Management International Review
https://doi.org/10.1007/s11575-026-00643-6

RESEARCH ARTICLE

Bridging Global Mandates and Local Realities: A Comparative Analysis of Environmental Upgrading of Salmon Global Value Chains

Umair Shafi Choksy[1,2] · Muhammad Ayaz[3] · Fraser Gorvett[1] · Wesley Malcorps[4] · Richard Newton[4]

Received: 21 January 2025 / Revised: 15 December 2025 / Accepted: 18 January 2026
© The Author(s) 2026

Abstract
This study examines the role of multinational enterprise (MNE) subsidiaries in facilitating environmental upgrading in value chains, with a specific focus on the salmon aquaculture sector. Addressing the critical challenge of Scope 3 emissions, this research investigates the dynamics between a French food MNE's UK subsidiary (Company X) in UK, acting as a Tier 1 supplier, and its lower-tier suppliers in Scotland and Norway. We explore how do multinational enterprise subsidiaries act as bridging mechanisms to mediate sustainability mandates and local institutional contexts, driving environmental upgrading and addressing Scope 3 emissions in the context of salmon value chains. Through qualitative analysis of interviews and secondary data, the findings highlight the subsidiary's bridging role in reconciling global corporate mandates with local institutional pressures. Institutional context plays a defining role in shaping subsidiary's bridging strategy with divergent implications for Scottish and Norwegian suppliers environmental upgrading.

Keywords Global Value Chains · Bridging · Environmental upgrading · Scope 3 emissions · Salmon Aquaculture · Greenhouse gas emissions · MNE subsidiary · Lower-tier suppliers

1 Introduction

Climate change presents an unprecedented challenge to global businesses and governments, necessitating transformative action across all sectors. Human activities, such as burning fossil fuels, industrial and agricultural activities, have contributed to increased greenhouse gases (GHGs) in the earth's atmosphere, which traps the suns heat, thus raising Earth's temperatures (Boehm, 2022; IPCC, 2018; United Nations, 2023). This phenomenon threatens the balance of ecosystems on which food supply

Extended author information available on the last page of the article

Published online: 16 October 2026

is dependent, posing worldwide concerns and a need for a system wide transformation in industry and agriculture value chains to reduce carbon footprints and GHG emissions (Mishra et al., 2022).

Multinational enterprises (MNEs) hold a pivotal role in this urgent response as they are significant contributors to GHG emissions and are therefore responsible for mitigation of GHG emissions in their global value chains (GVCs) (Buckley et al., 2022). Existing research often centres on the actions of MNEs, which are often lead firms in GVCs, overlooking the coordination of GVC actors and orchestrating the management of environmental sustainability (Golgeci et al., 2021; Khattak et al., 2015). We build upon this research agenda and respond to one of the calls on *the role of MNEs in addressing climate-change-related issues within their extended value chains* in this special issue.

To effectively tackle the environmental impact embedded in GVC operations, increasing attention is being paid to the phenomenon of *environmental upgrading*—that is, process of improvements in products, processes, and organizational practices that reduce environmental harm (Marchi et al., 2013a, 2013b, 2020). A key challenge in addressing environmental upgrading across GVCs lies in the complexity of GHG emissions accountability. The Greenhouse Gas Protocol (2004) categorizes emissions into three scopes. Scope 1 refers to *direct emissions* from an organization's own facilities and vehicles (e.g., fuel combustion on site). Scope 2 includes *indirect emissions* from purchased electricity, steam, or heating. Most critically, Scope 3 emissions cover *all other indirect emissions* across the value chain, including those from upstream suppliers and downstream product use and disposal. These emissions are typically the largest component of a firm's carbon footprint and the most difficult to control, as they require coordination beyond the firm's boundaries with actors such as raw material providers, transporters, and end-users. Understanding how MNEs engage with Scope 3 emissions is thus vital for advancing GVC-based sustainability transitions (Klaaßen & Stoll, 2021).

However, despite growing attention to sustainability, mostly environmental efforts in GVCs are focused on Scope 1 and 2 emissions with Scope 3 emissions often being ignored, due to complexities of doing end-to-end value chain analysis, even though in many sectors, and especially the *aquaculture salmon value chain* (the context of this study) they can make up most of a product's carbon footprint (Hammer et al., 2022; Newton & Little, 2018). Feed production, for instance, is the single largest contributor to Scope 3 emissions in farmed salmon production, responsible for over 90% of total GHG emissions up to the farm gate (Gephart et al., 2020; Newton & Little, 2018). In this study, we define environmental upgrading *as a multidimensional climate-change mitigation process by which firms enhance their capacity to minimize the emissions across GVCs*. This approach emphasizes systemic coordination and innovation beyond the firm's boundaries, particularly in upstream activities like feed sourcing and downstream utilization of processing co-products.

In this study, we argue that there is a need to move beyond the MNE and investigate the agency of other actors such as MNE subsidiaries and various tier suppliers in understanding environmental upgrading to minimize Scope 3 emissions, which often are overlooked (Marchi et al., 2020; Meyer et al., 2020). It is argued that a subsidiary-focused view of GVC could help illuminate the bottom-up process of

upgrading (social or environmental) followed by MNE subsidiaries to connect local suppliers with GVCs (Soliman et al., 2023). MNE subsidiaries are distinct entities that engage with the local institutional environments in various ways to gain strength within the MNE (Pananond, 2013).

GVC studies have explored the role of lead firms (Hammer et al., 2022) in reducing environmental impacts in their value chains. While MNEs are often cast as dominant actors in shaping environmental upgrading in GVCs, less attention has been paid to the intermediary and bridging (Soliman et al., 2023) role of their subsidiaries, particularly in orchestrating environmental upgrading across diverse supplier networks. Soliman et al. (2023) define bridging as *"activities that connect local value chain actors to GVCs …. Bridging involves transferring new meanings and practices that are sensitive to existing norms and relationships"* (p. 7). Despite growing recognition of the pivotal role subsidiaries play in GVCs, existing research has yet to fully explore their capacity in driving environmental upgrading, particularly in addressing Scope 3 emissions. Subsidiaries, often positioned between the strategic priorities of multinational headquarters and the operational realities of local suppliers, face unique challenges in bridging global sustainability mandates with local constraints and opportunities. Little attention has been given to how subsidiaries leverage their embeddedness within local institutional contexts to bridge collaboration and innovation among suppliers, particularly in sectors like aquaculture where environmental impacts are heavily concentrated upstream.

This study addresses the above gap and draws upon Soliman et al. (2023) to define bridging as subsidiary activities to connect, adapt, and implement global/local climate-change mitigation requirements (from MNE HQ, GVC lead firms, and local regulation) into locally embedded supplier practices. Our core research question is: ***How do multinational enterprise subsidiaries act as bridging mechanisms to mediate sustainability mandates and local institutional contexts, driving environmental upgrading and addressing Scope 3 emissions in the context of Atlantic salmon value chains?***

Through a case study design, this study explores the bridging role of a French MNE subsidiary operating in Scotland – Company X which functions as a Tier 1 processor in salmon GVC. This study looks at both MNE subsidiary Company X linkages with Tier 2 salmon producers as shown in Figure 1. As discussed in more details in the findings section, Company X is embedded in a multi-polar value chain whereby they are tasked with *bridging* global sustainability mandates into localized practices, while also adapting these practices to the specific institutional environments in which they operate (Soliman et al., 2023). While Company X has operational independence—including discretion over sourcing, supplier engagement, and implementation of sustainability initiatives—they remain strategically aligned with the MNE's global climate goals and science-based targets (SBTs).

In order to address our research question, we integrate insights from subsidiary bridging perspective (Soliman et al., 2023) and environmental upgrading framework (Krishnan et al., 2022) with complementary insights from Varieties of Capitalism perspective (Hall & Soskice, 2001). Our findings reveal that while suppliers in both regions invest in environmental upgrading initiatives, subsidiary's bridging mechanisms play a critical role in mediating external pressures and internal efforts into

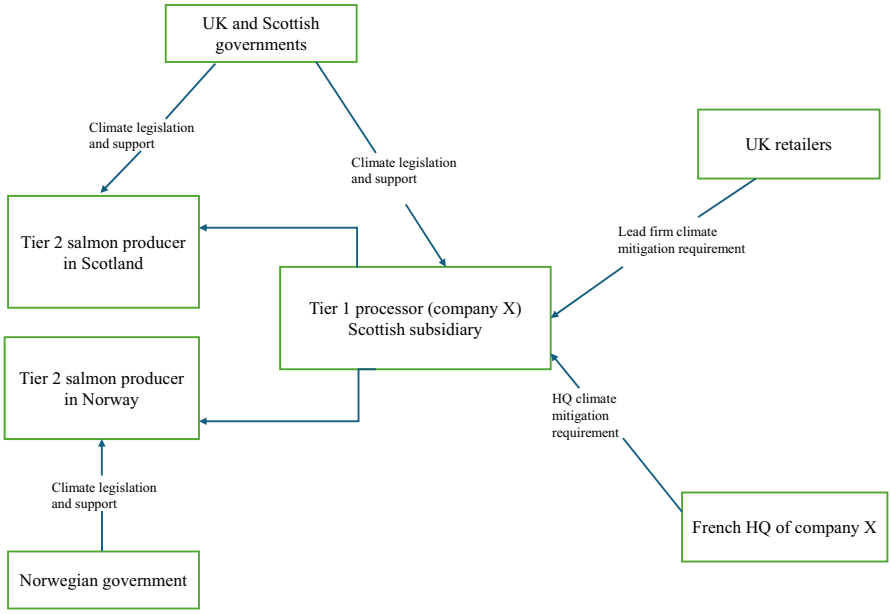

Fig. 1 Company X internal and external linkages (Authors' own based on interviews)

positive/negative environmental outcomes. Furthermore, the institutional context plays a defining role in shaping the pathways, outcomes, and distribution of associated costs.

Our study advances the environmental upgrading literature in global value chains (GVCs) by unpacking how value is created, appropriated, and translated into outcomes through the mediating role of multinational enterprise (MNE) subsidiaries. Extending Krishnan et al. (2022), we shift analytical focus from lead firms to subsidiaries as bridging mechanisms that interpret and align global sustainability mandates with local institutional and market contexts. Drawing on the Varieties of Capitalism perspective, we show how subsidiary strategies are shaped by national institutional configurations—Norwegian subsidiaries in coordinated economies foster biophysical improvements through public–private collaboration, while Scottish subsidiaries in liberal economies rely on compliance-oriented routines. This results in divergent patterns of environmental upgrading, where reputational and biophysical outcomes may align or decouple depending on the institutional context and bridging approach.

In the next section, we present the relevant literature and conceptual framework to position our study. After that, we will discuss the methodology and, finally, we will present our findings and discuss them to illuminate the theoretical contributions.

2 Literature Review and Conceptual Framework

2.1 Subsidiary as Tier 1 Supplier in GVCs

The traditional view of subsidiaries in the International Business (IB) literature has predominantly framed them as extensions of multinational enterprises (MNEs), primarily tasked with operational responsibilities determined by the headquarters (HQ) (Bartlett & Ghoshal, 1991; Rugman & Verbeke, 2001). Early studies largely positioned subsidiaries as passive actors, whose autonomy was limited to predefined mandates from the HQ. The focus was on vertical HQ-subsidiary relationships, with minimal attention to subsidiary agency or strategic decision-making capacity (Bartlett & Ghoshal, 1991). Recent research has shifted to recognize subsidiaries as entities capable of shaping their strategic roles within MNE networks (Birkinshaw & Hood, 1998; Cantwell & Mudambi, 2005). These studies emphasize the capacity of subsidiaries to engage in innovation, knowledge creation, and upgrading, particularly in response to local institutional demands and market conditions (Forsgren 2017).

Subsidiaries are increasingly positioned critical nodes within global value chains (Pananond, 2013). The concept of GVCs has become central to understanding the global economy in the age of globalization and is defined as a "nexus of interconnected functions and operations through which goods and services are produced, distributed, and consumed on a global basis" (Kano et al., 2020, p. 579). While previous studies have investigated subsidiary-HQ link, *in this study we explore the subsidiary's bridging role as a Tier 1 supplier within the GVC.* The bridging role of subsidiaries within GVCs is increasingly pivotal in balancing multiple layers of influence. Soliman et al. (2023) explore the bridging role of subsidiaries to connect local value chains with global value chains by addressing institutional voids via three bridging strategies – internalization, alliance and brokering. In our study, we focus on subsidiary operating at the intersection of pressures from headquarters (HQ), buyer-driven lead firms in GVCs, and the institutional environments of their local contexts in facilitating or hindering environmental upgrading. Understanding their bridging role requires integrating insights from the IB and GVC literature which mostly worked independently from each other (Buckley et al., 2017; Choksy et al., 2017).

As the traditional GVC literature (insights emerging from economic sociology and economic geography) explains that GVCs are governed by lead firms that control production practices, standards, and supplier engagement through mechanisms such as contractual agreements and codes of conduct (Gibbon et al., 2008; Golgeci et al., 2021). This places subsidiaries in a dual role of bridging global pressures (including internally from HQ and externally from lead firms in GVCs) and local institutional context. However, current studies have yet to understand this bridging role of subsidiaries in the context of minimizing Scope 3 emissions in value chains.

2.2 Environmental Upgrading and Agencies of Lower-Tier Suppliers

In the GVC literature, environmental upgrading is the process of improvement or reduction in environmental impact along the value chain (Khattak et al., 2015; Marchi et al., 2013a, 2013b). In the salmon industry, environmental upgrading is evident in innovations such as the development of sustainable feed, improved waste management, and recycling initiatives (Glencross et al., 2024; Gudbrandsdottir et al., 2021; Kenzhegaliyeva & Lund, 2024; Regueiro et al., 2022). For example, Norwegian salmon producers have employed advanced feed technologies to reduce carbon footprints, aligning production with the sustainability demands of global markets (Bush, 2018; Gudbrandsdottir et al., 2021).

The studies on environmental upgrading have generally focused on the impacts of various forms of governance mechanisms and conditions under which these are implemented to driving change in GVCs (Langford et al., 2023; Lund-Thomsen & Lindgreen, 2014; Marchi et al., 2013a, 2013b). In salmon industry, the GVC framework has highlighted the interplay between lead firms and producers, particularly in managing sustainability standards (Bush, 2018; Kenzhegaliyeva & Lund, 2024; Rainbird & Ramirez, 2012). Lead firms in Europe and North America often impose stringent environmental and quality standards, driving producers in countries to adopt innovative practices and technologies. These dynamics illustrate the governance of GVCs, where lead firms control access to high-value markets through regulatory and certification requirements (Van Der Ven, 2018). However, limited attention has been paid to the role of MNE subsidiary facilitating/hindering environmental upgrading particularly in the case of salmon GVCs.

