Sustainable ESG-oriented Supply Chains:

A Strategic Imperative for Modern Businesses

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Introduction

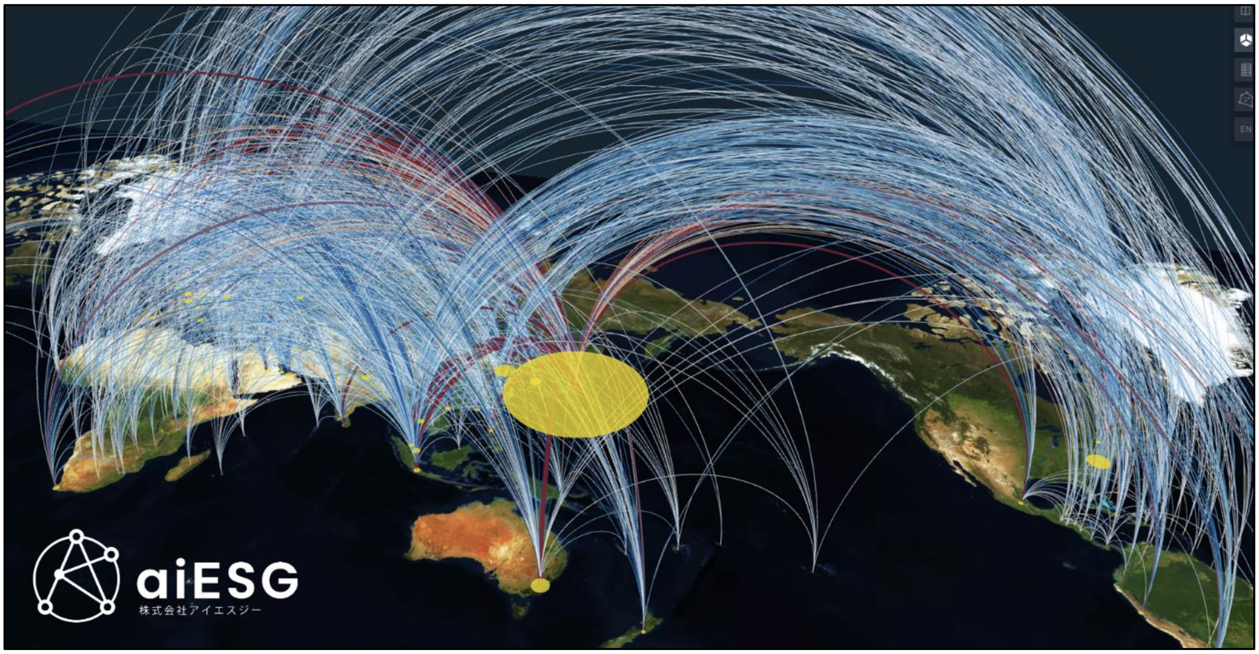


Figure 1 The visualization map showing various ESG impacts from the supply chain impact when producing a certain product

The significance of supply networks in today's society is hard to overstate. Supply chains link all the people, organizations, resources, activities, and technology involved in the transformation of the resources and energy into a consumer good or service through multiple processes such as extraction, transportation, production, and sales. Needless to say, in a modern highly globalized world, any producer or service provider, be it a multinational corporation or SME, is essentially a hub with extensive and highly complex supply chains, spanning across multiple countries and involving a multitude of supply actors.

As such, a company's business activities have real effects (i.e., impacts), both globally and locally, on the environment (e.g., resource use, energy consumption, waste generation, carbon emissions, etc.) and society (e.g., employment practices, worker safety, community relations, etc.) through the activities of its supply chain. This means that companies are responsible for the potential adverse impacts on the planet and people through their supply chain operations, even if they are not fully aware of these impacts or would typically consider them beyond their accountability. While traditionally companies were only concerned with increasing efficiency and managing costs when it comes to supply chain management, recent trends indicate that this paradigm is rapidly shifting. Today, companies are expected to not only understand and report the potential ESG risks[1] that are embedded in their supply chains but also take proactive measures to mitigate such risks and improve ESG performance by engaging closely on this issue with the suppliers.

In this article, we will discuss the following themes:

[1] Risks that can hurt the company as a result of its impact on the Environment (e.g., climate change, resource scarcity, pollution, biodiversity loss), Society (human rights violations, labor and community impacts) and Governance (corruption, unethical behavior)

- What impacts do supply chains have on the environment and society?
- What trends drive the recognition of the importance of considering ESG in supply chains by the business community?
- What potential benefits and opportunities motivate businesses to begin the journey towards making their supply chain sustainable and resilient?
- What are the risks of not doing anything?
- What are the necessary steps and what are the challenges?
- How can technology help companies understand and improve their supply chain ESG performance?
- What is the cutting-edge solution from aiESG?
- What are the near future trends for supply chains?

First, we will begin by establishing the significance of the supply chain's impacts on the environment and society.

