

# **Blockchain Innovation for Sustainable Supply Chain Management under EU Corporate Sustainability Reporting Directive (CSRD) Regulation**

Marianna Manfrino

Department of Business and Management, H-Farm College, affiliated with University of Chichester, London, England

Email: marianna.manfrino@gmail.com (M.M.)

Manuscript received January 24, 2024; accepted February 18, 2024; published February 27, 2024

DOI: 10.18178/IJBTA.2024.2.1.8-15

---

**Abstract:** This paper explores the transformative role of blockchain technology in advancing the sustainability of supply chain management within the context of the EU Corporate Sustainability Reporting Directive (CSRD) regulation. As companies grapple with an expanded scope under the CSRD, encompassing a broader array of reporting entities, the need for robust and innovative solutions becomes increasingly evident. Blockchain, with its inherent characteristics of transparency, security, and decentralized consensus, emerges as a promising tool to address the multifaceted challenges associated with sustainable supply chain management. The paper investigates the role of blockchain in fostering sustainability across various dimensions of the supply chain, including ethical sourcing, environmental conservation, and the empowerment of local communities. The “Fashion Passport” project represents a case study of blockchain solutions to the fashion industry, with a specific focus on traceability. By utilizing blockchain, the “Fashion Passport” project aims to verify the authenticity and origin of garments throughout the supply chain. Through this case study, the paper aims to elucidate how blockchain technology acts as a catalyst for positive change, empowering businesses to align their operations with sustainable practices.

**Keywords:** blockchain, sustainable supply chain, corporate sustainability reporting directive, greenhouse gas emissions

---

## **1. Introduction**

In recent years, the intersection of blockchain technology and supply chain management has emerged as a focal point for innovative solutions that address the pressing challenges of sustainability and transparency. As global commerce continues to expand, concerns related to environmental impact, ethical sourcing, and social responsibility have gained prominence. In this context, blockchain technology has emerged as a transformative force, offering a decentralized and transparent framework capable of reshaping conventional paradigms in supply chain management.

With a focus on transparency, traceability, and resilience, blockchain’s decentralized ledger system has the potential to revolutionize the way organizations approach and integrate sustainability initiatives within their supply chains. By providing an immutable and transparent record of transactions, blockchain not only

mitigates risks associated with fraud and counterfeiting but also enables stakeholders to make informed decisions based on verified and real-time data.

## **2. The Role of the EU's CSRD in the Supply Chain Management**

In the rapidly evolving landscape of corporate sustainability reporting, the European Union's Corporate Sustainability Reporting Directive (CSRD) [1] stands as a pivotal regulatory framework aimed at bolstering transparency and accountability in the business sector.

The proposed Corporate Sustainability Reporting Directive (CSRD) within the European Union represents a significant evolution in sustainability reporting, succeeding the extant Non-Financial Reporting Directive (NFRD). The CSRD is poised to expand the ambit of companies obligated to report on their sustainability performance from approximately 11,000 to over 50,000 in Europe.

To adhere to the CSRD, companies must meet at least two of the following criteria:

- Achieve a net turnover of €40 million;
- Maintain a balance sheet exceeding €20 million;
- Employ a workforce of 250 individuals or more.

This implies that the CSRD will encompass a considerable number of large manufacturing entities and other companies with intricate value chains, including those involved in assembly or food production [2].

The transition timeline dictates that, by 2025, large companies already subject to the NFRD must report their sustainability-related information for the financial year 2024. By 2026, this obligation extends to all other large companies falling under the CSRD's purview, covering the financial year 2025. Consequently, companies need to formulate a comprehensive sustainability plan expeditiously, with a particular focus on supplier-related initiatives.

Calculating the environmental footprint of the entire company can be achieved through the Greenhouse Gas (GHG) Protocol, or nearly entirely (95%) via the Life Cycle Assessment (LCA) scientific method, particularly relevant for manufacturing companies employing activity-based footprinting. This baseline, rooted in averages, provides large companies with specific insights into which suppliers significantly contribute to their overall footprint.