However, focusing merely on Tier 1 supplier ignores the fact that much of the negative environmental impact in aquaculture GVCs originates from lower-tier suppliers (Klaaßen & Stoll, 2021). Scope 3 emissions—such as those arising from feed production, transportation, and ancillary services—pose significant challenges to achieving sustainability goals (Ababouch et al., 2022; Kenzhegaliyeva & Lund, 2024). This requires moving beyond the traditional focus on lead firms and Tier 1 suppliers.

In this study we draw upon Krishnan et al. (2022) to conceptualize environmental upgrading as a multidimensional climate-change mitigation process through which firms in GVCs improve their capacity to minimize emissions in GVCs. Krishnan et al. (2022) distinguishes between the processes of value creation (e.g., adopting green technologies, improving resource efficiency), the appropriation dynamics due to power asymmetries in GVCs and the environmental outcomes (e.g., reduced pollution, improved biodiversity). According to Krishnan et al. (2022) value creation for environmental upgrading is a process through which different GVC actors execute strategic practices to achieve certain environmental outcomes (e.g., waste minimization). While value creation relates to the active efforts to minimize Scope 3 emissions (e.g., sustainable sourcing, supplier engagement mechanisms), and value appropriation refers to how these efforts translate into competitive or strategic gains, the third component—environmental outcomes—represents the realized improvements in subsidiaries' and suppliers' capabilities to reduce Scope 3 emissions. This

framing allows us to locate mitigation efforts within the broader upgrading trajectory and evaluate them as evidence of improved environmental performance.

2.3 Institutional Context in GVCs

GVC literature emphasizes on how institutions influence the individual firm's upgrading. Whereas the early research on GVC was rooted in dominant firm governance (also known as private governance) and inter-firm relationship (Gereffi et al., 2005), the research focus has also incorporated to how national and subnational institutional context (aka public governance) influence the firms' development paths. Horner (2017) developed a model highlighting that governments take on diverse and changing roles in value chains, acting not only as regulators but also as producers, coordinators, and purchasers.

Horner and Alford (2019) expanded the framework by pointing out that subnational differentiation, varying strengths of government institutions, and interactions between public and private governance all shape how GVC work in different political settings. De Marchi and Alford (2022) reviewed how government involvement affects firm upgrading, with a particular focus on social and environmental aspects. They further examined how policy measures and institutional strengths impact firms' potential to improve economic, social and environmental upgrading.

In addition to insights from GVC studies, the VoC framework takes a broader institutional view for analyzing how various capitalist models affect companies' decision-making and innovation (Hall & Soskice, 2001). The Varieties of Capitalism (VoC) framework (Hall & Soskice, 2001) provides a particularly valuable approach for understanding strategic divergence. It distinguishes between Liberal Market Economies (LMEs), where firms coordinate primarily through competitive markets, and Coordinated Market Economies (CMEs), where firms rely on non-market forms of coordination, such as networks and collaboration with stakeholders. These systemic logics shape the capabilities firms develop and the forms of institutional support they rely upon—factors which in turn condition the choice between strategies like internalization versus alliance-based coordination.

The VoC framework in GVC allows for a systematic comparison of how firms in different institutional environments respond to similar demands for upgrading, helping to explain why upgrading outcomes vary across countries. Lane (2008) gives an example of such a situation, he noted that German firms benefit from strong local institutions, that help uphold high environmental standards, unlike firms in more loosely organized economies such as the USA, where these local connections are weaker. This comparison highlights how different capitalist models influence firms' ability to adopt sustainable practices, which results in varying levels of progress across firms within GVCs. Similarly, Rana and Allen (2024) show that institutional contexts influence how firms develop climate strategies, as navigating regulatory complexity plays a key role in shaping their sustainability efforts within GVC. The Institutional structure ultimately shape how effectively firms can deal with environmental issues like emissions control and resource management, thereby guiding the types of sustainability strategies they adopt. The findings reveal notable differences

that firms' ability to adopt sustainability varies widely and is shaped by the institutional and regulatory frameworks in which they operate. This highlights the importance of considering how institutional factors interacts with GVC dynamics to influence environmental upgrading outcomes in various national contexts.

2.4 Conceptual Framework

This study will integrate insights primarily from the multi-actor environmental upgrading framework (Krishnan et al., 2022) and subsidiary bridging framework (Soliman et al., 2023) to investigate how MNE subsidiary (acting as a Tier 1 supplier in salmon value chains) manages environmental upgrading in GVCs. We also take complementary insights from the VoC approach (Hall & Soskice, 2001) to understand the comparative GVC linkages of MNE subsidiary with Scottish and Norway lower-tier suppliers in achieving environmental upgrading. Figure 2 visualizes our integrated conceptual framework.

In terms of global pressures, subsidiary comply to HQ sustainability requirements as well as GVC lead firm's requirements. In terms of local institutional environment, subsidiary has to comply with the local policy environment related to GHG emissions. However, we also recognize that Tier 2 suppliers are themselves embedded within national institutional environments and global pressures. Thus, their environmental practices may reflect not only the influence of MNE and subsidiary coordination, but also exposure to local regulations and global sustainability discourses. MNE subsidiary is positioned as central mediators within GVCs highlighting the subsidiary's ability to bridge global/local pressures and the local institutional pressures to coordinate environmental efforts across the value chains to minimize Scope 3 emissions. Furthermore, Tier 2 suppliers play a pivotal role in the implementation of environmental upgrading process within GVCs, as they bridge the crucial connection between Tier 1 suppliers and Tier 3 suppliers (Sinkovics et al., 2021). These attributes position tier 2 suppliers as key actors in orchestrating sustainability practices to lower-tier suppliers, thereby amplifying the impact of environmental

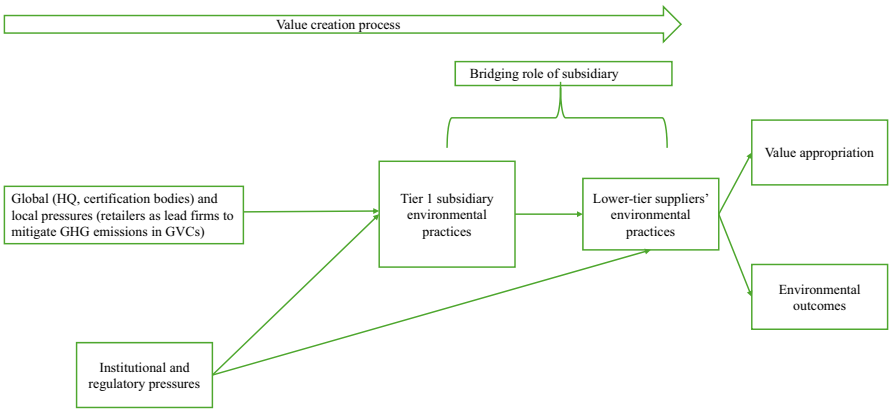

Fig. 2 Conceptual framework (Authors' own drawn from Krishnan et al., 2022 and Soliman et al., 2023)

upgrading throughout the value chain. These bridging mechanisms will in turn shape how the distribution of value and appropriation is achieved and the conditions under which biophysical and reputational environmental outcomes are realized.

3 Context

3.1 CO2 Emissions and its Dimensions

A carbon footprint refers to the total amount of greenhouse gases (GHGs), primarily carbon dioxide (CO_2), emitted by an individual, organization, product, or activity over a specific time frame throughout their life cycle including entire supply chains (World Resources Institute, 2004). It is measured in terms of CO_2 equivalents (CO_2e), which allows other GHGs, such as methane (CH_4) or nitrous oxide (N_2O), to be included based on their relative radiative forcing or Global Warming Potential (GWP). Scope 1 emissions are defined as direct emissions from owned or controlled sources (Greenhouse Gas Protocol Initiative, 2004). These are emissions that occur as a result of activities over which an entity has direct control. They can be further classified into two types: (1) Stationary Combustion: Emissions from the burning of fossil fuels for electricity, heating, or other energy services. For example, burning natural gas in a company-owned boiler or furnace. (2) Mobile Combustion: Emissions from the burning of fuel in company-owned vehicles and equipment, such as cars, trucks, and forklifts. Scope 2 emissions are indirect emissions from the consumption of purchased electricity, steam, heating, and cooling (Greenhouse Gas Protocol Initiative, 2004). These emissions are generated by the production of energy that is consumed by an organization, but the emissions occur outside the direct control of the organization. For example, if a company purchases electricity from a grid powered by fossil fuels, the emissions produced at the power plants are considered Scope 2 .

Scope 3 emissions are the most complex and extensive category of emissions, as they include all other indirect emissions that occur in the value chain of the reporting company, both upstream and downstream (Greenhouse Gas Protocol Initiative, 2004). This encompasses a wide range of activities beyond direct operations and energy use, such as: (1) Upstream Emissions: These include embodied emissions from the production of raw materials, purchased goods and services, transport, waste disposal, and capital goods. (2) Downstream Emissions: These cover emissions related to the use and disposal of products sold by the company. For example, the energy used by a household appliance. Scope 3 emissions are often the largest portion of an organization's total carbon footprint, but they are also the most challenging to measure and manage. These emissions typically occur beyond the boundaries of an organization's direct control and often require collaboration with suppliers, customers, and other stakeholders to reduce.

3.2 Global Salmon Aquaculture Industry

The context of this study is farmed Atlantic salmon aquaculture industry in Scotland and Norway. Aquaculture, the farming of fish, has emerged as the world's fastest-growing food production sector over recent decades, with output expanding from 15.4 million metric tons in 1992 to 94.7 million metric tons by 2023, although mostly freshwater species in Asia (OECD-FAO, 2023). In 2021, aquaculture accounted for approximately 52% of seafood destined for human consumption, with farmed salmon representing a significant share. In many countries, aquaculture directly contributes to national food security, especially in Asia. However, Atlantic salmon is considered a high-value species throughout Europe, the Americas and increasingly gaining traction among the growing middle classes in Asia (Budhathoki et al., 2024).

Approximately 80% of global salmon production is attributed to farming operations in Norway, Chile, Scotland, and Canada (GSI, 2023). The Atlantic salmon industry is characterized by its consolidation around a few large multinational corporations (MNCs) and its substantial contribution to global aquaculture.

MNCs dominate the salmon-farming sector. Mowi, the largest producer, operates across Norway, Scotland, Canada, and Chile, producing over 20% of the world's Atlantic salmon. Other major players include Lerøy Seafood Group, producing approximately 180,000 tons annually, and Cermaq, owned by Mitsubishi Corporation, produces approximately 200,000 tons annually. These companies not only control farming but also have vertically integrated operations extending to feed production, processing, and distribution. Despite their scale, these MNCs face mounting pressure to reduce GHG emissions and adopt sustainable practices (Gephart et al., 2020).

Feed production remains the primary challenge in Scope 3 emissions. The provision of feed, through sourcing and processing raw materials into ingredients for aquafeed, contributes in excess of 90% of climate-change emissions, henceforth referred to as Global Warming Potential (GWP), measured in CO_2 equivalents (Newton & Little, 2018; Pelletier et al., 2009). It is therefore paramount to reduce the amount of feed used and improve the impacts of the ingredients used within aquafeed per unit of edible yield supplied by the industry. The efficiency of feed to animal conversion is known as the economic Feed Conversion Ratio (eFCR), currently stands at around 1.3 (i.e., it takes 1.3 kg of feed to produce 1kg of live salmon), including accounting for losses during the production cycle (Aas et al., 2022). This is lower than for almost any other fed livestock species, yet there are substantial sourcing issues for feed ingredients which have raised concerns among academic and NGO communities.

Feed composition has changed markedly since the first commercial salmon production, over 50 years ago. Initially feeds were composed mostly of "marine ingredients" (Aas et al., 2022), i.e., fishmeals and fish oils (FMFO) made from dried and ground fish, particularly pelagic species such as anchovy and herring (Newton et al., 2023). However, due to multiple factors including higher prices resulting from limited supply and public criticism over perceived impact on fisheries, feed formulators have steadily replaced marine ingredients with more plant -based ingredients, such

as soy protein concentrate (SPC) and rapeseed oils, in salmon feed formulations (Aas et al., 2022).

Addressing Scope 3 emission challenges requires an understanding of the value chain activities between Tier 1 and lower-tier suppliers across Scotland and Norway, which serve as pivotal hubs for salmon aquaculture. *This study situates itself within this critical context, focusing on feed as the primary source of Scope 3 emissions and examining how key actors navigate the constraints and complexities of local and regional value chains.*

3.3 Introduction to Case Organization

The case study organization is a UK subsidiary of a French food multinational corporation here termed as Company X and primarily a Tier 1 salmon processor operating in Scotland selling processed salmon directly to UK retailers. The French HQ group employs 4600 individuals and generates approximately €1.1 billion annually. HQ sells products in sixty countries around the world. The UK subsidiary Company X specializes in sourcing, supplying, and processing smoked salmon where it is now currently one of the largest salmon processors in the United Kingdom (UK). Company X has a factory in Scotland where they process salmon, employing over 700 people and have been established for over thirty years, starting production in 1982. The activities of Company X predominantly involve the preparation and processing of seafood products, such as smoked salmon and shrimp.

4 Research Design

This study employs case study research methodology with a qualitative approach. We use a qualitative approach to capture the detailed account of interviewees' personal "experiences, behaviors, and beliefs" (Saunders et al., 2019). It is appropriate for addressing the interlinkages of Company X (Tier 1 Salmon processor) and Tier 2 salmon producers in Scotland and Norway and to investigate comparative perspectives on environmental upgrading.

4.1 Data Collection and Sampling

The primary data for this study is sixteen semi-structured interviews, including five interviews with French HQ of Company X employees (Employee A, C, and E) and Company X subsidiary (Employee A, Employee B, and Employee D), five interviews with Tier 2 salmon producers in Scotland (Supplier A, Supplier B, Supplier D), four interviews with salmon producers in Norway (Supplier C and Supplier E), and two interviews with a feed producer that produces feed for both countries (Supplier F) (See Table 1 for list of participants). The interview with the feed producer is to triangulate the insights from Tier 1 and Tier 2 suppliers.