The significance of supply chain impacts on the environment and society

Supply chains have large impacts on both the environment and society. For instance, let's take greenhouse gas emissions. In fact, supply chains are the biggest GHG emitters, responsible for over 60% of global emissions. Very often, the bulk of an organization's carbon footprint is attributed to scope 3 emissions, which are essentially emissions from the supply chain (upstream emissions) plus emissions from product use and utilization (downstream emissions)[2].

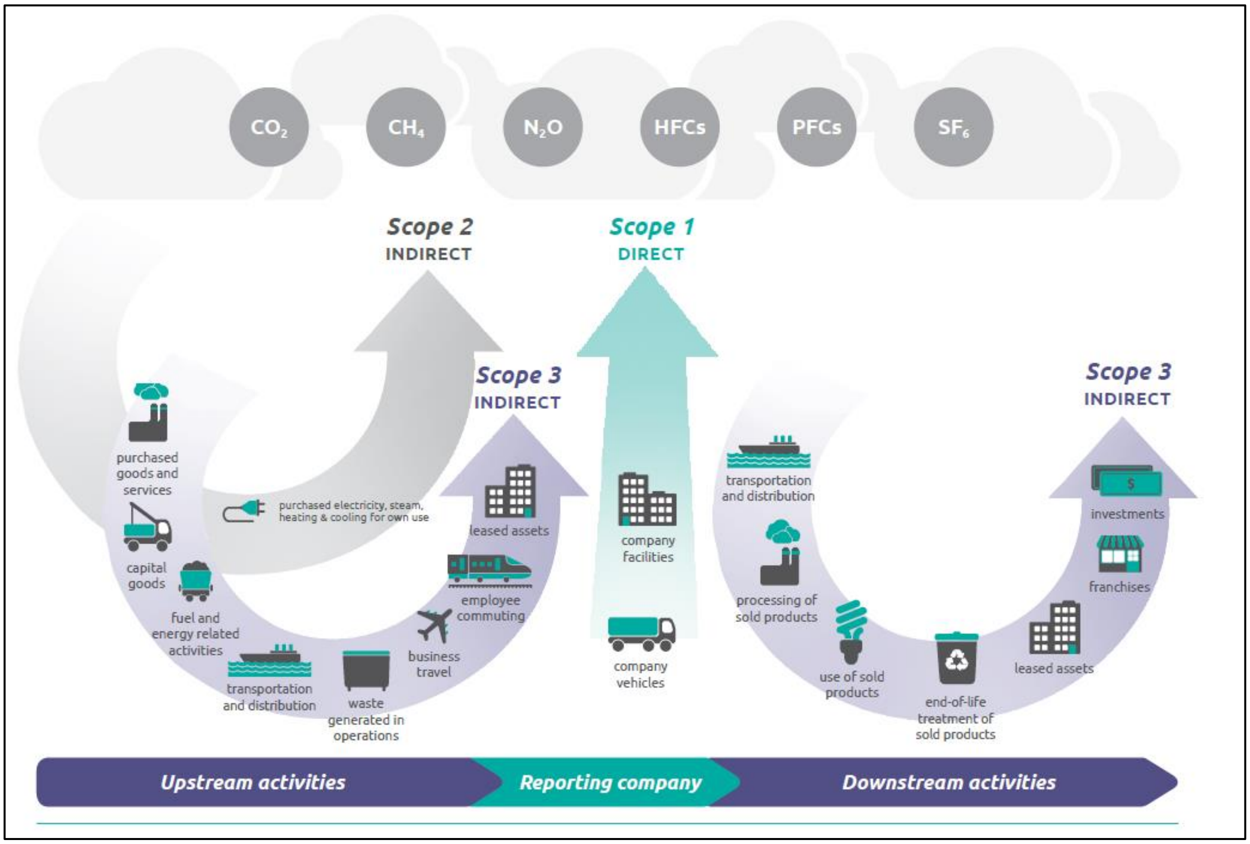
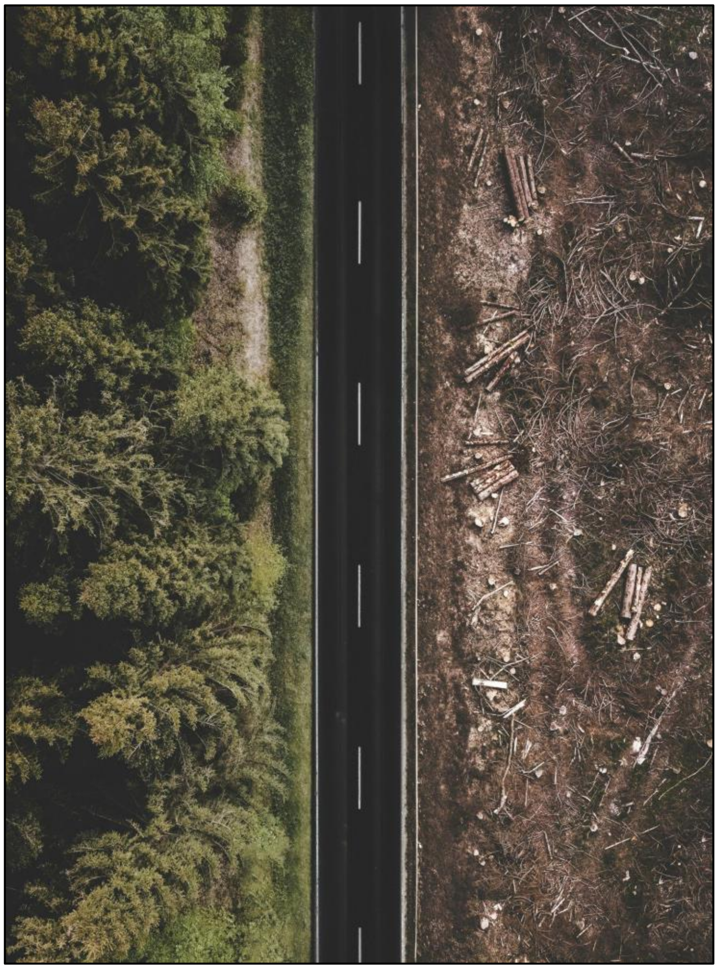