Subsequently, companies should request product footprints, preferably in the form of LCAs to align with CSRD requirements, from their highest emitters. These product footprints encompass crucial information such as greenhouse gas emissions and other environmental impacts, including land use and biodiversity.

Implementing such a process necessitates thorough preparation, involving the following key steps:

- Identify suppliers with the highest environmental impact in the supply chain;
- Explore shared value opportunities, potentially fostering partnerships centred around sustainability;
- Develop a systematic approach to managing supplier data, which may involve requesting product LCAs. A standardized reporting format or a uniform environmental data collection system/LCA tool can be employed across all suppliers;
- Roll out a comprehensive supplier data collection program, including training suppliers on measuring their own product footprints. Periodic check-ins are essential to monitor progress;
- Integrate primary environmental data collected from suppliers into the company's own system for a consolidated view of sustainability performance.

### **3. Defining Sustainable Value Chain**

In pursuit of minimizing environmental impact and fostering societal well-being, enterprises direct their focus toward addressing overarching global concerns within the framework of a Sustainable Value Chain (SVC). The Sustainable Value Chain concept [3] is centred around multifaceted global issues encompassing human rights, climate change, equitable labour practices, marine pollution, deforestation, plastic waste, air pollution, and more, reflecting a comprehensive approach to corporate responsibility.

In the context of global value chains, many companies traditionally prioritize operational efficiency, emphasizing speed, cost-effectiveness, reliability, and quality of goods and services. However, only a select few integrate strategic objectives that consider the environmental and social implications of these global issues. These strategic goals may manifest as endeavours to reduce carbon emissions and enhance labour conditions.

The imperative to reduce environmental impact necessitates a fundamental shift in the prevailing business model towards sustainable, inclusive, and resilient value chains. Moreover, companies must scrutinize the origins of raw materials, examining their ecological footprint on the Earth.

While sustainability presents a significant opportunity for businesses, comprehending and aligning with global goals, trade regulations, policies, and concurrently improving social, environmental, and economic dimensions pose formidable challenges. The concept of a sustainable value chain is intricately intertwined with the core facets of a business, permeating from strategic considerations to product development and stakeholder relationships.

Responsibility along the value chain implies that each business partner contributes to creating ecological, economic, and social value for society. This extends beyond the supply chain and customer relationships to encompass a company's internal operations.

Considering the global reach of large corporations, operating within an intricate network impacts a substantial number of individuals, generating income, prosperity, and employment opportunities. However, this expansive reach also has the potential to generate environmental and social burdens.

Responsible design and management of global value chains can yield a profoundly positive societal impact, particularly for companies engaged in international operations [4]. By embracing responsible practices, companies actively shape their future trajectories and establish sustainable access to resources and markets.

Addressing the extant challenges requires a departure from isolated initiatives; instead, global companies must commit to the implementation and expansion of holistic and enduring sustainable business practices. In doing so, these enterprises not only contribute to societal well-being but also fortify their long-term resilience and viability.

### **4. Challenges in Sustainable Supply Chain Management**

In the realm of sustainable business practices, navigating the complexities of the supply chain presents a set of challenges that demand careful consideration. Three critical issues often encountered are the commitment of suppliers, the availability of information, and cost implications.

**Supplier Commitment:** Not all suppliers share a steadfast commitment to sustainability, and the adoption of more responsible practices may not occur organically. Some suppliers may require adequate incentives before readily embracing sustainable initiatives. This reluctance poses a hurdle for businesses striving to cultivate a supply chain deeply rooted in eco-friendly principles.

**Information Availability:** Gaining access to comprehensive information about suppliers and their sustainable practices is a common obstacle. Some companies may choose not to transparently disclose their initiatives, or they may lack proper monitoring and documentation of their sustainability efforts. This dearth

of information complicates the task of identifying and partnering with suppliers aligned with a company's sustainability goals.