The 'purposive sampling' technique is used for selecting the respondents. This is an appropriate technique and allowed us to select specific individuals in Company X

Table 1 List of participants

Label	Role	Company affiliation	Value chain role
Employee A	Head of aquaculture and quality	HQ of company X (France) and subsidiary (Scotland)	Tier 1 processor
Employee B	Environment manager	Company X subsidiary (Scotland)	
Employee C	Group CSR manager	HQ of company X (France)	
Employee D	Responsible sourcing & aquaculture manager	Company X subsidiary (Scotland)	
Employee E	Seafood purchasing director	HQ of company X (France)	
Supplier A	Environmental manager	Company X direct supplier in Scotland	Tier 2 salmon producer
Supplier A	Head of technical		
Supplier B	Communications and new business development director		
Supplier B	Sustainability business partner		
Supplier C	Technical manager		
Supplier D	Head of feed and sustainability	Company X direct supplier in Norway	
Supplier D	Chief commercial officer		
Supplier E	Product quality manager		
Supplier E	Head of sustainability		
Supplier F	Group head	Norwegian company - supplier of salmon producers in Norway and Scotland	Tier 3 feeds producer
Supplier F	Sustainability manager		

and their suppliers (salmon producers and feed producer) that were knowledgeable and had insightful information on the topic (Saunders et al., 2019).

Interviews were approximately sixty minutes in length and were conducted online. The interviews started with a pre-determined list of topics and key questions related to these topics which will guide the interview. This approach allows understanding of the "reality" of the phenomenon under study. The interview goal was to "find out what is happening and to understand the context" of GVC governance challenges for Company X and their Tier 2 suppliers in facilitating environmental upgrading regarding reducing GHG emissions and Carbon Footprint (Saunders et al., 2019). These were recorded with the consent of the interviewees and then transcribed verbatim in a Microsoft Word document.

In addition to the primary interview data, the study drew on a range of secondary data sources to enhance the depth and reliability of the analysis. These included internal documents and publicly available materials such as annual sustainability/CSR reports organizational climate-change strategy statements and news related to the company. Secondary data also included industry reports, academic literature on salmon aquaculture in Scotland and Norway, and relevant government publications. Internal documents obtained from the Company X Group Head of Aquaculture and Quality, and the Group Seafood Purchasing Director. These materials—comprising strategic board-level presentations and internal communications from 2021—offered insight into Company X's climate objectives, operational structure, and value chain priorities. The use of secondary data served a dual purpose: it triangulated and contextualize the qualitative interview data and provided a richer understanding of Company X bridging role and lower-tier suppliers strategies in relation to Scope 3 emissions. Particularly, the company CSR/sustainability reports, website and other information about participant companies have been very instrumental in finding data related to positive/negative environmental outcomes related to Scope 3 emissions. Together, these sources allowed for a more robust mapping of environmental upgrading efforts, appropriation and outcomes within the salmon supply chains in Norway and Scotland.

4.2 Analytical Approach

To explore how multinational enterprise (MNE) subsidiary bridge global sustainability mandates and local institutional environments in driving environmental upgrading—particularly regarding Scope 3 emissions—we adopted an abductive thematic coding approach on NVivo software grounded in the structured logic of Gioia et al. (2013) and Gioia et al. (2019). This approach was appropriate given the multi-actor nature of our research focus and the study's aim to refine and extend theoretical understanding rather than test predefined hypotheses.

An abductive approach allowed us to iteratively move between our empirical data and existing conceptual frameworks, enabling both confirmation and theoretical refinement. Our starting point was a conceptually informed coding template derived from our framework that integrated Krishnan et al.'s (2022) environmental upgrading and Soliman et al.'s (2023) articulation of subsidiary bridging mechanisms.

This initial structure served as a scaffolding for our aggregate dimensions and to some extent informed the second-order themes. The coding process remained open and grounded in participants' language and lived experiences, particularly at the first-order category (open coding) level. This allowed new patterns, practices, and interpretations to emerge organically, especially in relation to country-specific responses (e.g., contrasting institutional structures in Scotland and Norway) using VoC approach.

The second-order concepts are analytically deduced by the dimensions of environmental upgrading as set out in Krishnan et al. (2022), allowing for a coherent level of analysis. Such a structure also provided a rich micro-level reality to examine the cross-national variation in Norwegian and Scottish supplier experiences. We revised our thematic representation and coded data into first-order categories, which were clustered into second-order themes that were theoretically resonant. To illustrate, within the horizontal value creation, such categories as innovation infrastructure, investment in environmental initiatives, and multi-actor collaboration quality were involved.

Using the same approach, when it comes to environmental outcomes, we also differentiated between the biophysical outcomes (e.g., actual emissions reduction because of feed innovation), and market/reputational outcomes (e.g., reporting and certification branding). Table 2 is a complete coding scheme used in the work, including the relationship of the aggregate dimensions, the second-order theme, first-order category, and illustrative empirical material. The clarity of this structure will enable the reader to follow our suggestion about the grounding of our knowledge in data and at the same time the theoretic improvement.

To ensure rigor and consistency, all transcripts were double-coded by two researchers using NVivo, with discrepancies discussed and resolved in iterative coding sessions to ensure intercoder consistency and reliability. We also developed comparative coding templates for Scottish and Norwegian supplier contexts and for subsidiary mechanisms, which facilitated transparent cross-case analysis and theoretical synthesis.

These templates provided a systematic mapping from grounded empirical data to higher-level theoretical categories, supporting both analytical depth and methodological transparency.

5 Findings

In the following sections, we apply our conceptual framework on subsidiary bridging perspective to highlight the comparison between Company X' linkages with Tier 2 suppliers in Scotland (Supplier A, Supplier B and Supplier D) and Company X' linkages with and Tier 2 and Tier 3 suppliers in Norway (Supplier C, Supplier E and Supplier F) engage in environmental upgrading, to what extent they appropriate value from environmental upgrading and their environmental outcomes. A comparative analysis of Company X's interactions with its Scottish and Norwegian Tier 2 suppliers highlights distinct approaches to environmental upgrading.

Table 2 Coding for environmental upgrading

Aggregate dimension	Second-order themes	First order categories	Empirical examples
Environmental upgrading process – value creation	Vertical (top-down) value creation	Unilateral goal-setting	Retailers, HQ, subsidiary mandate ESG criteria to maintain access to premium markets (UK, EU), with no consultation with upstream actors.
		Mandatory scope 3 data reporting	Company X requires quarterly Scope 3 data updates from salmon producers, with no financial or technical support.
		Feed supplier mandates	Norwegian salmon firms mandate all feed suppliers to switch to certified deforestation-free soy.
	Horizontal-value creation	Innovation infrastructure	In Norway, cross-sector innovation platforms (e.g., NCE Seafood, Blue Maritime Cluster, SINTEF) bring together state bodies, research institutions, feed producers, and farmers, co-producing low-carbon technologies (e.g., algae feed, Scope 3 dashboards). State R&D incentives or grants for low-carbon transitions are underfunded.
		Investment in environmental initiatives	Government support is structured, proactive, and long-term, often tied to regional development or biodiversity regeneration. Aquaculture-specific public funding (e.g., the Marine Fund Scotland) rarely prioritizes Scope 3 transformation, and interviews reveal perceived detachment of policymakers from aquaculture realities. The Scottish government lacks an industrial aquaculture strategy tied to environmental upgrading. Support is often short-term and framed as regulatory enforcement, not innovation.
		Nature of collaboration between non-firm actors and firm actors in GVCs	Producers report isolation in facing certification demands, with "no one to turn to" for support or co-learning. In contrast to Norwegian clusters, Scottish pre-competitive collaboration remains weak—NGOs, universities, and producers do not systematically engage with each other. Scottish producers note that state actions are reactive, responding only after NGO pressure, often resulting in blunt regulatory imposition without capacity-building. Certification schemes like ASC standardize expectations, but offer little flexibility for regional contexts (e.g., Scottish marine conditions).

Table 2 (continued)

Aggregate dimension	Second-order themes	First order categories	Empirical examples
	Bottom-up value creation	Voluntary initiatives	Norwegian salmon and feed producers lead innovation in sustainable feed; adopted voluntarily before certification mandates. Some Scottish producers independently trial biodegradable packaging without retail reward.
Environmental upgrading process – Value Appropriation	Direct appropriation by lead firms	Reputational gain via supplier data	Retailers and HQ report ESG wins in investor presentations using supplier Scope 3 data (CDP, SDG targets). HQs benefit from cost-free reputational gain, passing implementation burden downstream.
		Certification fee extraction	Certifiers (ASC, GlobalGAP) extract fees for audits and trainings without delivering technical upgrading. Scottish salmon producers describe audits as "tick-box exercises" with no feedback or system-level learning.
	Indirect appropriation via value-neutral conduits	Standard translation without redistribution	Certification bodies operate as conduits, translating emission reduction expectations into mandatory processes without redistributing value or power (e.g., third-party carbon tracking standards enforced by HQ but designed by certifiers). Certification processes are too rigid, particularly in Scotland where two producers exited ASC in 2023 citing disproportionate cost-benefit.
	Indirect appropriation via environmental burdens	Cost burden of green inputs	Cost of algae-based feed or biodegradable trays borne by salmon producers. Transport decarbonization demands (e.g., switching to train or electric fleet) are unfeasible for remote Scottish farms. No support offered for Scope 3 measurement software implementation or training.
		Loss of autonomy despite compliance	Company X's Scottish suppliers describe "compliance as punishment," citing loss of autonomy and rising costs despite "doing the right thing."

Table 2 (continued)

Aggregate dimension	Second-order themes	First order categories	Empirical examples
Environmental upgrading outcomes	Biophysical outcomes	Feed innovation outcomes	Measurable emissions reductions from algae feed (Norway) and eco-packaging (both regions).
		Certification-aligned Metrics	In Norway, Feed traceability systems improve awareness among producers (Scope 3 dashboard pilots).
	Market/reputational environmental outcomes	Investor reporting	Retailers and HQs use emissions data in marketing (green labels, SDG alignment).
		Certification labeling impact	Certification logos improve market access in UK/EU for compliant firms. Some suppliers describe carbon emission reduction requirements as "badge-based" branding rather than systemic change.

5.1 Sources of Scope 3 Emissions in Company X Salmon Value Chain

Based on our interviews with participants from Company X subsidiary and its French HQ, we mapped the Salmon Aquaculture Value Chain of Company X (See Figure 3 for detailed salmon value chain of Company X), comprising several interconnected stages, with feed-related emissions as the dominant contributor across the chain. The value chain includes feed suppliers of Atlantic salmon, farming operations in Scottish and Norwegian fish farms, primary processing, secondary value-addition processing, distribution, and retail (Company X documents, 2021).

Table 3 summarizes the sources of Scope 3 emissions in the Salmon value chain.

Feed production remains the dominant source of environmental impact in fed aquaculture to farm gate (Bohnes et al., 2018). *Feed production* accounts for 90% of Scope 3 emissions (Newton & Little, 2018), making it the most significant environmental challenge in the value chain. This is primarily driven by emissions from energy-intensive processes required to produce feed ingredients such as emissions of nitrous oxide from managed soils, along with the effects of deforestation and processing energy to transform the raw crops to high-performance ingredients. Salmon require few other inputs, such as heating, compared with terrestrial livestock, so that feed is the dominant source of GHGs (Naylor et al., 2021; Tlusty et al., 2019). One of the Tier 2 Salmon producers mentioned: *"Deforestation and land-use for soy sourcing in feed are persistent challenges"* (Supplier E). Along the same line, one of the Company X employees shared: *"Our supply chain depends on feed that comes with a high embedded carbon footprint from soy and marine ingredients*" (Employee E).

Feed production is inherently energy-intensive, as it involves the processing of raw materials like fishmeal and soy protein concentrate. The energy requirements for feed manufacturing facilities, including drying, milling, and mixing, are substantial and depend heavily on nonrenewable energy sources. One of the Salmon producers said, *"Feed production facilities rely on substantial energy inputs, often non-renewable."* (Supplier D). Similarly, Supplier A mentioned, *"The energy footprint of feed production contributes to emissions across the chain."* (Supplier A).

One effort to increase the supply of fish meals fish oils (FMFO) has been to *recycled fish byproducts..* , Although the FMFO from byproducts is considered of lower quality than from forage fish, the practice reduces fishery waste and provides valuable nutrition to farmed fish. The process still generates moderate emissions,

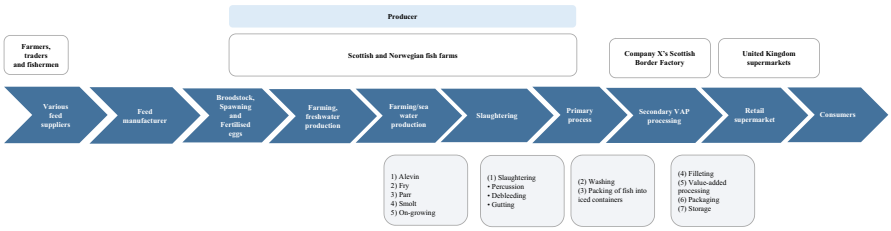

Fig. 3 Salmon value chain (Authors' own based on interviews with company X participants)

Table 3 Sources of scope 3 emissions

Source	Contribution to scope 3 emissions	Link to feed	Selected evidence from transcripts
Feed production	90%	Energy-intensive production of feed ingredients, including fishmeal, fish oil, and soy.	"We collaborate to ensure feed meets certifications... requires understanding of raw material sources and environmental standards." (Supplier D) "Deforestation and land-use for soy sourcing in feed are persistent challenges." (Supplier E) Our supply chain depends on feed that comes with a high embedded carbon footprint from soy and marine ingredients." (Employee E)
Transportation	Moderate	Long-distance transport of feed ingredients from production sites to manufacturers and farms.	"Feed logistics... depend heavily on transport modes, adding to emissions."(Supplier A) "Logistics optimization for feed is critical due to geographical isolation of Scottish farms." (Supplier D) "The logistics of feed transport, especially to Scottish farms, adds emissions due to geographic isolation and reliance on imported ingredients." (Employee D)
Packaging	Moderate	Use of non-recyclable materials for feed packaging.	"Feed packaging plays a small role, but recyclability is a challenge." (Supplier B) "Feed packaging is necessary for preservation during transport, but we face issues with non-recyclable materials contributing to emissions." (Employee E)
Energy use	Significant	High energy use in feed manufacturing processes, including drying and milling.	"Feed production facilities rely on substantial energy inputs, often non-renewable." (Supplier D) "The energy footprint of feed production contributes to emissions across the chain." (Supplier A)
Waste management	Moderate	Recycling fish byproducts (fishmeal and fish oil) contributes to emissions.	"Recycling marine byproducts, while helpful, carries embedded emissions from sourcing and processing." (Supplier B)

originating from the initial capture and processing of marine resources, but considerably less than most other marine ingredients and much lower than plant ingredients (Netwon et al, 2023). As one of the Tier 2 producers mentioned *"Recycling marine byproducts, while helpful, carries embedded emissions from sourcing and processing."* (Supplier B).