Figure 2. Overview of the GHG Protocol's scopes of emissions across the value chain

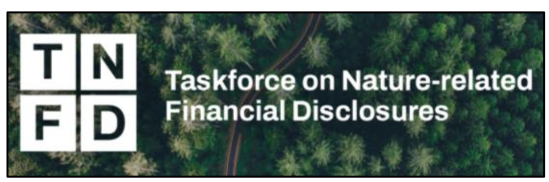
Some industries have over 80-90% of their entire carbon footprints coming from scope 3. That is the reason why so much attention nowadays are being focused on encouraging companies to measure and take action on reducing their scope 3 emissions and report the progress through various initiatives, such as SBTi, CDP, GRI, TCFD, ISSB and others.

Not only are supply chains the biggest emitters, but they are also the biggest victims of climate change. Extreme weather events, such as heat waves, droughts, hurricanes, flash floods, and others, are increasing in frequency and magnitude due to global warming and cause disruptions in supply chains by posing health hazards to vulnerable workers and communities at the extraction and production sites. According to recent surveys, every second CEO mentions struggling with supply chain disruptions due to climate change, with 25% of CEOs calling it one of the biggest business risks.

[2] For more information regarding Scope 3 refer to the original source: GHG Protocol Corporate Value Chain (Scope 3) Accounting and Reporting Standard



In addition to exacerbating climate change, supply chains greatly impact the broader environment, including pollution, resource depletion, biodiversity loss, and other effects. According to the UN, many industries have much larger impacts on the environment from their supply chain operations than from their direct business operations. For example, in such industries as financial services, food and beverages, and banking, the impact on the environment comes predominately from supply chains (98%) compared to only a minuscule impact coming from direct company operations (2%). Companies, therefore, cannot simply claim that their business operations are green, without addressing the elephant in the room - their supply chain operations. With such realization, new initiatives are emerging (e.g., TNFD, SBTN) that require companies to report on the nature-related risks (e.g., biodiversity loss, ecosystem degradation, and resource scarcity) of their business operations, including up- and downstream of their value chains.



Similarly, on the social front, supply chains have enormous social responsibility, employing an estimated 450 million people annually, according to ILO data. Supply chains often present serious human rights risks that many companies have failed to mitigate. As supply depth increases, visibility decreases, raising the likelihood of violations, especially in the deeper tiers where abuses are often overlooked. Limited visibility in supply chains increases risks of violations, especially in emerging markets, where many businesses are unaware of their adverse impacts on workers and broader society. Vulnerable groups such as women, migrants, and children are particularly at risk.

Human Rights Watch recorded a plethora of unethical labor practices and human rights violations in deep supply chains. For example, the apparel industry has seen abuses on textile fabrics, including news-breaking disasters such as Rana Plaza textile fabric building collapse in Bangladesh, which killed 1,138 garment workers. The jewelry sector is infamous for the case of "blood diamonds" referring to human rights abuses associated with diamond mining in conflict zones like Zimbabwe and Angola. The technology and manufacturing sectors are plagued with scandals related to the mining and excavation of raw minerals such as tantalum, tungsten, gold, lithium, and cobalt which are known as "conflict minerals" as they are sourced in conflict-ridden areas in the Democratic Republic of the Congo and adjoining countries. Global carmakers are put on the spot regarding the use of aluminum sourced from the Chinese province of Xinjiang, implicating the risk of forced labor of Uyghurs. According to ILO, globally, an estimated 28 million people are victims of forced labor.

