

WOVEN PATHWAYS

**Strategies driving
Supply Chain
Sustainability**

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Vasundhara is the student-led magazine of TERI SAS and comprehensively embodies diverse youth opinions along with the views of field experts on several contemporary burning topics aligning various aspects of climate change and sustainable development, containing intellectual writeups loaded with factual information, opinions and constructive way forward. What makes it even more enriching are the exclusive interviews with eminent personalities, gaining practical insights in different aspects of sustainability. It is curated keeping a holistic and global perspective in mind that includes legislations, conventions, regulations and traditional knowledge systems under numerous distinguished themes. Since 2019, the magazine has published 17 issues, with a wide reach of students, academicians, experts and researchers within and outside TERI SAS.

THE TEAM

CORE TEAM

ANANYA C G – MBA SM
DAMINI MALHOTRA – MBA SM
MANISH KUDALE – MA SDP
MUGDHA SAHU – MSC ESRM
PUJEET JHA – MSC ESRM
PRADNYA KURDUKAR – MBA SM

CONTENT TEAM MEMBERS

ANANYA C G – MBA SM
DEVYANI SRIVASTAVA – MA PPSD
HARSHITA GUPTA – MBA SM
KASHISH SAINI – MBA SM
KHUSHI GANGWAL – MA SDP
MADHURIMA PATRA – MBA SM
MUGDHA SAHU – MSC ESRM
PRADNYA KURDUKAR – MBA SM
PUJEET JHA – MSC ESRM
SHREYA MISHRA – MSC ESRM

EDITORIAL TEAM MEMBERS

MANISH KUDALE – MA SDP
MUSKAN SHARMA – MSC ESRM
YASHWINI – MA SDP

DESIGN TEAM MEMBERS

ARCHIYA KUMARI – M.SC. ESRM
DAMINI MALHOTRA – MBA SM
PARESH KUMAR SAHOO – MTECH REEM
SANDEEPAN SANTRA – MBA SM
SHOUBHONIC DUTTA – MA SDP



Email: vasundhara.ecoclub@terisas.ac.in
Instagram: @ecoclubtsas
Twitter: @ecoclubtsas
Facebook: @ecoclubtsas



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From the Vice Chancellor's Desk

In an increasingly interconnected world where every decision has a ripple effect across continents, the concept of sustainable supply chains has emerged as one of the most pressing challenges of our time. The traditional linear model of 'take, make, dispose' is giving way to a more conscious approach that recognizes the finite nature of our planet's resources and the urgent need for systemic transformation.

At TERI School of Advanced Studies, we understand that supply chains are the arteries through which our global economy flows. They connect raw materials to consumers, developing nations to developed markets, and local communities to international commerce. However, these very networks that fuel prosperity also carry the potential for environmental degradation, social inequity, and economic instability if not managed responsibly.

The latest edition Vasundhara addresses the multifaceted dimensions of supply chains with remarkable depth and clarity. From examining ethical workforce practices in the Global South to understanding the complexities of Scope 3 emissions, our contributors have crafted a comprehensive narrative that spans regulatory frameworks, technological innovations, and grassroots solutions. The articles reflect our commitment to addressing some of the most pressing questions regarding supply chains: How can AI and blockchain revolutionize transparency? What role does the circular economy play in achieving a zero-waste future? How do geopolitical dynamics reshape global trade patterns? These inquiries are not merely academic; they represent the foundation upon which future business leaders and policymakers will build sustainable societies.

As India aspires to become a developed nation by 2047, the localization of supply chains and support for MSMEs becomes paramount. Similarly, as global regulations like the EU's CBAM reshape international trade, our understanding of climate adaptation and just energy transition must evolve accordingly. The integration of nature and biodiversity considerations into supply chain sustainability reminds us that business success cannot be divorced from ecological health. Each decision made in boardrooms today will determine whether future generations inherit a thriving planet or one struggling under the weight of unsustainable practices.