**Cost Considerations:** The initial costs associated with acquiring sustainable products or services can be higher. This financial aspect becomes a potential deterrent, especially when the immediate economic benefits of such investments are not readily apparent. The challenge lies in balancing the long-term advantages of sustainability with the short-term financial implications, requiring a nuanced approach to decision-making.

These challenges necessitate a more careful selection process, considering these multifaceted aspects. Companies committed to sustainability find themselves at a crossroads, where the pursuit of environmentally friendly practices must be harmonized with existing business relationships. Striking this delicate balance is essential for fostering a supply chain that not only meets environmental standards but also aligns with the economic imperatives of sustainable business practices.

## **5. Towards a More Environmentally Conscious and Ethically Driven Supply Chain**

In the commitment to fostering a sustainable and responsible business model, companies can prioritize engaging with local industries and Small and Medium-sized Enterprises (SMEs) over multinational corporations operating outside of Europe. This strategic decision is anchored in several key principles that contribute to a more environmentally conscious and ethically driven supply chain [5].

**Greater Production Flexibility:** By choosing to collaborate with Local industries and SMEs, companies can benefit from a higher level of production flexibility. This not only allows them to tailor the production to meet specific demand but also prevents potential waste resulting from excessive production. The agility and adaptability of local enterprises can provide a dynamic and efficient production environment.

**Stronger Human Rights Safeguards:** Operating within the framework of European regulations can offer a more robust guarantee of human rights protection compared to the standards in many non-European countries. European legislation, with its stringent requirements, ensures that our business partners adhere to ethical practices, protecting the rights and well-being of workers involved in our supply chain.

**Reduced Environmental Impact:** Choosing local suppliers over those situated far beyond European borders can contribute to a reduction in the environmental footprint associated with long-distance transportation. This decision can align with the commitment to sustainability by minimizing carbon emissions and decreasing the overall impact of operations on the environment.

**On-site Inspections for Accountability:** To uphold the commitment to transparency and accountability, companies can conduct on-site inspections to personally verify the production processes of our partners. This hands-on approach allows us to ensure that their suppliers adhere to their ethical and quality standards, providing their customers with the assurance that their products are manufactured responsibly.

**Gathering Information on Sustainable Practices:** Companies can actively collect information on the sustainable practices of their chosen suppliers. This includes examining supply contracts that highlight the use of renewable resources, verifying certifications such as ISO and UNI for quality and environmental management systems, and ensuring a commitment to environmentally friendly and ethical business practices.

By privileging local industries and SMEs over multinational corporations operating outside of Europe, we aim to not only contribute to the local economy but also to build a supply chain that aligns with the values of flexibility, ethical production, and environmental responsibility. This approach reflects the dedication to creating a sustainable and socially responsible business ecosystem.

## **6. The New Human-Centric Industry**

The sustainable supply chain model is based on the concept of a Human-Centric Industry, recognizing the power of the sector to achieve social goals beyond jobs and growth by placing worker well-being at the heart

of the production process [6]. The model invests in production that respects the limits of our planet, with the primary goals being the centrality of human beings and sustainability [7].

Human-centricity is ensured by:

**Respecting human production and consumption timelines:** By respecting human production and consumption timelines, companies can create a work environment that values the balance between professional responsibilities and personal well-being. This approach fosters a more sustainable and humane workplace culture, minimizing stress and burnout while enhancing overall job satisfaction.

**Considering each worker as an investment, not a resource to be exploited:** This perspective entails fostering a supportive and inclusive work environment that recognizes the unique skills, talents, and contributions of every team member. By investing in the professional and personal development of their workforce, companies can cultivate a sense of belonging and commitment, ultimately leading to increased productivity and organizational success.

