities between internal and external capabilities lead to sustainable innovation. The RBV emphasises that unique and inimitable resources create competitive advantage (Barney, 1991), while the NRBV extends this notion by identifying environmental competencies as strategic assets (Hart, 1995). The strong influence of EMPs on STIP indicates that internal ecological routines, such as employee training, pollution prevention, and green strategy alignment, constitute valuable, rare, and difficult-to-imitate resources that foster innovation (Hart & Dowell, 2011).

However, this study also evidences that such internal competencies alone are insufficient. The mediating role of GSCI suggests that firms must leverage external relational capabilities—such as shared IT systems, joint product development, and mutual sustainability commitments—to translate internal environmental assets into tangible innovation outcomes. This finding corroborates dynamic capabilities theory, which argues that organisations must integrate, build, and reconfigure resources to sustain innovation amid environmental uncertainty (Teece, 2018; Eisenhardt & Martin, 2000).

Furthermore, the partial mediation outcome supports the argument of Srivastava (2007), who proposed that green supply chain management acts as an enabling mechanism that links environmental initiatives with performance. The synergy between EMP and GSCI in this study validates the co-evolutionary relationship between internal environmental orientation and external collaboration in driving sustainable innovation performance.

Managerial Implications

Managers should view environmental management practices (EMPs) as ways to encourage innovation, not just to follow regulations. When companies invest in green research and development, improve eco-efficiency, and earn certifications like ISO 14001, they not only meet compliance requirements but also become more innovative (Goyal et al., 2020). Research has shown that firms with strong environmental programs are better at meeting international market demands (Zhu et al., 2008), and recent evidence confirms that EMPs lead to real improvements in green innovation and business performance (Garad and Khalifa, 2024).

Working closely with suppliers and partners on sustainability projects also helps companies achieve better innovation results. Studies have found that strong relationships and social connections with supply chain partners are important for supporting eco-innovation (Sarkis et al., 2011; Jabbour et al., 2020). In addition, new digital tools, such as blockchain for tracking products and artificial intelligence for analysing data, can make supply chains more transparent and support sustainable innovation (Bag et al., 2021; Bag & Pretorius, 2022; Kamble et al., 2022).

For companies that operate internationally from the beginning, it is important to align their environmental practices with global supply chain networks. This helps them adapt to different rules in various countries and improves their performance in sustainability and innovation, as shown by firms with ISO 14001 certification (Lee, 2015).

This study adds to the theory of sustainable innovation by showing that both having strong environmental practices and being able to coordinate with others are important for driving innovation. This is especially true for born-global firms, which are not often studied in sustainability research, even though they are becoming more important in global markets. The findings are important because they show that focusing on sustainability is not just the right thing to do but also helps companies compete and innovate.

Recent research highlights that companies combining sustainability, innovation, and supply chain strategies are more resilient and can survive tough times, such as after the COVID-19 pandemic (Garad & Khalifa, 2024; Bag & Pretorius, 2022; Kamble et al., 2022). Therefore, this research suggests that Finnish-born global firms can gain a strategic advantage by making environmental management and supply chain integration a key part of their innovation strategies.

The discussion demonstrates that **environmental management and supply chain integration are mutually reinforcing drivers of sustainable innovation**. Finnish-born global firms enhance STIP by cultivating internal ecological capabilities and extending them through collaborative global networks. This dual approach strengthens adaptability, competitiveness, and long-term sustainability performance, making the

study both theoretically and practically significant in addressing current global challenges.

5 Conclusions

This research study set out to examine how Environmental Management Practices (EMPs) and Global Supply Chain Integration (GSCI) influence sustainable technological innovation performance (STIP) in Finnish born global companies. The main objective of the research was to understand how sustainability-oriented strategies could contribute to the innovation of Finnish born global companies and how they can use strategies related to EMP and GSCI collaboratively to maximize the innovation performance orienting sustainability. Accordingly, this study focused on three sub questions: (1) How do EMPs impact sustainable technological innovation? (2) How does affect GSCI on innovation performance? (3) How does GSCI act as a mediator between EMPs and STIP? To examine these questions, three variables were taken utilizing RBV (Wernerfelt, 1984; Barney, 1991) and NRBV framework (Hart, 1995), emphasizing how unique resources and proactive strategies can help companies to stay competitive. Likewise, the dependent variable of Sustainable technological innovation performance and the independent variables of Environmental management practices and Global supply chain integration are used in the study. The data was collected through a structured online survey, and results were presented comprehensively in chapter four, Data analysis, presentation, and Discussion.