Transportation is comparatively lower contributor to Scope 3 emissions in Company X-led GVCs, with feed logistics playing a significant role. Feed ingredients, such as soy and fishmeal, are often transported over long distances from production sites to feed manufacturers and subsequently to salmon farms but as they are usually transported by ocean freight, these emissions are low, although the remoteness of fish farms can add to those emissions (Aas et al., 2022; Gephart et al., 2020; Newton & Little, 2018). One of the employees of Company X mentioned: *"The logistics of feed transport, especially to Scottish farms, adds emissions due to geographic isolation and reliance on imported ingredients"* (Employee D).

Feed packaging also contributes to the carbon footprint of the value chain, albeit to a low extent. The packaging materials used for feed, often plastics, indirectly add to emissions. These materials are necessary for protecting and transporting feed, but their environmental impact is compounded by limited recyclability and reliance on fossil-based resources. Company X employee shared: *"Feed packaging is necessary for preservation during transport, but we face issues with non-recyclable materials contributing to emissions."* (Employee E)

5.2 Bridging Role of Subsidiary to Mitigate Scope 3 Emissions

Salmon value chain of Company X as a whole can be characterized as multi-polar (Ponte & Sturgeon, 2014)[1] whereby multiple firm and non-firm actors govern the value chain. Our analysis shows that Company X's approach to tackle the Scope 3 emissions was dictated by a complex interplay of influences from Company X's headquarters (HQ), buyer-driven lead firms within the global value chain (GVC), and the local institutional environment. Each of these actors and institutions exerts varying degrees of control, enabling Company X to *bridge* these global and local forces through a mix of internalization and alliance strategies. Figure 1 summarizes the internal and external linkages of Company X and multiple influences over climate-change mitigation requirements.

In terms of Company X's linkages with HQ, our interviews show moderate influence of Company X's HQ in former's environmental practices. Strategic functions such as salmon procurement, environmental policy, and overall oversight are closely coordinated with the wider Group and the other UK subsidiary. This integration is reinforced by the Group's centralized governance structure, where key personnel—such as the HR Director, Supply Chain Director, and Head of Aquaculture—are employed by the parent company and have oversight across both UK subsidiaries. As Employee E (HQ) highlighted:

[1] Multi-polar chains are governed by multiple actors and the direction of power and strategic influence from both firm and non-firm actors (Ponte & Sturgeon, 2014)

"The new sustainability roadmap has been defined and climate stakes have been put at the core of our sustainability strategy, which is led by the top management of the company."

For instance, Science-Based Targets (SBTs)[2] facilitate companies to set emission target in terms of tackling environmental issues across the value chain. Company X HQ encourage all subsidiary's commitment to SBTs[3] and their efforts to encourage suppliers to adopt similar standards. Their focus was on reducing deforestation in feed production, promoting sustainable fishing practices, and encouraging more local sourcing of ingredients. As a result, Company X required its Tier 2 suppliers to ensure that feed manufacturers implement a sustainable feed sourcing initiative, eliminating deforestation and land conversion from its supply chain, particularly in the production of salmon feed since 2020. Furthermore, through collaboration with WWF Brazil, the HQ influenced Company X to establish a comprehensive monitoring, reporting, and validation system ensuring their soy-based feed does not contribute to deforestation. As Employee D from Company X commented: *We've also agreed a monitoring, reporting and validation system that was set up with WWF Brazil to make sure that no soya was associated with deforestation."*

UK supermarkets, as lead firms in the aquaculture value chain, exerted significant influence throughout the chain. Complying with the national (UK) and local (Scottish) policy environment, lead firms pass down their climate targets and environmental standards to their Tier 1 supplier, Company X, who then enforces these targets/standards toward the Tier 2 supplier producers. Essentially, the UK supermarkets' motivation to minimize GHG emissions along the value chain is underpinned by pressure from third-party certification bodies such as GlobalGAP and Aquaculture Stewardship Council (ASC) [4] standards that have become prevalent norms among salmon value chain players for good farm practices. Most supermarket chains demand producers to be accredited with at least one certification label which create transparency and accountability, which can then be communicated to customers. In return certification makes it easier for producers to demonstrate their commitment to sustainability and access lucrative markets with a consistent level of expected performance.

[2] The **Science-Based Targets initiative** (**SBTi**) is a non-profit climate action organization that help companies to set emission reduction targets in line with climate sciences[4] and Paris Agreement goals. It partners with the Carbon Disclosure Project (CDP), the United Nations Global Compact, World Resources Institute (WRI) and the World Wide Fund for Nature (WWF)..

[3] Company X set its own SBTs, depending on if the supplier has capability to do so. This initiative demonstrates a shared commitment toward reducing greenhouse gas (GHG) emissions in alignment with the Paris Agreement goals. The resolve to adhere to SBTs by 2026 underlines a rigorous approach toward environmental conservation and upgrading.

[4] The Global GAP is a certified standard, recognized internationally which ensures 'Good Agricultural Practices'. Further, it outlines global standards that act as a safeguard for various elements such as health and safety, animal welfare, food safety and environmental protection; with specific focus on agricultural produce, livestock and aquaculture. The ASC is an internationally leading and recognized certification programme for farmed seafood, such as Salmon, working closely with their partners in the industry.

Retailers impose stringent sustainability standards, including requirements for carbon footprint reductions and improved packaging practices. These targets are built into Company X's climate road map which is shared, codified and passed down to Tier 2 suppliers including yearly supplier assessment and questionnaire, where it's an "*assessment of their performance on different sustainability issues, including climate. So, we assess what is the ability of our suppliers to help us to reach our targets. So that's part of the yearly assessments among other criteria"* (Company X Employee D). This annual assessment involves a qualitative and quantitative questionnaire that is self-reported by suppliers.'

Beyond the emissions from sourcing/production of feed, the analysis reveals that Company X also took action to mitigate the emissions associated with transporting raw materials for feed production. Recognizing road and air freight as significantly detrimental to the environment due to their high pollution levels, the company acknowledges sea travel and train transport as a considerably more eco-friendly option, though it still contributes to the overall carbon footprint. This approach applies not only to feed ingredients but also to the transportation of the final salmon product.

Before we elaborate on the bridging mechanisms, it is pertinent to discuss differences in institutional environment between Norway and Scotland which help illuminate the ways in which the strategies of Company X vary in both context.

5.2.1 Institutional Differences Between Norway and Scotland

Norway and Scotland exemplify two distinct institutional configurations within the *Varieties of Capitalism* (VoC) typology (Hall & Soskice, 2001), and these differences shape how firms pursue environmental upgrading. Norway conforms closely to the Coordinated Market Economy (CME) model, where governance is characterized by high levels of stakeholder engagement, tri-partite cooperation among the state, industry, and civil society, and long-term, trust-based relationships. Environmental governance in Norway reflects a co-regulatory model—favoring negotiation, mutual adjustment, and collaborative goal-setting—rather than a command-and-control approach. In contrast, Scotland (and the broader UK) fits the Liberal Market Economy (LME) model, where coordination occurs primarily through competitive markets, and relationships tend to be more transactional and arm's-length. Environmental regulation in this context is more fragmented, with less integrated coordination between state and industry actors (Jackson & Deeg, 2008; Witt & Jackson, 2016).

These macro-level institutional differences manifest clearly in the governance of environmental upgrading. In Norway, environmental objectives are embedded within a broader system of industry-state collaboration, which has produced a range of innovative policy tools. For instance, the *Green Permit* and *Development Permit* programs are designed to incentivize firms to improve environmental performance through technological innovation (Hersoug et al., 2019). Under the development concession scheme, firms receive additional production licenses in exchange for demonstrating environmental improvements over baseline technologies. Such programs not only reward innovation but also reinforce producers' commitment to

public regulatory goals. Norwegian farmers continue to participate in these schemes and remain loyal to the regulatory regime, reflecting a high degree of institutional trust and alignment (Aarset et al., 2020). Importantly, the Norwegian regulatory system is adaptive: it has evolved in response to the sector's dynamic and contested nature, and continues to adjust to emerging environmental risks and new knowledge (Osmundsen et al., 2017). This creates a governance context in which co-creation and learning are incentivized and where local knowledge is systematically leveraged to meet collective sustainability targets.

At the firm level, these institutional characteristics underpin a highly coordinated value chain. Norwegian salmon producers operate with structures that support collaborative sustainability practices. One Norwegian supplier explained their relationship with Company X as follows: "We do share a lot of knowledge between ourselves and we have a long-term relationship." This partnership model involves regular meetings, joint audits, and collective alignment on carbon footprint and GHG emissions metrics. Such coordination is made possible by the supportive institutional infrastructure of the CME context, which fosters trust and long-term alignment between buyers and suppliers.

By contrast, Scottish suppliers and processors function in a more fragmented institutional environment that offers fewer structural supports for coordination. Relationships are frequently transactional and compliance-driven. As one Scottish processor described: "We have several requirements, codes of conduct and standards … that we need to adhere to in order to supply them with our products." These relationships involve clear specifications from buyers but limited engagement beyond contractual terms. While collaboration does occur, it is typically initiated and directed by the lead firm and lacks the systemic support for reciprocity and long-term joint problem-solving that characterizes the Norwegian model.

This divergence extends to how Scope 3 emissions—those generated across the value chain—are managed. In Norway, feed producers and salmon farmers proactively engage in Life Cycle Assessments and align sourcing decisions with sustainability standards such as the ASC Feed Standard, often despite high administrative and operational burdens. In Scotland, by contrast, the responsibility for Scope 3 mitigation is frequently pushed upstream to suppliers, and upgrading tends to be framed in terms of cost-efficiency or compliance with retailer mandates, rather than as a shared institutional goal.

5.2.2 Strategic Implications: Bridging via Alliance versus Internalization

These contrasting institutional environments help explain the different upgrading strategies adopted by the multinational firm studied. In Norway, where institutions support collaboration, Company X pursued a "bridging as alliance" strategy (Soliman et al., 2023), partnering with suppliers and other stakeholders to co-create environmental solutions. The strategy benefits from the CME context's facilitation of joint problem-solving and long-term coordination.

In Scotland, the same Company X adopted a "bridging through internalization" strategy, whereby it translated external sustainability demands—particularly from UK retailers—into its own internal compliance standards, which were then imposed

upstream on suppliers. This approach reflects the characteristics of a Liberal Market Economy (LME), where weaker institutional support for coordinated action leads the subsidiary to function more as a compliance enforcer than a collaborative partner in driving environmental upgrading. These divergent strategies are not simply the result of managerial discretion but are shaped by the institutional environments in which subsidiaries and suppliers are embedded.

The following section provide detailed explanation of Company X's strategies and the dynamics of environmental upgrading using the theoretical framework discussed earlier. Table 4 provides an overview of the findings from each firm's perspective participated in this research.

5.3 Bridging Through Internalization

Bridging through internalization refers to the strategy of Company X and its Scottish salmon producers to integrate external pressures (local, global, institutional), such as sustainability regulatory mandates and lead firm requirements, into internal practices and operations to ensure compliance for environmental upgrading across the value chain. Table 5 provides the integration of bridging and environmental upgrading perspectives to unpack the bridging as internalization from Company X engagement with Scottish suppliers.

5.3.1 Environmental Upgrading – Value Creation

Value creation process is mainly driven by top-down (vertical) process, where Company X's subsidiary acts as a compliance transmitter, enforcing retailer and HQ-defined Scope 3 KPIs. Underpinning this process is the horizontal influence of certification bodies—particularly ASC and GlobalGAP—whose stringent frameworks are a key reason UK supermarkets embed these requirements. As a result, Company X is increasingly demanding (primarily driven by external pressures) Scottish Tier 2 suppliers to locally sourced crops for feed production instead of importing feed from geographically distant markets. According to interviews with both Company X and Scottish Tier 2 suppliers, several local feed manufacturers have taken proactive steps to offering specialized diets for salmon. These diets are carefully formulated using locally sourced plant proteins, which stakeholders perceive as reducing the carbon footprint of feed production. However, while shifting to local sourcing of feed reduces transport emissions linked to feed, it does not necessarily reduce the overall Carbon Footprint (Newton & Little, 2018) as echoed by some respondents. *The replacement of marine ingredients with plant materials... you're having to grow stuff and ship it halfway around the world. Is that better or worse than marine ingredients that are around the local area? So, there has to be a balance."* (Supplier D)

Furthermore, Scottish Tier 2 suppliers optimized logistics by minimizing empty trips and exploring alternative transport modes has been adopted to reduce emissions from feed transportation: *Key thing is never to have our truck running empty at any time. If there's no fish boxes coming in, it will take feed in, and so on and so forth, so you never have an empty truck running* (Supplier B)

Table 4 Environmental upgrading of sample participant companies

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Company X	Supplier code of conduct requires salmon suppliers to report Scope 3 emissions and adopt lower-emission feed and packaging practices	**Direct appropriation by Lead firms:** HQ profitability stable, but subsidiary margins under pressure due to higher procurement costs	**Reputational outcome:** Reported increased % of supply under ESG-evaluated contracts (now over 80%)	Company X CSR reports 2023–24
	Developed internal ESG scoring system influencing supplier selection	Interview data reveals increasing sustainability-driven procurement costs not offset by retail price—margins	Supplier disclosures improved (e.g., feed emission transparency, freight carbon data)	Interview: Employee A (HQ), Employee B (subsidiary), Employees C–E (HQ + subsidiary)
	Encourages use of low-emission transport and reusable packaging materials	Strong buyer power allows influence over supplier ESG compliance. Limited willingness to share cost burden with suppliers	**Biophysical outcome** Packaging weight per unit reduced (− 8%), linked to Scope 3 efficiency targets	Company X subsidiary website
	Participated in pre-competitive sustainability forums to harmonize Scope 3 metrics across suppliers		Limited traceability on actual supplier Scope 3 performance beyond reported indicators.	
	No in-house production; efforts focus on upstream influence via procurement and contractual obligations			