Table 1. Examples of human rights risks in the global supply chain

Forced or compulsory labor
Human trafficking
Bonded labor
Restrictions on freedom of association and the right to collective bargaining
Poor, unhygienic, or unsafe working conditions
Illegal child labor
Excessive working hours

Source: UNEP

Table 2. Examples of risks of human rights violations associated with supplier transactions (as identified by the financial company)

The risk that suppliers are not paying adequate wages or delaying salaries
The risk of long working hours at suppliers as a consequence from transactions with the suppliers
The risk of forced labor and threats of punishment, etc., as a consequence from transactions with the suppliers
The risk of discrimination or disadvantage in hiring, promotion, or wages without reasonable cause due to race, gender, language, age, etc., in companies within the supply chain

Source: SMBC. 2023/05

The majority of risks associated with human rights violations or environmental damage occur deep within supply chains. Most companies are unaware that they may be unintentionally contributing to these violations unless they have the necessary intelligence into their value chain operations. This includes insights into the ethics of supplier business practices, as well as an intricate understanding of the product lifecycle, such as the geographical origins of the source materials, their journey to the company gates, and the associated ESG risks. Until recently, companies had few incentives and lacked the necessary know-how to address these issues. However, this is rapidly changing.

What factors push companies towards supply chain sustainability?

A. View from the academic side

Academic studies that reviewed the body of academic literature related to sustainable supply chains have identified over 40 distinct factors (also known as ‘pressures’, ‘triggers’, ‘enablers’, and ‘drivers’) that push organizations toward the implementation of sustainability in supply chains. Among the most cited external pressures were government legislation, international regulations, and customer pressure, while influential internal pressures included drivers related to corporate strategy (e.g., top management commitment, organization mission statement) and the organizational resources (e.g., availability of resources for sustainability initiatives, pressure for more efficient use of natural resources) (Saeed & Kersten, 2019). We will not describe each driving factor here, but you can see the whole list of factors in the table below.

Academic research finds more than 40 major reasons why companies are pushed toward sustainable supply chains

Table 3. Drivers of sustainable supply chain implementation:

Drivers group	**Drivers**
External (outside of the organization)	
Regulatory pressures	• Government legislation (regulations on labor, employment, and environment; noncompliance results in fines) • Regional (e.g., the E.U.) or international regulators (supranational regulations influence organizations to adopt sustainable practice) • Professional/trade associations (trade associations impose requirements; non-compliance can lead to penalties) • Financial benefits (incentives like tax exemptions encourage sustainability adoption) • Certifications (standards like ISO help organizations meet ecological and social requirement)
Social pressures	• NGO pressure (NGOs push organizations to adopt sustainability initiatives) • Media/press (Media reports can damage reputations and prompt government action) • Value-based networks (Scientific communities encourage sustainable innovation) • Public pressure (Public awareness drives demand for sustainable practices) • Consumer organizations (Organized consumer groups demand

	sustainability) • Social well-being/community focus (Communities expect organizations to support local welfare)
Market pressures	• Competitive advantage (Improving sustainability for a competitive edge) • Competitors' pressure (Competitors' sustainability practices set industry norms) • Shareholders'/investors' pressure (Shareholders and investors push for sustainability; poor performance can lead to divestment) • Institutional pressure (Banks and financial institutions pressure for sustainable practices) • Suppliers' pressure (Suppliers help and pressure organizations to adopt sustainability) • Customers' pressure (Consumer demand drives adoption of sustainability practices) • Reputation/image (Sustainability improves brand image and stakeholder satisfaction) • Globalization (Global market access increases pressure for supply chain sustainability)
Internal (inside the organization)	
Corporate strategies	• Top management commitment (Leadership supports proactive sustainability) • Organization strategy (Sustainability is integrated into the mission and strategy) • Cost-related pressure (Cost reduction through energy savings, reduction in material consumption, increased efficiency, and profit) • Operational/economic performance (Sustainable strategies for long-term economic benefit)
Organizational culture	• Socio-cultural responsibility (Moral obligation to meet social expectations) • Innovativeness (Willingness to improve and generate new sustainability ideas) • Code of business conduct (Standardized decisions and procedures for stakeholders) • Information dissemination (Sharing sustainability information to promote collaboration) • Health and safety (Pressure to report and reduce work-related incidents)
Organizational resources	• Organizational resources (Adequate resources drive sustainability initiatives).

	• Resource depletion (Pressure to use natural resources efficiently) • Human capital (skills and capabilities) (Sustainability practices improve expertise and capabilities) • Employees' pressure/involvement (Employees push internally for sustainability practices) • Physical capital (technology and equipment) (New technology aids in implementing sustainability practices) • Training & development (Training improves sustainability performance and reduces waste)
Organizational characteristics	• Size (Large organizations face more internal and external pressures) • Industrial sector (Different sectors require different sustainability initiatives) • Position in supply chain (Downstream organizations face more pressure for sustainability) • Geographical location (Compliance with local environmental and social regulations) • Degree of internationalization (Multinationals face more pressure to adopt sustainability practices) • Current level of sustainability actions (High sustainability performance reduces stakeholder pressure)

Source: Saeed, M.A.; Kersten, W. Drivers of Sustainable Supply Chain Management: Identification and Classification. Sustainability 2019, 11, 1137. https://doi.org/10.3390/su11041137

Academic research identifies causal relationships between supply chain sustainability and business success

In addition to identifying existing drivers, recent academic research has also made progress in establishing positive causal relationships between the implementation of sustainable supply chain management and benefits to companies, such as lower reputational risks and improved performance (Agoraki et al. 2023). Similarly, there is piling evidence that climate change is associated with health hazards for employees in supply chains, causing unstable commodity prices and thereby affecting companies downstream (Kovacs and Falagara Sigala, 2021).