**Paying attention to fundamental human rights such as autonomy and privacy:** Employees are afforded the autonomy to make decisions within their roles, fostering a sense of empowerment and accountability. Additionally, companies can prioritize the protection of privacy, ensuring that individuals feel secure in their personal and professional spaces. This commitment extends to safeguarding sensitive information, respecting personal boundaries, and promoting a workplace culture that values and protects the dignity of every individual.

Sustainability is pursued in its three dimensions: environmental, social, and governance (ESG), through:

**Redesigning value chains that serve to produce and consume:** Recognizing the interconnectedness of production and consumption, companies can actively work to create value chains that prioritize environmental and social considerations. This involves scrutinizing every step of the supply chain, from sourcing raw materials to the end-user experience, to ensure that each link contributes to a more sustainable and ethical ecosystem.

**Optimizing the life cycle of every product or service to avoid the depletion of natural resources:** This commitment involves continuous innovation in design, production, and post-consumer phases to minimize waste and extend the usefulness of our products, ultimately contributing to a circular economy.

**Reducing the impact of industrial activities on people and the environment:** This includes stringent measures to reduce emissions, waste, and pollution. By adopting eco-friendly technologies, ethical labour practices, and community engagement initiatives, companies can strive to create a positive impact on the communities where they operate while safeguarding the well-being of the planet.

It is crucial to place models that respect inclusivity and value their workers at the core of the corporate project. To do this, companies in the supply chain have various options, including acquiring the status of a Benefit Corporation. This legal form, through statutory changes, makes an organization's commitment tangible not only to economic performance but also to social and environmental performance, as well as responsibility and transparency in the company's structure and performance.

There are also various solutions to enhance the journey towards social and environmental sustainability. For instance, to reduce their CO<sub>2</sub> emissions tangibly and measurably, even smaller companies can voluntarily adopt the standards imposed by the European Union on large and listed companies.

Furthermore, if companies can directly achieve by changing their business model and production processes to be sufficient, they can also support environmental and social projects firsthand. This involves participating in certified ESG initiatives that can be reported in their impact statements or sustainability reports. An example of this is the purchase of certified carbon credits.

## **7. The Pillars of Sustainable Supply Chain**

In the dynamic landscape of today's industry, companies are committed to embracing sustainable practices that not only benefit the environment but also contribute to a more responsible and consumer-friendly approach. Three key pillars define this strategy: small batch production, durability of the garment, and the circularity of products.

Small batch production is at the core of ethos. Recognizing the environmental impact of excess production, companies strive to produce only what we anticipate selling. This approach minimizes the creation of unsold inventory, eliminates surplus stock, and mitigates the need for discounted sales. By aligning production closely with demand, they not only reduce waste but also ensure a more efficient and economically viable supply chain.

Dedication to sustainability extends to the durability of garments. Company that prioritizes the use of high-quality raw materials and implement manufacturing processes, enhance the longevity and resilience of their products. By investing in durability, they aim to shift away from the fast production model, encouraging consumers to make mindful and lasting choices when it comes to their shopping.

Embracing the circularity of production, companies can use a marketplace online that allows consumers to actively participate in the lifecycle of our garments. Through the marketplace online, customers can easily resell or purchase pre-owned items, promoting a more sustainable and responsible way of consuming products. This not only extends the life of products but also contributes to a reduction in overall waste in the industry.

In pursuit of transparency and authenticity, companies can integrate blockchain technology and introduce digital garments with Non-Fungible Tokens (NFTs). This ensures complete traceability throughout the lifecycle of each garment, from its origin to the point of sale. Consumers can confidently verify the originality and authenticity of their purchase, fostering trust and transparency in the supply chain.

By combining small batch production, garment durability, circularity, and traceability, companies aim to redefine the industry's standards, paving the way for a more sustainable and responsible future.

## **8. The Role of Blockchain Technology in the Sustainability of Supply Chain**

Blockchain can accelerate the physical flow of products in the supply chain line [8]. It can potentially improve the environment and significantly increase sustainability. Integrating the supply chain with the blockchain enables enhanced product transportation and inventory management as well as increased sustainability.