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier A–Scottish salmon producer)	Fully integrated feed production with deforestation-free soy and novel proteins	**Direct appropriation by buyers and indirect appropriation through negative environmental transfer:** *costs absorbed by supplier*	**Biophysical outcome**	Annual report 2024
	Co-development of carbon tracking tools with logistics providers	Revenue: £822 million	Achieved 15% Scope 3 reduction by 2023 (vs. 2020 baseline)	Sustainability chapter
	Use of internal carbon pricing to guide investment	Operating profit: £174 million	Measurable gains in embedded emissions from feed and freight	Interview findings
	Science-Based Target Initiative (SBTi) commitment: −52% Scope 3 per tonne by 2030 (vs. 2020 baseline)	Net profit: £127 million Interview insight: Despite solid topline, company is absorbing sustainability costs (e.g., feed, freight) with no buyer premium, which "affects the bottom line"	**Reputational outcome:** Improved supplier data and emissions transparency	

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier B–Scottish salmon producer	Feed reformulation with higher-quality marine inputs	**Indirect appropriation via negative environmental transfer:** *Certification paused limits ESG capture; high treatment costs = supplier bears costs with no value return*	**Biophysical outcome** Packaging emissions cut by 51% (2023 vs. 2021)	Company annual accounts 2023
	Supplier collaboration to reduce packaging emissions	Revenue: ~£277 million (flat YoY)	Reduction in Scope 3 emissions related to packaging and feed efficiency (not fully quantified)	Company environmental report
	Switched to reusable harvest bins to cut single-use plastics	Operating loss: ~£23 million	**Reputational outcome:** Continued efforts in supplier-side emission reporting	Interview findings
	Use of hybrid power systems on feed barges	High biological losses and treatment costs eroded operational margins		
		Paused ASC certification limits further ESG market access		

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier D–Scottish salmon producer)	Own feed mill enabling control over input quality and logistics	**Indirect appropriation through negative environmental transfer:** *Profit ↓ despite revenue ↑; efficiency gains outweighed by rising costs*	**Biophysical outcome** Significant packaging waste reduction (− 46%)	Company annual accounts 2023
	Hybrid vessels and feed barges to reduce fuel-related emissions	Revenue: £243 million (+ 17% YoY)	Indirect transport emissions reduced (no specific Scope 3% disclosed)	Company sustainability report
	Partnerships with local suppliers to reduce transport emissions	Net profit: £21.2 million (− 21% YoY)	**Reputational outcome:** Improved traceability of feed and input sources	Interview findings
	Circular economy practices (e.g., repurposing organic marine waste)	Rising feed and energy costs outweighed sustainability efficiency gains		

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier C–Norwegian salmon producer)	Early adopter of deforestation-free feed (since 2020)	**Partial direct appropriation by the salmon producer**	**Biophysical outcome** Achieved 12% Scope 3 reduction (2020–2023), mainly via feed sourcing changes	Company website
	Integrates renewable energy into operations	Feed and renewables initially affected profit margins. However, improved feed conversion ratio (FCR) has driven long-term savings per unit	Logistics carbon intensity reduced through route optimisation	Interview with two managers
	Requires supplier GHG disclosure and actively tracks logistics-related Scope 3 emissions	GVC role strong in reputation, but still subject to buyer control over price terms	**Reputational outcome:** Supplier engagement led to improved data quality and transparent GHG reporting	Industry news
	Publicly aligned with SBTi (Science-Based Targets initiative)			

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier E–Norwegian salmon producer)	Full transition to deforestation	**Indirect appropriation via market structure:** *High investment; value retained* via *ESG access (UK/EU/US) = value recaptured* via *market preference*	**Biophysical outcome** 37% reduction in carbon intensity from 2019–2023	Sustainability reports 2021–2023
	Free soy in feed	Feed efficiency has led to long-term operational savings	**Reputational outcome:** 100% certified deforestation-free soy achieved	Aquaculture magazine ESG feature (2023)
	Shift from road to rail in transportation, cutting upstream emissions	High upfront investments, but reduced emissions per fish produced	Strong lifecycle analysis tools and supplier ESG audits in place	Trade briefings
	Emphasis on feed efficiency (low Feed Conversion Ratio) to reduce embedded emissions	ESG compliance with buyer KPIs prevents exclusion from high-value markets	Focused emissions tracking from feed input to harvest	Interview findings
	SBTi-aligned targets: 35% reduction across GHGs, including Scope 3	Maintains preferential access to UK, EU, and US markets due to ASC standards		

Table 4 (continued)

Company	Value creation	Value appropriation	Environmental outcomes	Data sources
Supplier F–Norwegian feed producer)	RegenConnect program to promote regenerative farming on upstream feed crops (cover crops, reduced tillage)	**Indirect appropriation via indirect appropriation through negative environmental transfer:** *No cost pass-through to buyers*	**Biophysical outcome** Report doesn't yet quantify total Scope 3 reductions but indicates progressive improvement in feed sourcing carbon data	Company 2024 impact report
	Deforestation-free soy commitment by 2025 in key soy-sourcing countries (e.g., Brazil)	High investment in ESG and digital tools without cost pass-through to buyers	**Reputational outcome:**	Interviews findings
	Supplier GHG dashboards rolled out across networks for better Scope 3 visibility.- Targeting 30% Scope 3 reduction by 2030	Company absorbs sustainability costs	Over 10 million acres under regenerative farming Improved traceability and early evidence of upstream emissions decline, especially in feed	

Table 5 Bridging as internalisation

Dimension	Sources of pressure & influence *(retailers, certification bodies, HQ, regulation)*	Company X subsidiary bridging strategy	Impact on Scottish salmon producers
Value creation	Retailers demand certified, traceable supply chains Certification bodies (ASC, GlobalGAP) shape audit frameworks adopted by HQ and enforced by subsidiaries. HQ sets Scope 3 KPIs (e.g., sustainable feed, packaging, logistics). UK/Scottish regulation (e.g., plastic ban, net-zero goals) adds legal pressure but with minimal support.	Translates retailer, HQ and certification expectations into operational audits and requirements. Acts as enforcer: mandates suppliers to submit carbon data, switch to certified inputs. Provides informal capacity-building (e.g., emissions templates), but not financial support.	Required to adopt low-carbon inputs (feed, packaging), share data, cut transport emissions. Compliance increases operational burden and cost. Most of the initiatives internally driven without much support from buyers or government.
Value appropriation	Scope 3 transparency has improved: more data on feed, packaging, logistics. Incremental emissions reduction (e.g., 5–15%) in packaging and feed chain. Driven more by audit and certification than by law.	Internalization of emission targets improves environmental compliance on paper. Enables company to claim ESG leadership in export markets.	Some emission reductions via material switch (e.g., biodegradable packaging).
Environmental outcomes	Retailers do not adjust prices to reflect sustainability investments. Retailers maintain power: dictate standards, reject uncertified supply. Regulations increase compliance costs. - Regulation provides mandate without much institutional support. Certification bodies indirectly reinforce retailer power.	Subsidiary absorbs coordination costs without financial return. Margin pressure due to rising Scope 3-linked costs (transport, audits, input switch). Acts as 'compliant supplier' to retailers and gains reputational legitimacy	Profits decline due to expensive input substitution and compliance admin. Perceived injustice: higher emission reduction costs with no compensation. Suppliers bear brunt of sustainability push.

Horizontal value creation in terms of support from public institutions, is limited to compliance rather than coordinated support. The UK government has introduced several policies aimed at promoting sustainability across various sectors, including salmon aquaculture. UK Net-Zero Target 2050 is a legally binding target that requires all sectors, including food production, to significantly reduce their greenhouse gas emissions. A key component is the commitment to achieving net-zero greenhouse gas emissions by 2050 (GOV.UK, 2021). Scotland has set even more ambitious climate targets than the UK, aiming for net-zero emissions by 2045. This places significant pressure on Scottish salmon companies to reduce their environmental impact (The Scottish Government, 2019). Interviewees mentioned the requirement for all companies and sectors, including companies sourcing salmon, such as Company X, to produce plans outlining their pathway to achieve Net-Zero emissions by 2045 in Scotland and by 2050 in the UK. Interviews with salmon producers indicate that although regulatory push is present, these regulations are stringent and often fragmented, creating uncertainty and inconsistencies that increase the costs and difficulties of implementing sustainable practices. *There's quite a bit of confusion from a regulation point of view as to what should be included, and how do you measure Scope 3.* (Supplier A, Scottish Tier 2 Salmon Producer)

Interviews from Scottish Tier 2 suppliers also revealed that Scotland's policy environment may influence compliance, but it is less supportive of sustainable environmental upgrading, creating greater challenges for all local value chain actors. *We get a lot of direction on what we should be doing, but there's very little support from the government on how to actually do it (Supplier B, Scottish Tier 2 Salmon Producer)*

You've got government telling you to reduce emissions, but they're not funding or facilitating the technology or infrastructure to do that (*Supplier D, Scottish Tier 2 Salmon Producer)*

While, lead firms and Company X drive the environmental upgrading from a compliance perspective, the Scottish salmon producers (Supplier A, Supplier B, and Supplier D) shared the view that the implementation of environmental upgrading process was mainly driven by the internal efforts of Tier 2 suppliers and the role of Company X was more as an enforcer. According to the Scottish Tier 2 suppliers, they are actively seeking to create value through their environmental efforts, investing in new technologies, optimizing their processes, and exploring innovative solutions. Scottish Tier 2 suppliers – Supplier A and Supplier D - focus on implementing returnable and recyclable packaging materials, aiming to reduce single-use plastics and overall waste. Furthermore, Supplier D demonstrates a strong internal commitment to resource efficiency and a circular economy. However, initiatives linked to packaging and waste management has limited utility in minimizing Scope 3 emissions from feed.

5.3.2 Environmental Upgrading – Value Appropriation and Environmental Outcomes

The appropriation of value in this context is influenced by the existence of transparent direct appropriation by the lead firms, wherein HQ and retailers gain monetary,

reputational, and strategic advantage at the expense of suppliers when it comes to environmental reporting documentation (e.g., Scope 3 disclosures), as they pass the costs to the downstream entities. Certification bodies are value-neutral intermediaries, whose role is to turn expectations of emissions into the strict language of audit demand, without any capacity-building or participation in common investment. The funding providers are the suppliers, who accept the financial cost of the sustainability activities via price premiums and long-term returns, substituting the cost of certified inputs and logistical improvement, representing direct expropriation through indirect environmental costs (See Tables 4 and 5).

Our interview analysis shows that Scottish suppliers bear the cost of environmental compliance, potentially impacting their profitability without commensurate benefit: *"I mean, everything involves investment, doesn't it? So, you've got to be profitable to be able to invest"* (Supplier A). Supplier B explicitly advocates for a more collaborative approach in setting environmental targets, suggesting that the current system places an undue burden on them. The current implicit cost-shifting, whereby Company X sets standards without providing sufficient financial or collaborative support, is explicitly identified as a problem. This directly highlights the negative distributional consequences, where the costs are unfairly concentrated on the supplier: *"having a more collaborative framework work where you set those targets and together, rather than just coming to us at the delivery stage would help ensure that there's like larger success overall"* (Supplier B).

The achievement of ambitious environmental targets depends on technological advancements. The absence of readily available or affordable technologies to meet those targets creates an additional hidden cost for Supplier D, illustrating how external factors can contribute to uneven financial burdens in the pursuit of sustainability: *"if we're really going to crack the dates that have been set 2030, 2035, 2040, 2045, 2050. Technology needs to catch up and very, very quickly, yeah."* (Supplier D). The availability of renewable energy and established certification programs directly decreases the cost of adopting sustainable practices. The less supportive regulatory environment and limited access to renewable energy and financial support in Scotland create substantial hidden costs. A primary challenge is the lack of infrastructure for hydrogen and electric vessels, which limits the industry's ability to adopt these technologies. Suppliers highlighted the absence of charging stations and hydrogen fueling systems, especially in remote and rural areas: *"We're looking to move to hydrogen, but the infrastructure isn't available in Scotland"* (Supplier B)

As indicated in Table 4 and 5, environmental outcomes of suppliers in Scotland are not very substantial, and they are more fragmented and mostly resultant to compliance. On the one hand, some concrete initiatives, like 15% and 51% decreases emissions made by Suppliers A and B, respectively, in emissions produced by packaging activities, serve as evidence of some progress. On the other hand, however, these gains remain marginal and fail to solve the core problem of emissions that is attributed to feed production. There is an increased cost of switching to certified inputs, recyclable packages and tracking emissions that is not matched by support given by Company X and the environment provided by the institutions. Certification frameworks, though prevalent, function more as branding mechanisms than drivers of systemic environmental change. The subsidiary, acting primarily as a compliance

enforcer, transmits sustainability expectations without the capability to foster innovation or absorb costs. As a result, environmental upgrading remains incremental and uneven, reflecting a broader institutional context that emphasizes individual compliance over coordinated transformation.

5.4 Bridging Through Alliance

Bridging through alliances refers to a strategy of Norwegian Tier 2 suppliers to ally with Tier 3 feed manufacturers, the Norwegian government, and to some extent with Company X to collaborate on innovations, such as sustainable feed sourcing and hybrid transportation technologies. Table 6 provides the integration of bridging and environmental upgrading perspectives to unpack bridging as an alliance from Company X engagement with Norwegian suppliers.

5.4.1 Environmental Upgrading – Value Creation

In Norway, environmental upgrading through bridging as alliance is enabled primarily through horizontal value creation. For Norwegian Tier 2 suppliers, regulations have played a significant role in the development process of the industry, as constraints themselves provide incentives to innovate and produce more environmentally friendly (Afewerki et al., 2023). Most industry stakeholders in Norway have the capacity and interest to innovate, in particular government authorities, integrated companies, grow-out farms, R&D (Malcorps, 2023). Norwegian aquaculture is unique in this way because it succeeded in establishing collaboration among former competitors (e.g., farmers and suppliers), the R&D community, technology suppliers, and the government (Afewerki et al., 2023). It is estimated that more than half of the research is conducted and funded by companies, while funding from public sources made up a third of the budget (Afewerki et al., 2023). Norway demonstrates a supportive and robust policy environment for environmental upgrading in the aquaculture sector. *"The Norwegian farmed salmon industry would be the one who's pushing and using deforestation-free soy…"* (Supplier E). The Norwegian government actively supports research and development efforts aimed at improving the sustainability of its aquaculture industry. This support facilitates technological innovation and makes it easier for producers to adopt environmentally friendly practices. *"The government has a strong focus on environmental protection, and that their industry self-regulatory mechanisms are quite well-developed"* (Supplier E).