B. View from the business side

Voices from business leaders and industry experts: "The business case for supply chain sustainability has never been clearer and the stakes for not doing so have never been higher.

From the perspective of business owners, implementing sustainability in supply chains has ceased to be just a "nice-to-have" but instead has become a "need-to-have", and makes perfect sense for running a modern competitive business.

Recent surveys indicate that CEOs and supply chain officers strongly agree that incorporating sustainability is crucial in their own operations (53%) and among suppliers (45%). This sentiment is echoed among leaders and experts in the Asia Pacific region, who identified resilience in the supply chain as the top success factor for business competitiveness. Furthermore, The World Economic Forum interviewed large businesses running global supply chain networks, revealing that many interviewees associate supply chain sustainability with long-term financial success, citing operational gains such as reduced material wastage, improved energy efficiency, and streamlined processes, alongside shifting investor interests.

ESG-oriented companies are favored by investors and can gain capital at lower costs

According to experts, businesses are increasingly aware that investors nowadays evaluate companies based on their ESG performance. Furthermore, the cost of capital can be prohibitively high for companies exposed to high ESG risks in supply chains. Already, ⅔ of all capital is allocated through some sort of ESG lens, making it costly for low ESG-performing companies.

Global scarcity of talent

Another concern for companies worldwide is talent shortages. An international survey reports that globally 75% of employers are struggling to find the talent they need to fill positions, with Japan topping the list with the world's worst shortages at 85%. *"The talent shortage is real, and many businesses are struggling"*, writes Forbes, stating that *"employers in multiple countries and industries—and those of all sizes—are experiencing a shortage in attracting and retaining workers"*. In this context, companies are in fierce competition for attracting talent, while talented workers themselves nowadays are attracted by the sense of purpose and meaning in a company, rather than by simply receiving a salary. As such, companies that fail to prove that their business operations are ethical and sustainable, including supply chain operations, will struggle to attract and maintain a talented workforce.

Other concerns

Finally, companies are highly concerned about increasing regulations, raising consumer awareness, and increasing public scrutiny and demand for transparency in the supply chains, which we will discuss further.

C. View from the public side

The global trend of increased public scrutiny towards supply chain operations

As supply chains are more complex than ever, it is no surprise that public scrutiny is rising, vulnerabilities are being exposed, and regulations and demands from stakeholders are rapidly increasing. As consumer awareness increases, there is more pressure on businesses to comply with sustainability principles and more pressure on governments to establish the necessary regulations and guidelines to ensure such compliance. Moreover, the growth of social justice movements in recent years, along with the shifting climate change narrative towards 'climate justice' and 'just transition', is contributing to a heightened focus on ensuring human rights and fairness, particularly for people from vulnerable groups. These are people who labor in supply chains directly or people from the communities who are affected by the impacts from the supply chain operations. In such a context, companies must be constantly vigilant over their business practices within their supply chains.

Regulations are tightening around the world

While international frameworks promoted by international organizations and NPOs have been largely voluntary and focused on reporting, recent years have seen national governments (and supranational, i.e., the EU) proposing, discussing, and passing legislation with a particular focus on ensuring that businesses adhere to sustainable practices in their supply chains.

The Securities and Exchange Commission of the United States proposed a legislature that will legally require publicly traded companies to report their GHG emissions, including indirect scope 3 emissions. The legislature is currently at the public comment stage, but if passed, companies like Walmart will have to report the emissions from their entire supply chain, not just Walmart stores.

In the UK a law has been discussed that will force big companies to clean up their supply chains by fining them if they use agricultural products (e.g., cocoa, rubber, soy and palm oil) grown on illegally deforested land.

But perhaps it is the European region that is moving the fastest in the direction of tightening ESG laws, including regulations that specifically focus on supply chains. In Germany, the Act on Corporate Due Diligence Obligations in Supply Chains came into force on 1st January 2023, which legally requires large German enterprises to exercise due diligence in their supply chain to minimize environmental-related and human rights-related risks. The Corporate Sustainability Reporting Directive (CSRD) and Corporate Sustainability Due Diligence Directive (CSDDD) are two complementary legislations by the European Commission under the umbrella of the European Green Deal[3]. Both acts have already entered into force in 2023 and 2024 respectively, and target EU or non-EU companies operating on the EU market. Both regulations apply to companies' own operations and their supply/value chain operations. CSRD focuses on the disclosure of information relevant to the company's social and environmental impacts, while CSDDD requires companies to establish due diligence* procedures regarding human rights and environmental issues when they interact with their supply/value chain counterparties. Non-compliant companies risk exclusion from public procurement contracts, financial penalties and administrative measures.