I commend our students and faculty for their dedication to exploring these complex themes. Their work represents not just academic excellence, but a beacon of hope for creating supply chains that serve profit, purpose and are sustainable. Together, let us continue building bridges between knowledge and action, ensuring that sustainability becomes not just an aspiration, but the very foundation of how we conduct business in the 21st century.



Prof. Suman Kumar Dhar
Vice Chancellor,
TERI School of Advanced Studies

Note from Editor in Chief

From the food that we eat, cloths we wear to gadgets we use, they pass through complex supply chains. In today's globalized VUCA (Volatile, Uncertain, Complex, Ambiguous) world, system thinking, collaboration, and understanding interconnections are crucial for sustainable development. In a world facing climate change, geopolitical shifts, and rapid technological disruption, resilience is more important than ever. From the EU's CBAM and CSRD to India's BRSR Core and Green Credit Program, it's clear that sustainable supply chains are becoming the global norm. Supply chains are critical for the business to drive their top line and bottom line. Any disruption in the supply chains not impacts businesses, but also to the economy and consumers, being part of stakeholders in supply chains. Thus, sustainability of supply chains refers to their long-term continuance. Though supply chains play a critical role, yet there are ambiguities while turning targets and commitments into practice.

This edition "Woven pathways: Strategies Driving Supply Chains Sustainability" is centered around different aspects of supply chain sustainability, covering key facts, case studies and strategies for corporates, businesses, policymakers, consumers and other supply chain stakeholders, covering aspects such as regulatory landscape, greening the supply chains, financing, risks and opportunities, technology and ethics in workforce.

Ranging from policy aspects namely EU CBAM and greening MSMEs in India, the edition highlights vulnerability of global supply chains. Decluttering scope 3 (indirect) emissions, it also highlights sectoral bottlenecks in supply chains of fast fashion and renewable energy technologies. The edition also covers nature and biodiversity-related risks to supply chains, ethical issues in workforce practices and strategies such as integrating circularity principles in supply chains, localizing supply chains for better resilience and financing for sustainable supply chains.

In addition to research-based articles, this edition also includes interviews of experts infusing on-ground insights.

I would like to extend my heartfelt thanks to the team members for their dedication and passion towards the vision of Vasundhara which shaped this edition. I extend gratitude to faculties and external experts for sharing their valuable inputs. I would also like to thank administration for their logistical and budgetary support.

Team Vasundhara considers this as responsibility to aware masses on emerging issues in sustainability. Let this edition inspires to contribute making supply chains sustainable.

Pradnya Kurdukar
Editor-in-Chief, Vasundhara 17th Edition

EU's CBAM: Reshaping Global Supply Chain Sustainability

-Madhurima Patra

In Thailand's Rayong province, a \$2 billion electric-arc furnace (EAF) "green steel" facility is taking shape- not just as an engineering feat but as a strategic move in response to shifting global trade dynamics driven by climate policy 

Meranti Green Steel, aiming for access to European markets, is counting on the European Union's Carbon Border Adjustment Mechanism (CBAM) to reward its low-carbon production with reduced tariffs. This reflects a growing realisation among global producers: decarbonization is no longer merely a climate goal- it is a business necessity. As CBAM begins to influence global trade flows and competitiveness, it is prompting industries worldwide to embed sustainability into their core operations and supply chain strategies. This quickly leads us to examine the evolving landscape of the global supply chain, where sustainability now takes centre stage with the introduction of the EU's CBAM.

With the ambitious target of reducing net greenhouse gas emissions by at least 55% by 2030, the EU has introduced the 'Green Deal' and the 'Fit For 55' package for the industries. Now, how does CBAM fit into all these?