According to the results, the first results proved that EMPs have a strong positive impact on STIP, confirming that firms that take proactive steps, like eco-design, pollution prevention, and sustainable sourcing, can see better results (Yang et al., 2015; Triguero et al., 2013). This is further confirmed through the NRBV framework that these actions are ecological capabilities that can drive innovation and competitive advantage (Hart & Dowell, 2011). Evidence from Finnish-born global firms shows that EMPs are more than just compliance—they are strategic resources that boost eco-innovation and competitiveness, supporting earlier research (Porter & van der Linde, 1995; Hirvonen-Ere & Bask, 2023). As per the second research question, the results proved that GSCI significantly improves STIP, confirming that firms that work closely with partners in the

supply chain internationally and deliberately share knowledge and integrate sustainability practices across their networks can achieve stronger innovation and adaptability (Flynn et al., 2010; Wichmann et al., 2022). For born-global firms, GSCI is especially important because it helps them use external resources and quickly scale innovations in global markets (Kuivalainen et al., 2023). These findings support the relational view (Dyer & Singh, 1998), which emphasizes the value created through close collaboration between organizations. The third research question was further supported by the results showing that GSCI mediates the relationship between EMPs and STIP. While EMPs directly improve innovation, their impact is even greater when sustainability practices are integrated throughout the supply chain. This supports Srivastava (2007), who argued that environmental practices are more effective when extended across the supply chain, and Yang et al. (2015), who found that supply chain integration amplifies the effect of EMPs on innovation. So, GSCI not only adds value on its own but also makes internal environmental strategies more effective.

To elaborate, the theoretical contribution of this study to the existing literature is, ecological capabilities are more effective when it is combined with collaborative mechanisms like supply chain integration, stressing the NRBV framework (Hart, 1995; Sarkis, Zhu, & Lai, 2011). Further, it also contributes to the research on born global companies, emphasising the importance of sustainability and integration for companies that internationalize quickly (Gabrielsson & Gabrielsson, 2009; Kuivalainen et al., 2023). Finally, it strengthens Global supply chain research by confirming that integration links environmental practices to innovation performance, contextualizing the Finland context (Cai, Jun, & Yang, 2010). In practical implications from the managerial perspective, this study suggests that management should see EMPs as a strategic tool for innovation rather than a regulatory requirement (Lozano, 2015; Dangelico et al., 2017). Investing in environmental management can lead to eco-innovations, stronger brands, and better competitiveness in markets that value sustainability (Triguero et al., 2013). Managers of born global firms should also focus on Global supply chain integration, building trust-based partnerships, and using digital tools like blockchain and IoT to improve

transparency (Kähkönen & Lintukangas, 2023). For policymakers, the study highlights the need for policies that encourage collaboration and help smaller firms integrate sustainability into their supply chains (European Commission, 2020; Ministry of Economic Affairs and Employment of Finland, 2021).

Nevertheless, this study has limitations too. Using only an online survey made it easy to collect data from many companies but didn't provide the deep insights that interviews or case studies could offer. Future research should combine surveys with qualitative methods to better understand managerial perspectives and context. The study was also cross-sectional, so it couldn't track changes over time. Longitudinal studies would help show how EMPs, GSCI, and STIP develop as sustainability and technology evolve (Teece, Pisano, & Shuen, 1997). Finally, since the focus was on Finnish born global firms, the results might not apply to all companies or industries. Comparative studies across countries and sectors could explore how different environments affect the relationship between EMPs, GSCI, and innovation (Chen et al., 2013; Kuivalainen et al., 2023).
For future research, it could expand on this study in numerous ways, including, utilization of mixed methods combining surveys with interviews or case studies will provide broader and deeper insights. Secondly, utilization of longitudinal research could help identify cause-and-effect relationships and show how companies' environmental and supply chain practices change over time (Albort-Morant et al., 2016). Third, comparative studies could look at differences across industries or countries to see how institutional and cultural factors affect the link between sustainability and innovation (Räty et al., 2023). Finally, future studies should pay more attention to how digital technologies enable sustainable supply chain integration, as Industry 4.0 tools are increasingly important for innovation (Bag, Pretorius, & Gupta, 2020).