As these laws are being passed nationally with a focus on large enterprises, they will inevitably affect companies globally, including smaller companies with fewer employees. Large companies under the jurisdiction of such laws will have to engage their global and smaller partners to comply with relevant requirements in order to do business with them, or even oblige them by specifying relevant clauses in supply contracts.

In summary, according to the above tendencies and viewpoints from all three sides (academia, private, and public sectors), the global trend towards more emphasis on ESG in supply chains is undeniable. It would be a mistake, however, to think that companies are simply forced to follow and unwilling to act on their own. As companies begin to recognize that numerous benefits and opportunities can be realized on

[3]European Green Deal is a package of policy initiatives, which aims to set the EU on the path to a green transition, with the ultimate goal of reaching climate neutrality by 2050

this pathway, they become motivated and thus they themselves become a large driving force behind the trend toward ESG-oriented supply chains.

Motivations: benefits and opportunities of implementing ESG-oriented supply chains

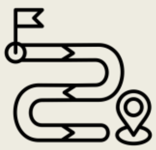
aiESG research team has explored numerous sources to understand what motivates companies

Let's examine in more detail why companies may get motivated to pursue sustainability and ESG-orientation throughout their supply chains. Through exploration of academic sources, as well as online news articles and blog articles, we have compiled a table of factors (i.e., benefits and opportunities) that motivate companies (and investors) to pursue sustainability throughout their supply chains.

Table 4. Motivations for companies that implement ESG-oriented supply chains: potential benefits and opportunities

	**Enhanced response to regulations and enhanced quality standards**	• Quicker response to regulations • Smoother compliance • Lower cost toward regulation compliance • Receiving sustainability certification/label • Raising quality standards above average
	**Access to new contracts and markets**	• Gaining access to government contracts • Entering new markets
	**Increased stakeholder confidence and improved brand image**	• Gaining the image of a responsible and trustworthy company • Gaining priority from investors • Creating enduring stakeholder value • Reputation enhancements • Enhanced brand value • Gaining trust through transparency and traceability

	**Improved risk management**	• Reducing supply chain risks by:
		  ○ Improved ability to anticipate risks
		  ○ Improved ability to respond to and recover from disruption
		  ○ Resilience of supply chain to disruption
		  ○ Preventing harmful activities
		• Cost reduction and increased financial stability through better risk management.

	**Long-term success**	• Enhancing business continuity and long-term success • Driving innovation • Increasing competitiveness • Achieving a circular economy • Improving relations with shareholders
	**Enhance value creation and operational performance**	• Developing new sourcing routes and better supplier management • Leveraging new technologies • Efficiency gains (through optimization and cleaner operations) • Flexible and green product design • Logistics optimization • Improved supply chain cooperation
	**Reduced costs and improved financial stability**	• Reduced product costs through energy and resource savings • Access to capital on beneficial terms • Lower cost of capital • Lower debt cost • Increase financial performance • Gaining the right to price the product at a premium (consumers are willing to pay more for eco-friendly products) • Logistics optimization
	**Enhanced human resources**	• Improving relations with employees • Attracting employees who value sustainability, including premium talent • Retaining employees (being socially responsible reduces the annual quit rate by at least 3%) • greater employee involvement leading to improved productivity • improved job quality and working conditions for employees in both the company and supply partners

	**Enhanced customer relations**	• Improving relations with consumers • Attracts customers who value sustainability • Enhanced customer loyalty • Being able to deliver a premium to consumers
	**Enhanced partner relations**	• Improved collaboration with suppliers • Development of long-term partnerships with suppliers
	**Enhanced corporate social responsibility performance**	• Help meet emission reduction commitments, including reducing scope 3 emission, by engaging supply chain partners • Enhanced social performance • Enhanced corporate governance
	**Benefits from the investors' perspective**	• Aligning with responsible investment policies and best practices; • Higher company revenue from realized opportunities mentioned above

Source: Compiled by aiESG research team by reviewing academic and online sources

With so many opportunities and potential benefits (the number of which is growing as knowledge in the academic and business community grows), companies are not only driven by pressures (as discussed in the above chapter) but also intrinsically motivated as they aspire to realize these opportunities and benefits.

This is a great opportunity for frontrunning companies that moved early to improve the ESG performance of their supply chains. For others, it is getting harder to avoid serious risks to their businesses.

Due to numerous opportunities, motivated companies themselves are becoming the driving force behind the sustainable supply chain trend

Risks of inaction

Companies are increasingly expected to understand and manage their exposure to supply chain risks. As we discussed above, those with a good understanding of their supply chain have great opportunities for business stability and long-term success. Companies that ignore current trends and become late in orienting their supply chain operations towards ESG principles face various risks.