Blockchain technology has a very useful structure for creating sustainable operations in supply chains. Promoting sustainable logistics and closed-loop supply chains for reuse, recycling and refurbishment is an increasing research topic, especially for cleaner production and circular economy [9].

Blockchain enables monitoring of sustainability performance to evaluate suppliers, ensure that products transported from producer to consumer are unmediated, packaging is traceable and thus environmental impacts are monitored. It is known that blockchain technology, which is so related to sustainable supply chain management, will also benefit Sustainable Development Goals (SDG). It has become openly accepted since the United Nations published a report discussing how blockchain technology can help its potential contribution to these ends. Sustainable development goals can be achieved by properly managing the supply and distribution processes in supply chain networks and applying the concept of sustainability to each chain operation at these stages.

Supply chain stakeholders can identify all inputs and applications used, as well as the movement of each product in the supply chain to shipping and storage conditions. Another important aspect of this technology

is that for every registered product in the product supply chain, every movement in the journey from production to sales can be monitored transparently by all consumers, risks can be tracked, and problematic products can be detected as soon as possible, allowing their consumption to be prevented or recalled.

Decentralized, transparent, immutability, irreversible, autonomy, open source, anonymity, ownership and uniqueness, source, contract automation (smart contract) are among the features that allow blockchain technology to be accepted within the sectors. Thanks to these features, it finds application potential in many areas and has an important position in supply chain management. These features have a significant impact on supply chain management and affect the design, organization and operations of the supply chain.

## **9. Revolutionizing Luxury Fashion with the “Fashion Passport” Project: A Case Study on Blockchain**

Imagine an innovative startup in the fashion industry, dedicated to developing technologies for the digital certification of the authenticity of luxury garments. Specifically, this startup aims to promote the principles of the circular economy by emphasizing the appreciation and resale of high-end fashion items [10].

The objective is to keep components and materials circulating in the economy, contributing to a sustainable and responsible approach. In addition, the startup strives to champion values of sustainability, equity, inclusion, and gender equality, actively combating stereotypes that undermine human dignity and fostering cultural change within the fashion sector towards inclusivity and respect for individuals.

The startup plans to establish a prominent online presence for its luxury fashion brand, ranging from the creation of a web portal to narrate the project to defining the criteria for obtaining the “innovative startup” certification, particularly regarding the “Fashion Passport” project. According to the project’s objectives, “Fashion Passport” aims to act as an enabler for digital certification on the blockchain through Non-Fungible Tokens (NFTs).

The “Fashion Passport” project represents an innovative leap in the application of blockchain solutions to the fashion industry. Blockchain traceability allows for the verification of the authenticity and origin of garments. Every step along the supply chain can be recorded on the blockchain, enabling the tracking of a product’s journey from production to delivery. This not only helps prevent counterfeiting but also ensures that the garments are authentic and sourced from reliable origins.

The primary goal of “Fashion Passport” is to transform the product into a digital asset by associating each garment with an NFT through the blockchain structure. This integration creates a seamless purchasing experience between the physical and digital worlds, linking the digital token to the physical garment in a way that makes the owner the exclusive possessor of that product, fostering a robust sense of community.

The “Fashion Passport” project’s technical development, in its initial phase, includes:

- Minting NFTs with metadata for 300 garments;
- Creating a custodial “parent” wallet containing the NFTs;
- Drafting smart contracts to facilitate ownership transfer and establish relationships with the physical garments.

The subsequent phases involve the creation of backend management software for updating NFT metadata, integration with the front-end website, and preparing the code to display NFT metadata to customers.

This industrial research project aims to trace the product’s history, certify the value and originality of each garment, and foster customer loyalty within an exclusive community that generates benefits and new marketing opportunities.

“Fashion Passport” is poised to bring significant technological advancements to the luxury fashion market, specifically in the realms of circularity and traceability of high-end apparel, challenging the current industry norms and promoting the adoption of blockchain certification for used and certified items.