In conclusion, this research study demonstrates how sustainability and innovation support each other, particularly the born global companies in the international business context. The study proves that Finnish born global firms that make environmental management a core part of their strategy and extend these practices through their

supply chains achieve better innovation and competitiveness. These findings support the idea that ecological responsibility, combined with collaboration, is a strategic resource that helps companies succeed in a world that increasingly values sustainability (Hart & Dowell, 2011; Kuivalainen et al., 2023). Ultimately, companies that align environmental practices with supply chain collaboration will not only secure long-term success but also contribute to broader environmental and societal goals.

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Appendices

Appendix 1. Final Questionnaire Design for SPSS

Section A: Demographic Questions

(Categorical/Nominal or Ordinal variables for control or descriptive analysis)

Code	Question	Options
D1	What is your job position?	CEO / Senior Manager / Middle Manager / Other
D2	How many years has your company been in operation?	<1 / 1–5 / 6–10 / 11–20 / >20 years
D3	What is the primary industry of your company?	Manufacturing / Services / Technology / Other
D4	What markets does your company serve?	Local / EU / Global
D5	Number of employees (Enterprise Size – **Control Variable**)	1 = ≤50, 2 = 51–300, 3 = 301–1000, 4 = >1000
D6	Does your company have a formal sustainability policy?	Yes / No / Planning to Implement

Section B: Environmental Management Practices (EMP)

Scale: 1 = No consideration, 5 = Fully implemented successfully
Source: Adapted from Xue and Gao (2004)

Code	Item
EMP1	We have established clear green/environmental management goals.
EMP2	We train employees on environmental awareness.
EMP3	We invest in pollution prevention and eco-efficiency.
EMP4	We comply with local and international environmental standards.
EMP5	We use sustainable/eco-friendly raw materials.

EMP6	We adopt green packaging and logistics practices.
EMP7	We measure and monitor environmental performance.
EMP8	We integrate environmental sustainability into corporate strategy.

Section C: Global Supply Chain Integration (GSCI)

Scale: 1 = Not at all, 5 = To a great extent
Sources: Flynn et al. (2010); Frohlich & Westbrook (2001)

Code	**Item**
GSCI1	We integrate planning and forecasting with our supply chain partners.
GSCI2	We share logistics and inventory systems with partners.
GSCI3	We share product demand and production data across the supply chain.
GSCI4	We use joint IT platforms with suppliers/customers.
GSCI5	We maintain strong communication and trust with partners.
GSCI6	We collaborate on product development with supply chain partners.
GSCI7	We share real-time environmental or sustainability data with partners.
GSCI8	We make joint decisions regarding production and sourcing.
GSCI9	We engage in sustainable practices jointly across our supply chain.

Section D: Sustainable Technological Innovation Performance (TIP)

Scale: 1 = Very Low, 5 = Very High
Focus: Technological performance in **sustainable innovation**
Sources: Yang et al. (2015); Hagedoorn & Cloodt (2003); Chen & Chen (2006)

Code	**Item**
TIP1	Launch of sustainable or green new products.
TIP2	Growth in sales of environmentally sustainable products.

TIP3	Speed of developing new eco-innovative solutions.
TIP4	Investment in sustainable R&D initiatives.
TIP5	Success rate of projects aimed at sustainability-driven innovation.

Appendices 2. Grammarly use disclaimer

In conducting this study, the author utilized Grammarly software to enhance the manuscript's grammatical consistency and clarity. This support was limited strictly to language refinement; all conceptual and analytical content represents the author's independent contribution. As English is not the author's first language, the software was employed solely to assist in producing a high-quality research paper. The work itself remains entirely the author's own.