While there are numerous benefits of action, there are also significant risks of inaction

These risks can include direct impacts from supply chain disruptions, such as interruption of the flow of materials, impact on delivery times, loss of social license to operate, increase in cost of materials due to last-minute change of supplier, etc. Other risks include reputation damage, regulatory non-compliance, operational disruptions, financial risk, being unable to attract and retain employees, and lost business opportunities.

There are direct risks related to supply chain disruptions and indirect risks of damaging the company as a result of ESG violations in the supply chain

As public scrutiny of this issue increases, many global companies are increasingly held accountable for their supply chain operations. In 2020, executives from Amazon, Ikea, Nike and other major companies were asked to appear before the U.K. Parliament to address claims that their suppliers were using forced labor. Another company, the UK based fashion retailer Boohoo, lost over $1.5 billion in market value on a single day after poor working conditions at one of their garment manufacturers were disclosed. ESG-related supply chain scandals have recently brought financial and reputational damage to other corporations like Hershey's and Nike.

Companies are increasingly being held accountable for ESG violations in their supply chains

Growing ESG and Human Rights regulations make firms directly accountable for violations, such as child labor, that are happening deep in the upstream supply chain operations. Such violations may have been committed by a supplier, or a supplier of a supplier, which the company might not even know existed. Yet, experts caution that if such violations' risks materialize and become scandals, firms can see 30-40% of their entire value wiped out instantly.

Most companies are unaware of the significant risks arising from ESG violations deep in the supply chain

In the above chapters, we have seen in detail how various pressures and motivations, including the necessity to avoid serious risks, all drive companies to start working on gaining the proper understanding and improving their supply chains' ESG performance. Let's turn to the necessary steps for companies and the challenges on that pathway.

The trend is clear, but how do we address the issue?

ESG-oriented supply chains: What are the necessary steps and challenges?

Most academic research and experts mention that in general, the following steps must be taken by firms in order to grasp and improve their supply chain ESG performance:

- Measurement & Monitoring (gathering data on ESG performance indicators)
- Supplier Engagement (Communicating expectations for regulatory compliance and ethical/sustainability standards to suppliers)
- Procurement Decisions (consider labor conditions, ESG impact from transport methods, and supplier transparency about materials used when making procurement decisions)
- Supplier Management Program (regular reviews of supplier performance against metrics)
- Sustainable Supply Chain Management Strategy (Develop an effective strategy with goals)

Recommendations from business and academic experts

While there exist various recommendations for what steps should be taken, most follow the simple scheme: "get facts -> mobilize resources and create an action plan -> take action -> monitor". It is the first step - "get facts" - that most companies have to focus on first, which most companies are currently struggling with. According to academic research, the "get facts" stage may include the following actions:

- get consultancy
- understand sustainability and ESG
- gather facts to understand where change is needed
- assess the current stage
- identify the kind of change needed
- identify regulatory and compliance requirements
- identify ESG risks
- identify opportunities

It is however with this "get facts" stage that most companies are struggling nowadays, due to the complexity of the supply chains and lack of ESG expertise in companies. Companies need to understand their supply chain ESG risks by first mapping out their supply chains and understanding where major risk hotspots[4] are located. This however is challenging without having the necessary expertise and tools.

[4] Risk hotspots are areas within a supply chain that are particularly vulnerable to disruptions due to high exposure to environmental, social, economic, or operational risks.

Indeed, surveys reveal that while procurement professionals face a lot of pressure due to a growing understanding of the necessity to reduce negative environmental and social impacts across supply chains, they are not always clear on how to begin addressing these issues. In addition, companies face challenges such as financial constraints or high costs, confusion with many ESG frameworks and standards, lack of skills, lack of external assistance, and other challenges.

The importance and the struggle with the initial stage

That is why supply chain professionals have recently been eager to utilize cost-effective IT technology solutions that will help them take the first steps toward ensuring sustainability within supply chain operations.

Technological Solutions

The issues described above bring us to the indispensable role that external consultancy and IT solutions can play in assisting companies in assessing and improving the ESG performance of their supply chains. According to experts who conducted surveys with business owners, most CEOs agree that the use of IT technology for improving the sustainability of their supply chains is crucial.

Despite the fact that most environmental and social impacts of businesses occur in the activities of their supply chains, most businesses don't know how much of that impact happens, where the biggest risks are located, and so on. In fact, many businesses often don't know anything about suppliers beyond direct tier-1 suppliers. While mapping the extended supply chain beyond direct suppliers can seem too daunting as the resulting image may be too complex, in reality, the big impact is often situated among just a few suppliers with the highest ESG risks. Therefore companies can prioritize engaging with these high-risk suppliers to make the entire supply chain more sustainable.