As a result of innovation support from the Norway government primarily, Norwegian producers demonstrate a more proactive and collaborative linkages with Tier 3 feed manufacturers to improving the sustainability of their feed, including a greater emphasis on sourcing deforestation-free soy, reducing reliance on fishmeal, and exploring alternative feed ingredients such as insect meals. Both Norwegian suppliers—Supplier C and Supplier E—actively set their own ambitious sustainability targets, exceeding the expectations set by Company X. They demonstrate a strong sense of agency, taking ownership of their environmental impact and developing a long-term strategy for reducing greenhouse gas emissions. Supplier C illustrates this

Table 6 Bridging as alliance

Dimension	Sources of pressure & influence *(retailers, certification bodies, HQ, regulation)*	Company X subsidiary bridging strategy*(alliance role)*	Impact on Norwegian salmon & feed producers
Value creation	Norwegian regulation sets high environmental standards backed by public funding and R&D clusters. Retailers demand certified, low-emission products (e.g., ASC, deforestation-free feed) due to pressure from certification bodies. Both are harmonized with national Norwegian regulatory standards. HQ influence remain but are harmonized with national standards.	Acts as collaborative partner rather than enforcer. Co-develops traceability and emission tracking tools with producers. Facilitates joint innovation projects (e.g., low-carbon feed, digital traceability). Aligns internal requirements with national compliance support.	High willingness to adopt certified feed and new materials. Innovation capacity boosted by strong public-private research support Active engagement in emission tracking and continuous improvement.
Value appropriation	Government innovation grants and tax credits reduce burden of emission reduction. Cost of compliance is offset by innovation funding and export advantage. Power more evenly distributed due to state involvement. Norwegian institutions act as a counterbalance to retailer dominance. Certification embedded in public sustainability framework.	Joint applications for sustainability grants improve financial feasibility of innovation. Bridges state regulations to influence retail and HQ expectations.	Innovation partially funded; Financial burden is shared via subsidies or alliances. Producers seen as innovation leaders rather than mere compliance actors. Feed producers gain strategic GVC role through data-driven Scope 3 insights.
Environmental outcomes	Substantial Scope 3 reductions in feed and packaging through innovation and support. Public accountability mechanisms (audits, R&D reports) increase transparency. Aligned standards avoid duplication or greenwashing. Better alignment of certification and regulation.	Bridges firm-level emission reduction goals with national frameworks. Enables producers to align with EU Green Deal and Norwegian sustainability roadmap. Consolidates data from suppliers to enhance emission reduction reporting in export markets.	Achieved measurable emission cuts, especially in feed chain . Access to sustainability incentives boosts environmental investment. Better alignment of certification and government audits enables integrated improvements.

proactive approach, "*In a combination of this, we have set together a strategy of our own company targets that we have set for the next coming years and decades."* Supplier E also emphasizes their commitment to exceeding expectations, stating, *"and "We are also looking at the new technologies also, I mentioned some battery technologies."* This internal drive to improve and go beyond external requirements underscores their commitment to sustainable practices. Supplier E is a multinational subsidiary as well and it collaborates with its parent company and other industry stakeholders to develop sustainable solutions, as evidenced by statements like, *"Our parent company as well is giving some guidelines in terms of what they want us to do and then of course we have in the license to operate there," "We are also following some ISO standards," and "We as an industry, we have been pushing a lot on deforestation-free soy".*

In terms of inter-firm linkages, Company X has a more collaborative relationship with Norwegian suppliers, emphasizing frequent meetings, knowledge-sharing, and joint target-setting. Relationship between Norwegian suppliers and Company X is characterized by long-term, trust-based collaboration. This link allows suppliers to influence decision-making processes and share valuable knowledge. For instance, one supplier stated, *"We share data on GHG emissions openly with Company X, and they consult us when developing their sustainability strategy"*. There are quarterly and bimonthly meetings between Company X and Norwegian Tier 2 suppliers which are dedicated to the climate road map and associated environmental requirements. A company X employee states that *"we have put in place regular meetings with our key suppliers. These meetings are dedicated to climate stakes. We have structured our climate road map with clear expectations with the KPI's and timeline to be able to track the progress"*. Furthermore, tri-partite meetings between the UK retailer, Company X, and Norwegian Tier 2 suppliers play a critical role in driving change within the supply chain. These tri-partite meetings which are called *"farming group meetings" and* are held quarterly. UK retailers' expectations for greenhouse gas emission reductions necessitate action plans and objectives from Company X and its salmon suppliers, aiming for a harmonized approach to environmental sustainability. This emphasizes a strong focus on collaboration, information sharing, and transparency, reflecting a commitment to organizational improvements. Their adoption of various sustainability standards and certifications further supports this. *"We have had a very good dialogue with them. So before they set their spec, we are in a dialogue so they know*" (Supplier C). This illustrates a willingness to collaborate with Company X and incorporate feedback into their sustainability efforts. Furthermore, the inter-firm linkages between Norwegian Tier 2 suppliers and Tier 3 feed manufacturers is also characterized by collaboration: *"We have frequent meetings and interactions, and we do share a lot of knowledge between ourselves"* (Supplier E).

From a bottom-up perspective, Norwegian Tier 2 suppliers invest substantially in energy-efficient vessels, including the adoption of hybrid and electric boats, to reduce emissions from transportation. *"We've also invested quite heavily in hybrid boats or electric boats"* (Supplier E). Supplier E also collaborates with feed manufacturers to ensure that all energy consumption within the operations of their feed manufacturers is sourced from 100% green supply, eliminating the use of non-renewable or 'brown' energy sources entirely. Supplier C has focused on reducing

diesel usage by supporting feed manufacturers' transition to hybrid generators. They have taken significant measures to streamline boat operations and enhance energy efficiency. By investing in hybridization of diesel generators and exploring alternative fuel solutions, the supplier is actively working toward reducing energy consumption and carbon emissions associated with marine activities. Norway's readily available green energy also helps facilitate this approach. Norway's abundant hydropower resources make the transition to renewable energy relatively straightforward for aquaculture producers. *"In Norway, we're not coupled to the electrical grids to the continent. So, we know that it's green"* (Supplier C). This readily available green energy significantly reduces the environmental impact of operations and lowers the cost of adopting sustainable practices.

5.4.2 Environmental Upgrading – Value Appropriation and Environmental Outcomes

Appropriation dynamics in Norway reflect more equitable and reciprocal mechanisms. While Norwegian suppliers make high initial investments in feed reformulation, hybrid transport, and certification, they benefit from partial direct appropriation, capturing long-term savings and market access advantages. Unlike the Scottish case, indirect appropriation via environmental burdens is mitigated through public innovation grants, reduced certification duplication, and coordinated compliance structures. As a result, Norwegian producers retain more control over their sustainability narratives and gain reputational and strategic advantages within the value chain. The strong role of horizontal institutions reduces power asymmetries and enables relational upgrading, where both firms and public actors benefit from cumulative environmental gains.

The ability to negotiate sustainability goals with Company X and other buyers ensures that Norwegian suppliers are not disproportionately burdened by compliance costs. *"We are in a dialogue with Company X before they set their specifications so that they know their demands are not totally off the charts... This ensures that we can meet their requirements while keeping the supply stable"*.

The regulatory environment also ensures a high degree of transparency, as explained by a supplier: *"The Norwegian aquaculture industry is quite transparent because we self-report to the government... environmental interests are reported at the macro level"*. Furthermore, state-backed renewable energy infrastructure in Norway reduces operational costs, enabling suppliers to meet environmental goals more efficiently: *"Norway is hydro-powered, so it's green energy, and we're not connected to the continental grid"*. This infrastructure reduces dependency on fossil fuels, lowering costs and strengthens the suppliers' credibility, both domestically and internationally, enhancing their bargaining power in global markets.

As a result, the Norwegian industry has enabled more substantive and systemic environmental outcomes. Norwegian suppliers have achieved measurable Scope 3 reductions—Supplier C reduced emissions by 12% (2020–2023), and Supplier E achieved a 37% decline in carbon intensity (2019–2023)—primarily through innovations in sustainable feed sourcing, logistics optimization, and adherence to deforestation-free standards. These improvements are underpinned by strong public–private

collaboration, national innovation grants, and integrated certification frameworks that align with government environmental goals. While the Scottish industry is linked through many of the same supply chains and stakeholders, and has made substantial improvements, the reporting is less evident and measurable than the Norwegian industry's commitment to improvements.

6 Discussion and Conclusion

This study set out to explore how MNE subsidiaries as Tier 1 suppliers bridge the global sustainability mandates with local institutional realities to facilitate environmental upgrading, particularly in relation to Scope 3 emissions. Developing a conceptual framework based on Soliman et al. (2023) and Krishna et al. (2022) complemented by a VoC framework (Hall & Soskice, 2001), we conducted a case study analysis of Company X and their Tier 2 and Tier 3 suppliers in Scotland and Norway. Figure 4 presents a visual model of our comparative examination.

As discussed in the findings section (See Tables 4, 5 and 6 and Figure 4), Norwegian suppliers operate within a Coordinated Market Economy (CME), characterized by collaborative governance and policy traditions, and systemic support for innovation. Here, Company X adopts a "bridging for alliance" strategy, enabled by strong, trust-based relationships with suppliers and a supportive regulatory environment. These structures facilitate regular knowledge exchange, joint target-setting, and co-development of sustainability initiatives—such as deforestation-free soy sourcing and hybrid transport technologies. Conversely, the Scottish case highlights the case of a Liberal Market Economy (LME), characterized by less collaborative arrangements and fragmented environmental regulation. In this context, Company X adopts a "bridging through internalization" strategy, assuming an enforcer role

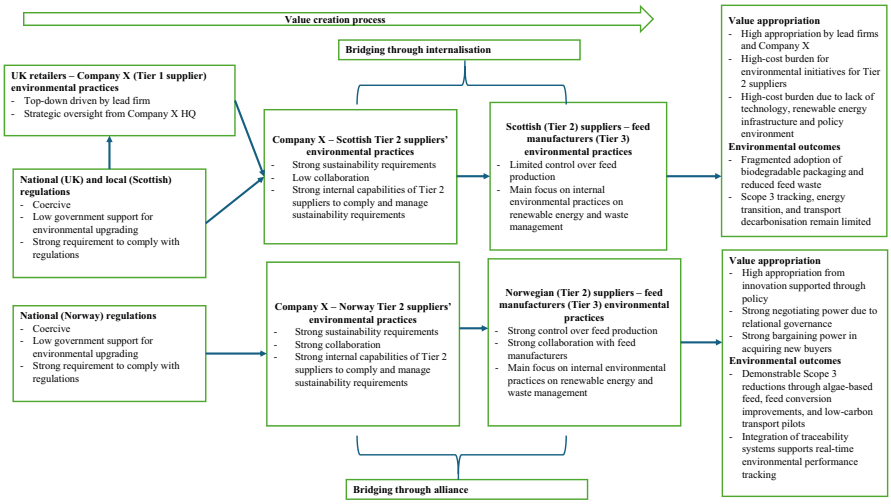

Fig. 4 Bridging mechanisms in GVCs for environmental upgrading (Authors' own)

by translating external sustainability demands—primarily from UK retailers—into internal compliance standards and cascading these requirements upstream to suppliers. This compliance-oriented approach emerges in the absence of strong institutional support or coordinated collaborative frameworks within the domestic supply base. As a result, Scottish suppliers are often left to absorb the costs of environmental upgrading independently, facing higher compliance burdens, constrained access to renewable energy, and infrastructural limitations. This dynamic reflects the transactional nature of governance in LMEs and underscores the uneven distribution of costs in sustainability transitions.

In Norway's CME context, the success of Company X's alliance-based strategy stems from institutional complementarities: strong state-industry coordination, adaptive regulatory tools (e.g., the development license scheme), and a cultural orientation toward long-term collaboration. These conditions foster inter-firm trust and enable systemic sustainability transitions across the value chain. In contrast, Scotland's LME environment—marked by arm's-length relationships, weaker public-private coordination, and a reliance on market mechanisms—constrains collaborative upgrading, leading Company X to internalize key sustainability functions. Below we discuss three theoretical contributions followed by implications for practice and future research.

6.1 Theoretical Contributions

First, our study extends the environmental upgrading framework proposed by Krishnan et al. (2022) by unpacking the *mechanisms* through which environmental value is created, appropriated, and translated into outcomes in global value chains (GVCs). While Krishnan et al. (2022) identify value creation, appropriation, and outcomes as distinct but related dimensions, they do not fully explain how these are *linked*. Our study advances the GVC environmental upgrading literature by shifting analytical focus from lead firms to the intermediary and coordinating role of MNE subsidiaries. While prior work has emphasized the dominance of lead firms in GVC governance (Gereffi & Lee, 2016; Ponte & Sturgeon, 2014), our study illustrates that subsidiaries are not merely passive implementers of sustainability mandates but active mediators. Building on Soliman et al. (2023), we propose an integrative framework that positions the subsidiary as a mediating actor—what we term a *bridging mechanism.* We show that subsidiaries play a dual role: (1) translating global sustainability expectations into locally viable strategies; and (2) reconfiguring supplier relationships to align with institutional and market pressures.

Second, the bridging role of subsidiary is not neutral—it is shaped by the institutional configuration of the host country, echoing the Varieties of Capitalism (VoC) perspective (Hall & Soskice, 2001; Soliman et al., 2023). For example, Norwegian subsidiaries embedded in coordinated institutional contexts leverage innovation networks and public-private collaboration to co-create biophysical improvements. In contrast, Scottish subsidiaries in liberal market contexts are more constrained, focusing on compliance. The VoC framework thus offers a powerful explanation for cross-national differences in environmental upgrading, revealing how institutional

arrangements enable or constrain firms' ability to coordinate sustainability initiatives within GVCs. By embedding the VoC perspective, this study highlights the importance of institutional fit in subsidiary's bridging mechanism and supplier's environmental upgrading. Our findings respond to calls by Choksy et al. (2017) and Jackson and Deeg (2008, 2019) for deeper engagement with institutional diversity in GVCs. This approach understands institutions not merely as variables, but as historically embedded configurations that shape the identities, interests, and capacities of economic actors. This perspective extends the institutional embeddedness literature in IB by showing that subsidiaries act as institutional interpreters and intermediaries within global value chains. Rather than simply adapting to external rules, they leverage or compensate for institutional complementarities to align global sustainability mandates with local capabilities and constraints. This advances recent efforts to bridge the comparative capitalism and IB literatures by focusing on the dynamic interaction between MNE agency and national institutional systems.