As the startup envisions the creation of the first marketplace for the resale of its certified used items, it not only adds tangible value to the products but also champions the circular economy. By spearheading blockchain technology projects in the fashion sector, the startup positions itself at the forefront of positive change, setting new standards for sustainability, innovation, and responsible business practices. The “Fashion Passport” project exemplifies how technology, when harnessed strategically, can serve as a catalyst for transformative change, not only within a single industry but for broader societal and environmental benefits.

## Conflict of Interest

The author declares no conflict of interest.

## References

- [1] Corporate sustainability reporting: [https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting\\_en](https://finance.ec.europa.eu/capital-markets-union-and-financial-markets/company-reporting-and-auditing/company-reporting/corporate-sustainability-reporting_en)
- [2] EU CSRD indirectly hits suppliers, August 2023, Ecochain: <https://ecochain.com/blog/eu-csrd-indirectly-hits-suppliers/>
- [3] Defining Sustainable Value Chain, The Complex Path to Sustainability, Olivia Tyler, TED Institute: <https://ecampusontario.pressbooks.pub/globalvaluechain/chapter/8-2-defining-sustainable-value-chain/#:~:text=Sustainable%20value%20chain%20is%20a,pollution%2C%20air%20pollution%2C%20etc>
- [4] From a literature review to a conceptual framework for sustainable supply chain management, Stefan Seuring, Martin Muller, June 2008: [https://www.researchgate.net/profile/Martin-Mueller-28/publication/223590572\\_From\\_a\\_Literature\\_Review\\_to\\_a\\_Conceptual\\_Framework\\_for\\_Sustainable\\_Supply\\_Chain\\_Management/links/628a8d658ecbaa07fccbbe8c/From-a-Literature-Review-to-a-Conceptual-Framework-for-Sustainable-Supply-Chain-Management.pdf](https://www.researchgate.net/profile/Martin-Mueller-28/publication/223590572_From_a_Literature_Review_to_a_Conceptual_Framework_for_Sustainable_Supply_Chain_Management/links/628a8d658ecbaa07fccbbe8c/From-a-Literature-Review-to-a-Conceptual-Framework-for-Sustainable-Supply-Chain-Management.pdf)
- [5] A More Sustainable Supply Chain, Verónica H. Villena and Dennis A. Gioia, <https://hbr.org/2020/03/a-more-sustainable-supply-chain>, March – April 2020:
- [6] Industry 5.0: Towards more sustainable, resilient and human-centric industry, Directorate-General for Research and Innovation, January 2021: [https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/industry-50-towards-more-sustainable-resilient-and-human-centric-industry-2021-01-07\\_en](https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/industry-50-towards-more-sustainable-resilient-and-human-centric-industry-2021-01-07_en)
- [7] The human-centric Industry 5.0 collaboration architecture, Attila Tóth, László Nagy, Roderick Kennedy, Belej Bohuš, János Abonyi, Tamás Ruppert, June 2023, <https://linkinghub.elsevier.com/retrieve/pii/S2215016123002571>
- [8] Digital Product Passport and Digital ID: what they are, how they work, which are the benefits: <https://theidfactory.com/blog/digital-product-passport-and-digital-id/>
- [9] E. Yontar, "The role of blockchain technology in the sustainability of supply chain management: gray based dematel implementation." *Cleaner Logistics and Supply Chain*, 100113, 2023.
- [10] Il fornitore giusto: esserlo, sceglierlo e diventarlo, novembre 2023, Assolombarda: <https://www.assolombarda.it/servizi/industria-innovazione-e-qualita/documenti/il-fornitore-giusto-esserlo-sceglierlo-diventarlo>

Copyright © 2024 by the authors. This is an open access article distributed under the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited ([CC BY 4.0](https://creativecommons.org/licenses/by/4.0/)).