Thus, a thorough supply chain analysis is required to reveal opportunities for increased sustainability. Sustainable supply chain management requires very detailed attention, which can be difficult without the right digital tools and external assistance to help make sense of complex structures and relationships.

IT solutions can help companies initiate their response strategies by bringing clarity and strategic insight into the complex issue of sustainable supply chain management

ESG work takes considerable resources, time, money, and care from companies. It may seem that only corporations with high financial endowments can afford to take comprehensive steps toward sustainable supply chains. Most companies utilize semi-manual tools to map out and assess ESG risks, such as supplier surveys, where companies ask suppliers to provide information via questionnaires. Apart from being costly and time-consuming, such surveys can often help map only a few direct suppliers who returned the surveys. They, however, usually need to create a complete picture of their supply chains beyond tier-1 suppliers. Without a thorough ESG impact analysis of the company's product/service throughout its entire lifecycle, companies cannot grasp the full picture of how their extended supply chain looks and where major ESG risk hotspots are located.

Modern supply chains may have thousands of nodes. In addition, as companies have to take into account the growing number of relevant ESG indicators (e.g., ESG contains hundreds of relevant indicators such as GHG emissions, water consumption, child labor risk hours, and so on) it quickly becomes unfeasible to manually manage such data.

The solution from aiESG

Fortunately, the integration of cutting-edge academic research and the latest developments in big data and AI have given rise to a new generation of tools to assist companies in such tasks. aiESG is proud that it is the first product-focused solution in Japan and worldwide that helps companies assess the ESG impacts of their products and services throughout the supply chain based on the lifecycle analysis principles.

The unique know-how of aiESG allows the creation of an approximate model of the extended supply chain of the company's product or service based on credible statistical data and a scientific approach. The product/service lifecycle model built by aiESG tracks the materials to their source and calculates ESG impacts associated with the journey throughout the supply chain, allowing one to view the entire picture of the supply chain. The company can use this model for various purposes, including:

aiESG offers a unique solution based on cutting-edge scientific research and powered by AI

- Grasping the approximate structure of the supply chain can help companies initiate the creation of their real-life extended supply chain maps. This will, in turn, allow companies to reach out to and engage with their suppliers (and their suppliers' suppliers) to work together on improving the sustainability performance of the whole value chain.
- Understanding which ESG impacts are the biggest and where they are located can help companies better manage their risks. This enables companies to understand what are the weak spots of their value chains.
- Companies can then begin optimizing their supply chain operations by addressing high-risk hotspots through supplier engagement or by developing new sourcing routes.
- Furthermore, these insights also enable companies to begin planning their compliance response to growing regulations.

There are many other beneficial ways companies can use aiESG services. In short, aiESG provides a cutting-edge solution that helps companies in their first "get information" step toward a sustainable supply chain. With these valuable insights at just a fraction of the price, companies can begin improving their supply chain ESG performance.

Conclusions and Future Trends

In this article, we have seen in detail how the trend towards making supply chain operations more sustainable and ESG-oriented is developing, what tendencies drive such a trend (e.g., objective pressures, companies' internal motivations, and growing risks of inaction), what steps companies should take in response, what challenges they face, and how modern technological solutions can assist companies. We have also briefly mentioned how aiESG service can be a low-cost and helpful solution for companies that plan to address the sustainability of their supply chains, particularly at the initial stage of their response.

Finally, based on our research at aiESG, we offer a brief outlook on the three major future trends regarding supply chains.

First, there is no doubt that public scrutiny will grow further and regulations will tighten, forcing companies to assess, improve, and report their extended supply chain performance. Voluntary reporting frameworks will become not just good business practice but a necessary one in on order to remain competitive. Legislation, currently in the discussion and testing phase in several forerunning countries, will become more widespread and harder to ignore.

Second, from the consumer perspective, we observe how growing consumer awareness and demand for ethically made products has spurred the market response in the form of a growing market niche of the "ethical products" and "ethical industries." For example, the trend of "ethical fashion" or "sustainable fashion" is rapidly growing within the apparel industry. Companies such as Patagonia (an American retailer of outdoor clothing), and Avantii (a Japanese fashion company specializing in organic cotton) are just a few examples of fashion brands making strides in this increasingly competitive market.

Finally, we observe the growing importance of social dimensions, particularly human rights considerations. The most recent academic review (Truant et al., 2024) revealed that discussions within the ESG field have steadily changed from 'financial performance' and 'environmental sustainability' to 'social disclosure'. Recent legislation in the European Union, such as the Germany Supply Chain Act and Corporate Sustainability Due Diligence Directive (CSDDD), obligates companies to implement human rights due diligence across their suppliers. Leading companies, such as Apple, FAST Retail (Uniqlo, GU), Mercedes-Benz Group and others, have already taken pioneering steps in this direction. In our next article, we will discuss this trend toward human rights due diligence in supply chains, describe case studies by leading companies, and describe how aiESG can help companies begin planning their compliance with the due diligence process.

aiESG