Finally, our study demonstrates that trade-offs, decoupling, or alignment across environmental upgrading dimensions are conditioned by subsidiary bridging mechanisms and institutional contexts. Specifically, we find that in liberal market economies like Scotland, where bridging takes the form of internalization, subsidiaries often translate global mandates into compliance-driven routines. This results in value being created and symbolically appropriated, but with limited material environmental outcomes. Conversely, in coordinated market economies like Norway, bridging occurs through alliance-based collaboration, supported by public–private innovation systems. Here, environmental value creation is shared, appropriation is mutual, and outcomes are biophysically realized, leading to a more integrated upgrading process. Along the same line, Krishnan et al. (2022) distinguish between biophysical (e.g., emissions reduction) and reputational (e.g., certification, branding) outcomes. Our findings reveal that these outcomes are frequently decoupled due to institutional context and divergent bridging mechanisms. In Scotland, environmental upgrading is driven by reputational compliance (e.g., certification schemes, public CSR commitments), but with limited biophysical gains. Subsidiaries focus on "ticking the box," resulting in mechanisms through which environmental codes circulate without transforming underlying practices. In contrast, the Norwegian case reflects greater coherence between reputational and biophysical outcomes, due to stronger regulatory mandates, industry collaboration, and long-term environmental commitments.

6.2 Managerial Implications

For managers, the findings offer actionable insights into fostering sustainability transitions within GVCs. First, multinational enterprises (MNEs) must adopt flexible governance models that align with the institutional and resource contexts of their suppliers. For example, bridging as alliance should be prioritized in regions like Norway, where collaboration drives innovation, while modular governance might be more feasible in less regulated contexts like Scotland. Second, managers should invest in capacity-building initiatives for Tier 2 suppliers, including training,

knowledge-sharing platforms, and access to affordable sustainable technologies. Third, as feed-related emissions dominate the environmental footprint of aquaculture, managers should prioritize partnerships with feed manufacturers to co-develop low-carbon alternatives and innovative sourcing strategies. Fourth, sustainability reporting frameworks should integrate comprehensive Scope 3 emission metrics to enhance transparency and align with global net-zero goals, helping firms demonstrate leadership in environmental upgrading. Finally, managers need to be conscious of the trade-offs between environmental upgrading and the financial costs GVC actors have to bear for environmental initiatives. Economic incentives are the main incentive for Salmon producers to shift toward crop-based ingredients (Pelletier et al., 2018), while also meeting demand for a growing industry in the face of a finite supply of marine ingredients (Froehlich et al., 2018). Nevertheless, substituting marine ingredients (to reduce costs) with plant ingredients, such as wheat, corn gluten, rapeseed oil, leads to higher greenhouse gas emissions because of energy-intensive processes, and especially when land-use change is considered (Newton et al., 2023).

6.3 Policy Implications

Policymakers play a crucial role in enabling environmental upgrading through coherent institutional frameworks and targeted interventions. First, governments must prioritize investments in renewable energy infrastructure and subsidized access to sustainable technologies, particularly for suppliers operating in regions like Scotland with fragmented support systems. Second, harmonized regulatory frameworks across local, national, and regional levels are essential to reduce compliance burdens and create uniform standards for sustainability practices. Third, governments should foster public–private partnerships to drive innovation in low-carbon feed production and logistics, as feed-related emissions represent the largest share of environmental impact in aquaculture. Policymakers must also take a direct and active role in addressing Scope 3 emissions from feed sourcing and manufacturing, which represent the largest contributor to environmental impacts in aquaculture. Governments should incentivize innovation in sustainable feed production through grants for research and development, fostering partnerships between feed manufacturers, MNEs, and academic institutions. Regulations should promote the reduction of waste through circular economy principles (Reguiero et al., 2022), adoption of deforestation-free soy, and alternative, low-carbon protein sources, and other low-carbon feed technologies, supported by clear, enforceable standards that align with global sustainability goals. Nevertheless, while novel feed ingredients such as insects and microalgae show potential for inclusion in aquaculture diets, challenges persist regarding their consistent nutritional value, availability, cost (Hua et al., 2019; Pelletier et al., 2018), and environmental impact (Maiolo et al., 2020). Additionally, policymakers should consider establishing regional feed certification schemes to ensure transparency and accountability in supply chains, creating market incentives for compliance with environmental standards.

6.4 Limitations and Future Research Directions

This study opens several avenues for future research in Global Value Chains (GVCs) and International Business (IB). First, current research, although it attempts to integrate Krishnan et al.'s (2022) environmental upgrading, our qualitative data was limited to effectively capture the tangible measures for value appropriation and environmental outcomes. While we were able to extrapolate valuable information from company reports and websites related to value appropriation and environmental outcomes, reporting measures were limited to understand the full extent of progress on Scope 3 emissions. Future studies will benefit from properly integrating Krishnan et al.'s (2022) framework through mixed method and multi-level research that incorporates both qualitative case studies and quantitative data analysis (e.g., lifecycle analysis). Second, our research was limited to a single case study of Company X and its two value chains. Future studies can improve the contextualization of the study by comparing and contrasting multiple case studies perhaps across different spatial nature of value chains. Further exploration is needed into how subsidiaries mediate sustainability mandates in other industries and geographies, particularly those with fragmented institutional frameworks like in Scotland. Comparative studies across sectors with varying levels of complexity (e.g., agriculture versus technology) could provide insights into the scalability of bridging mechanisms. Third, future research could investigate the long-term impacts of bridging on environmental upgrading outcomes, particularly under shifting regulatory and market pressures. Fourth, the role of Tier 2 and lower-tier suppliers in sustainability transitions warrants deeper investigation, as this study demonstrates the agency of Tier 1 and Tier 2 suppliers but does not capture the agencies of Tier 3 suppliers who have direct control over Scope 3 emissions linked to feed.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

References

Aarset, B., Carson, S. G., Wiig, H., Måren, I. E., & Marks, J. (2020). Lost in translation? Multiple discursive strategies and the interpretation of sustainability in the Norwegian salmon farming industry. *Food Ethics, 5*(1), 11.

Aas, T. S., Åsgård, T., & Ytrestøyl, T. (2022). Utilization of feed resources in the production of Atlantic salmon (*Salmo salar*) in Norway: An update for 2020. *Aquaculture Reports*. https://doi.org/10.1016/j.aqrep.2022.101316

Ababouch, L., Nguyen, K. A. T., Castro de Souza, M., & Fernandez-Polanco, J. (2023). Value chains and market access for aquaculture products. *Journal of the World Aquaculture Society, 54*(2), 527–553.

Abdulsamad, A., Frederick, S., Guinn. and Gereffi, G. (2015) Pro-Poor Development and Power Asymmetries in Global Value Chains. Duke University: Duke University Center on Globalization, Governance & Competitiveness.

Afewerki, S., Asche, F., Misund, B., Thorvaldsen, T., & Tveterås, R. (2023). Innovation in the Norwegian aquaculture industry. *Reviews in Aquaculture, 15*(2), 759–771.

Asche, F., Roll, K.H., Sandvold, H.N., Sørvig, A. and Zhang, D. (2013) Salmon aquaculture: larger companies and increased production. Aquaculture Economics & Management, 17 (3).

Bartlett, C. A., & Ghoshal, S. (1991). Global strategic management: Impact on the new frontiers of strategy research. *Strategic Management Journal*. https://doi.org/10.1002/smj.4250120903

Birkinshaw, J., & Hood, N. (1998). Multinational subsidiary evolution: Capability and charter change in foreign-owned subsidiary companies. *Academy of Management Review, 23*(4), 773–795.

Boehm, H. (2022). Physical climate change and the sovereign risk of emerging economies. *Journal of Economic Structures, 11*(1), 31.

Bohnes, F. A., Hauschild, M. Z., Schlundt, J., & Laurent, A. (2018). Life cycle assessments of aquaculture systems: A critical review of reported findings with recommendations for policy and system development. *Reviews in Aquaculture, 11*(4), 1061–1079.

Buckley, P. J., Doh, J. P., & Benischke, M. H. (2017). Towards a renaissance in international business research? Big questions, grand challenges, and the future of IB scholarship. *Journal of International Business Studies, 48*, 1045–1064.

Buckley, P. J., Strange, R., Timmer, M. P., & de Vries, G. J. (2022). Rent appropriation in global value chains: The past, present, and future of intangible assets. *Global Strategy Journal, 12*(4), 679–696.

Budhathoki, M., Lincen, L., Xu, H., Zhang, W., Li, S., Newton, R., ... & Little, D. (2024). Understanding farmed salmon imports and e-commerce consumer satisfaction in China: A text mining approach. *Journal of Agriculture and Food Research*, *18*, 101342.

Bush, S. R. (2018). Understanding the potential of eco-certification in salmon and shrimp aquaculture value chains. *Aquaculture, 493*, 376–383.

Cantwell, J., & Mudambi, R. (2005). MNE competence-creating subsidiary mandates. *Strategic Management Journal, 26*(12), 1109–1128.

Chapagain, A. K., & James, K. (2013). Chapter 12 - Accounting for the impact of food waste on water resources and climate change. In M. Kosseva & C. Webb (Eds.), *Food industry wastes: Assessment and recuperation of commodities* (pp. 217–236). Academic Press.

Choksy, U. S., Sinkovics, N., & Sinkovics, R. R. (2017). Exploring the relationship between upgrading and capturing profits from GVC participation for disadvantaged suppliers in developing countries. *Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration, 34*(4), 356–386.

Clauwaert, T., Kabir, L., Foote, E., Maksimainen, J. and Van Hoey, M. (2023) The Scope 3 challenge: Solutions across the materials value chain. Retrieved from Accessed: 15 June 2023].

Dallas, M. P., Ponte, S., & Sturgeon, T. J. (2019). Power in global value chains. *Review of International Political Economy, 26*(4), 666–694.

De Marchi, V., & Alford, M. (2022). State policies and upgrading in global value chains: A systematic literature review. *Journal of International Business Policy, 5*(1), 88–111.

Deloitte (2023) Scope 1, 2 and 3 emissions. Retrieved from Accessed: 20 December 2022].

Doh, J. P., Eden, L., Tsui, A. S., & Zaheer, S. (2023). Developing international business scholarship for global societal impact. *Journal of International Business Studies, 54*(5), 757–767.

Egels-Zandén, N. (2017). Responsibility boundaries in global value chains: Supplier audit prioritizations and moral disengagement among Swedish firms. *Journal of Business Ethics, 146*, 515–528.

Forsgren, M. (2017). Theories of the multinational firm: A multidimensional creature in the global economy. Edward Elgar Publishing.

Froehlich, H. E., Jacobsen, N. S., Essington, T. E., Clavelle, T., & Halpern, B. S. (2018). Avoiding the ecological limits of forage fish for fed aquaculture. *Nature Sustainability, 1*(6), 298–303.

Gephart, J. A., Golden, C. D., Asche, F., Belton, B., Brugere, C., Froehlich, H. E., ... & Allison, E. H. (2020). Scenarios for global aquaculture and its role in human nutrition. Reviews in Fisheries Science & Aquaculture, 29(1), 122-138.

Gereffi, G. (1994) The Organisation of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks. Modern Economy, 8 (7), pp. 95-122.

Gereffi, G., & Lee, J. (2016). *Economic and Social Upgrading in Global Value Chains and Industrial Clusters: Why Governance Matters., 133*(1), 25–38.

Gereffi, G., Humphrey, J., & Sturgeon, T. (2005). The governance of global value chains. *Review of International Political Economy, 12*(1), 78–104.

Gerffi, G., & Stark, K. F. (2016). *Global value chain analysis: A primer* (2nd ed). Duke University: Duke CGGC.

Gibbon, P., Bair, J., & Ponte, S. (2008). Governing global value chains: An introduction. *Economy and Society*. https://doi.org/10.1080/03085140802172656

Gioia, D. A. (2019). If I had a magic wand: Reflections on developing a systematic approach to qualitative research. In B. K. Boyd, T. R. Crook, J. K. Lê, & A. D. Smith (Eds.), Standing on the shoulders of giants: Traditions and innovations in research methodology (Research Methodology in Strategy and Management, Vol. 11, pp. 27–37). Emerald Publishing Limited.

Gioia, D. A., Corley, K. G., & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the Gioia methodology. *Organizational Research Methods, 16*(1), 15–31.

Glencross, B., Ling, X., Gatlin, D., Kaushik, S., Øverland, M., Newton, R., & Valente, L. M. (2024). A SWOT analysis of the use of marine, grain, terrestrial-animal and novel protein ingredients in aquaculture feeds. *Reviews in Fisheries Science & Aquaculture, 32*(3), 396–434.

Golgeci, I., Makhmadshoev, D., & Demirbag, M. (2021). Global value chains and the environmental sustainability of emerging market firms: A systematic review of literature and research agenda. *International Business Review, 30*(5), Article 101857.

Golini, R., Marchi, V., Boffelli, A., & Kalchschmidt, M. (2018). Which governance structures drive economic, environmental, and social upgrading? A quantitative analysis in the assembly industries. *International Journal of Production Economics, 203*, 13–23.

GOV.UK.. (2021, October 19). Net Zero Strategy: Build Back Greener. GOV.UK.

Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard (2004). World Resources Institute. Available at: https://ghgprotocol.org/ [Accessed:16 May 2025].

GSI (2023) About Salmon Farming. Retrieved from https://globalsalmoninitiative.org/en/about- salmon-farming/ Accessed: 18 January 2023].

Gudbrandsdottir, I. Y., Saviolidis, N. M., Olafsdottir, G., Oddsson, G. V., Stefansson, H., & Bogason, S. G. (2021). Transition pathways for the farmed salmon value chain: industry perspectives and sustainability implications. *Sustainability, 13*(21), 12106.

Hall, P. A., & Soskice, D. W. (2001). *Varieties of capitalism: The institutional foundations of comparative advantage*. Oxford University Press.

Hammer, A. J., Millar, C., & Hennige, S. J. (2022). Reducing carbon emissions in aquaculture: Using carbon disclosures to identify unbalanced mitigation strategies. *Environmental Impact Assessment Review, 96*, Article 106816.

Hansen, A. D., Kuramochi, T., & Wicke, B. (2022). The status of corporate greenhouse gas emissions reporting in the food sector: An evaluation of food and beverage manufacturers. *Journal of Cleaner Production, 132279*, 361.

Hernandez, V., & Pederson, T. (2017). Global value chain configuration: A review and research agenda. *BRQ Business Research Quartely, 20*(2), 137–150.

Hersoug, B., Mikkelsen, E., & Karlsen, K. M. (2019). "Great expectations" – Allocating licenses with special requirements in Norwegian salmon farming. *Marine Policy, 100*, 152–162.

Horner, R. (2017). Beyond facilitator? State roles in global value chains and global production networks. *Geography Compass, 11*(2), e12307.

Horner, R., & Alford, M. (2019). The roles of the state in global value chains. In Handbook on global value chains (pp. 555-569). Edward Elgar Publishing.

Hua, K., Cobcroft, J. M., Cole, A., Condon, K., Jerry, D. R., Mangott, A., Praeger, C., Vucko, M. J., Zeng, C., Zenger, K., & Strugnell, J. M. (2019). The future of aquatic protein: Implications for protein sources in aquaculture diets. *One Earth, 1*(3), 316–329.

Huang, Y. A., Weber, C. L., & Matthews, H. S. (2009). Categorization of scope 3 emissions for streamlined enterprise carbon footprinting. *Environmental Science & Technology, 43*(22), 8509–8515.

IPCC (2018) Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. IPCC. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf

Jackson, G., & Deeg, R. (2008). From comparing capitalisms to the politics of institutional change. *Review of International Political Economy, 15*(4), 680–709.

Jackson, G., & Deeg, R. (2019). Comparing capitalisms and taking institutional context seriously. *Journal of International Business Studies, 50*(1), 4–19.

Kano, L., Tsang, E. W. K., & Yeung, H. W. (2020). Global value chains: A review of the multi-disciplinary literature. *Review of International Political Economy, 51*, 577–622.

Kaur, R. R., Sahni, S., Kaur, G., & Singh, R. I. (2021). *Environmental Governance and Key Challenges at Local Level in Indian Context., 53*(3), 26–38.

Kenzhegaliyeva, A., & Lund, H. B. (2024). The role of proximity in environmental upgrading: plastics recycling in Norwegian aquaculture. *Geoforum, 150*, Article 103969.

Khattak, A., & Pinto, L. (2018). A systematic literature review of the environmental upgrading in global value chains and future research agenda. *Journal of Distribution Science, 16*(11), 11–19.

Khattak, A., & Stringer, C. (2016). The role of suppliers in the greening of GVCs: Evidence from the Sri Lankan apparel industry. *Handbook of research on green economic development initiatives and strategies.* IGI Global.

Khattak, A., Stringer, C., Maureen, B. R., & Haworth, N. (2015). Environmental upgrading of apparel firms in global value chains: Evidence from Sri Lanka. *Competition & Change, 19*(4), 317–335.

Klaaßen, L., & Stoll, C. (2021). Harmonizing corporate carbon footprints. *Nature Communications, 12*, Article 6149.

Krishnan, A., De Marchi, V. and Ponte, S. (2022) Environmental Upgrading and Downgrading in Global Value Chains: A Framework for Analysis. Economic Geography, pp. 1-26. Retrieved from https://doi.org/10.1080/00130095.2022.2100340 Accessed: 13 November 2022].

Lane, C. (2008). National capitalisms and global production networks: An analysis of their interaction in two global industries. *Socio-Economic Review, 6*(2), 227–260.

Langford, N. J., Nadvi, K., & Braun-Munzinger, C. (2023). The shaping of 'Southern'sustainability standards in a value chain world: comparative evidence from China and India. *Review of International Political Economy, 30*(3), 1151–1176.

Lemos, M. C., & Agrawal, A. (2008). Environmental governance. *Annual Review of Environment and Resources*. https://doi.org/10.1146/annurev.energy.31.042605.135621

Lorenzen, M., Mudambi, R., & Schotter, A. (2020). International connectedness and local disconnectedness: MNE strategy, city-regions and disruption. *Journal of International Business Studies, 51*(8), 1199.

Lund-Thomsen, P., & Lindgreen, A. (2014). Corporate social responsibility in global value chains: Where are we now and where are we going? *Journal of Business Ethics, 123*, 11–22.

Maiolo, S., Parisi, G., Biondi, N., Lunelli, F., Tibaldi, E., & Pastres, R. (2020). Fishmeal partial substitution within aquafeed formulations: Life cycle assessment of four alternative protein sources. *The International Journal of Life Cycle Assessment, 25*(8), 1455–1471.

Malcorps W. (2023) Stakeholder perceptions and sustainable intensification strategies for European aquaculture. University of Stirling. https://doi.org/10.13140/RG.2.2.25826.50882

Marchi, V. and Di Maria, E. (2019) Environmental upgrading and suppliers' agency in the leather global value chain. Sustainability, 6530, 11 (23).

Marchi, V. D., Maria, E. D., & Micelli, S. (2013). Environmental strategies, upgrading and competitive advantage in global value chains. *Business Strategy and the Environment, 22*(1), 62–72.

Marchi, V., Di Maria, E., & Ponte, S. (2013). The greening of global value chains: Insights from the furniture industry. *Competition & Change, 17*(4), 299–318.

Marchi, V., Di Maria, E., & Ponte, S. (2014). Multinational Firms and the Management of Global Networks: Insights from Global Value Chain Studies. *Advances in International Management, 27*, 463–486.

Marchi, V., Di Maria, E., Golini, R., & Perri, A. (2020). Nurturing international business research through global value chains literature: A review and discussion of future research opportunities. *International Business Review, 29*(5), Article 101708.

Marvin, H.J.P., Lorentzen, G., Asselt, E.V. and Johansen, L.H. (2020) Expert driven methodology to assess and predict the effects of drivers of change on vulnerabilities in a food supply chain: Aquaculture of Atlantic salmon in Norway as a showcase. Trends in Food Science & Technology, 103.

Meyer, K. E., Li, C., & Schotter, A. P. (2020). Managing the MNE subsidiary: Advancing a multi-level and dynamic research agenda. *Journal of International Business Studies, 51*, 538–576.

Mishra, R., Singh, R., & Govindan, K. (2022). Net-zero economy research in the field of supply chain management: A systematic literature review and future research agenda. *The International Journal of Logistics Management*. https://doi.org/10.1108/ijlm-01-2022-0016

Mohammad B. Rana, Matthew M. C. Allen (2024). "How Institutions Influence Firms' Climate Change Strategies: Extending the Perspectives of International Business and Global Value Chains with Business Systems", Van Tulder, R., Grøgaard, B., & Lunnan, R. (Eds.). Walking the Talk?: MNEs Transitioning Towards a Sustainable World (Vol. 18). Emerald Group Publishing.

Najam, A., Papa, M., & Taiyab, N. (2006). *Global environmental governance: A reform agenda* (1st ed). International Institute for Sustainable Development.

Navarette, S. D. S., & Borini, F. M. (2020). Environmental upgrading and the United Nations Sustainable Development Goals. *Journal of Cleaner Production, 264*, Article 121563.

Naylor, R. L., Hardy, R. W., Buschmann, A. H., Bush, S. R., Cao, L., Klinger, D. H., Little, D. C., Lubchenco, J., Shumway, S. E., & Troell, M. (2021). A 20-year retrospective review of global aquaculture. *Nature, 591*(7851), 551–563.

Newton, R. W., & Little, D. C. (2018). Mapping the impacts of farmed Scottish salmon from a life cycle perspective. *The International Journal of Life Cycle Assessment, 23*(5), 1018–1029.

Newton, R. W., Maiolo, S., Malcorps, W., & Little, D. C. (2023). Life cycle inventories of marine ingredients. *Aquaculture*. https://doi.org/10.1016/j.aquaculture.2022.739096

OECD-FAO Agricultural Outlook 2023-2032. (2023, July 6). OECD. https://www.oecd.org/en/publications/oecd-fao-agricultural-outlook-2023-2032_08801ab7-en.html

Olatunji, O. O., Akinlabi, S. A., Ayo, O. O., Madushele, N., Adedeji, P. A., & Fatoba, S. O. (2019). Drivers and barriers to competitive carbon footprint reduction in manufacturing supply chain: A brief review. *Procedia Manufacturing, 35*, 992–1000.

Osmundsen, T. C., Almklov, P., & Tveterås, R. (2017). Fish farmers and regulators coping with the wickedness of aquaculture. *Aquaculture Economics & Management, 21*(1), 163–183.

Palpacuer, F., Gibbon, P., & Thomsen, L. (2005). New challenges for developing country suppliers in global clothing chains: A comparative European perspective. *World Development, 33*(3), 409–430.

Pananond, P. (2013). Where do we go from here?: Globalizing subsidiaries moving up the value chain. *Journal of International Management, 19*(3), 207–219.

Pelletier, N., Klinger, D. H., Sims, N. A., Yoshioka, J. R., & Kittinger, J. N. (2018). Nutritional attributes, substitutability, scalability, and environmental intensity of an illustrative subset of current and future protein sources for aquaculture feeds: Joint consideration of potential synergies and trade-offs. *Environmental Science & Technology, 52*(10), 5532–5544.

Pelletier, N., Tydmers, P. H., Sonesson, U., Scholz, A. J., Ziegler, F., Flysjo, A., Kruse, S. A., Cancino, B., & Silverman, H. (2009). Not all salmon are created equal: Life cycle assessment (LCA) of global salmon farming systems. *Environmental Science & Technology, 43*, 8730–8736.

Plambeck, E. L. (2012). Reducing greenhouse gas emissions through operations and supply chain management. *Energy Economics, 34*(1), 64–74.

Ponte, S., & Sturgeon, T. (2014). Explaining governance in global value chains: A modular theory-building effort. *Review of International Political Economy, 21*(1), 195–223.

Ponte, S., Gereffi, G., & Raj-Reichert, G. (2019). Introduction to the Handbook on Global Value Chains. *Social and Political Science, 2019*, 1–27.

Puppim de Oliveira, J. A., & Qian, H. (2023). Perspectives in global environmental governance. *Global Public Policy and Governance, 3*, 5–11.

Rainbird, H., & Ramirez, P. (2012). Bringing social institutions into global value chain analysis: The case of salmon farming in Chile. *Work, Employment and Society, 26*(5), 789–805.

Regueiro, L., Newton, R., Soula, M., Méndez, D., Kok, B., Little, D. C., ... & Ferreira, M. (2022). Opportunities and limitations for the introduction of circular economy principles in EU aquaculture based on the regulatory framework. *Journal of Industrial Ecology*, *26*(6), 2033-2044.

Rugman, A. M., & Verbeke, A. (2001). Subsidiary-specific advantages in multinational enterprises. *Strategic Management Journal, 22*(3), 237–250.

Sako, M., & Zylberberg, E. (2019). Supplier strategy in global value chains: Shaping governance and profiting from upgrading. *Socio-Economic Review, 17*(3), 687–707.

Saunders, M. N., Lewis, P., & Thornhill, A. (2019). *Research methods for business students* (8th ed). Pearson Education Ltd.

Savage, J. M., Hudson, M. D., & Osborne, P. E. (2020). *Marine protected areas: Science, policy, and management*. Elsevier Ltd.

Sinkovics, N., Sinkovics, R. R., & Archie-Acheampong, J. (2021). Small-and medium-sized enterprises and sustainable development: In the shadows of large lead firms in global value chains. *Journal of International Business Policy, 4*(1), 80–101.

Soliman, S., Papanastassiou, M., & Saka-Helmhout, A. (2023). The role of subsidiaries in global value chains (GVCs): An institutional voids perspective on LVC upgrading and integration. *Journal of International Management, 29*(2), Article 101003.
The Scottish Government. (2019, September 25). Scotland to become a net-zero society. Gov.scot; The Scottish Government. https://www.gov.scot/news/scotland-to-become-a-net-zero-society/
Tlusty, M. F., Tyedmers, P., Bailey, M., Ziegler, F., Henriksson, P. J. G., Béné, C., Bush, S. R., Newton, R., Asche, F., Little, D. C., Troell, M., & Jonell, M. (2019). Reframing the sustainable seafood narrative. *Global Environmental Change, 59*, Article 101991.
UN Global Compact Network (2023) Scope 3 Emissions. Retrieved from [20 December 2022].
United Nations (2023) What is Climate Change? Retrieved from Accessed: 20 December 2022].
Van Der Ven, H. (2018). Gatekeeper power: Understanding the influence of lead firms over transnational sustainability standards. *Review of International Political Economy, 25*(5), 624–646.
Wiedmann, T., & Minx, J. (2007). *Ecological economics research trends*. Nova -Science Publishers, Inc.
Witt, M. A., & Jackson, G. (2016). Varieties of capitalism and institutional comparative advantage: A test and reinterpretation. *Journal of International Business Studies, 47*(7), 778–806.
World Resources Institute. (2004). *The greenhouse gas protocol initiative: Corporate standard*. World Resources Institute.
WRI and WBCSD. (2021). *The greenhouse gas protocol: A corporate accounting and reporting standard*. World Business Council for Sustainable Development and World Resources Institute.
Zhang, A., Alvi, M. F., Gong, Y., & Wang, J. X. (2022). Overcoming barriers to supply chain decarbonization: Case studies of first movers. *Resources, Conservation and Recycling*. https://doi.org/10.1016/j.resconrec.2022.106536

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Umair Shafi Choksy[1,2] · Muhammad Ayaz[3] · Fraser Gorvett[1] · Wesley Malcorps[4] · Richard Newton[4]

✉ Umair Shafi Choksy
umair.choksy@stir.ac.uk; umair.choksy@uwasa.fi

Muhammad Ayaz
muhammadayaz@iba.edu.pk

Fraser Gorvett
frasergorvett9@outlook.com

Wesley Malcorps
wesley.malcorps@stir.ac.uk

Richard Newton
richard.newton@stir.ac.uk

1 Stirling Business School, University of Stirling, Stirling, UK

2 InnoLab, University of Vaasa, Vaasa, Finland

3 School of Business Studies, Institute of Business Administration, Karachi, Pakistan

4 Faculty of Natural Sciences, University of Stirling, Stirling, UK