The Carbon Border Adjustment Mechanism (CBAM) is a crucial component of the European Green Deal and the Fit for 55 packages, which collectively aim to make the EU the first climate-neutral continent by 2050. CBAM helps prevent carbon leakage, a situation where companies move their production to countries with weaker climate rules to avoid higher carbon costs in the EU. It does this by placing a carbon price on certain imported goods, such as cement, steel, and aluminium, that matches the price EU producers pay for carbon emissions under the Emissions Trading System (EU ETS). This ensures that goods produced outside the EU are subject to the same carbon costs as those made within the EU, creating fair competition. The mechanism also encourages other countries to adopt similar climate policies. Starting in 2026, importers of these goods will need to buy CBAM certificates based on the carbon content of their products. These certificates will help cover the carbon costs, and companies that don't comply will face penalties.

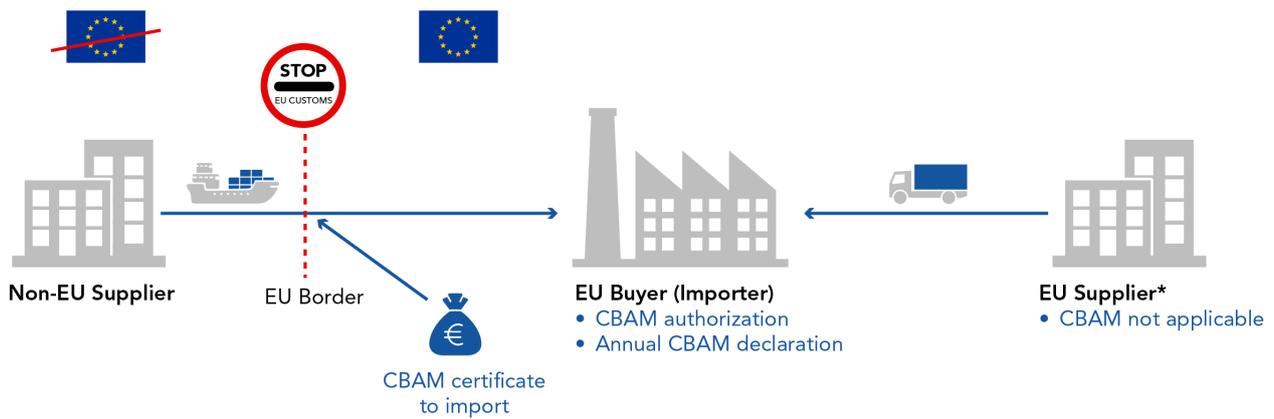
These certificates will help cover the carbon costs, and companies that don't comply will face penalties. Overall, CBAM will support the EU's climate goals by promoting decarbonization within the EU and encouraging global efforts to reduce emissions. [1]

Now that CBAM is being introduced, how will it help in tackling carbon leakage?

The Carbon Border Adjustment Mechanism (CBAM) is essential in preventing carbon leakage by aligning the carbon costs of imports with those of domestic production in the EU. The reform of the EU Emissions Trading System (EU ETS), aimed at reducing emissions by 55% by 2030, increases carbon prices within the EU, which could lead to production moving to countries with weaker emissions regulations. This increase in emissions outside the EU was previously expected to offset EU emissions reductions, with 34 Mt CO₂ equivalent more emissions being generated in partner economies. However, CBAM addresses this issue by imposing a carbon charge on imports ensuring that for every tonne of CO₂ avoided in the EU, a reduction of 0.12 tonnes is seen outside the EU. As a result, global emissions are projected to decrease by 0.54%, with about one-third of this reduction attributed to CBAM. Countries like Turkey, Chile, Mexico, and Canada that produce goods with low carbon emissions stand to gain, while high-emission economies such as India, Tunisia, and South Africa may experience small declines in value-added in CBAM sectors due to higher carbon costs. Ultimately, CBAM promotes global decarbonization by encouraging non-EU producers to improve carbon efficiency and ensuring fair competition between EU and non-EU industries. With CBAM being the new normal, sustainability needs to be deeply ingrained in the supply chain, thereby paving the way for global decarbonization. But how will it distort the supply chain and global trade? [2]



EU Carbon Border Adjustment Mechanism simplified illustration



*Including goods originating from Iceland, Liechtenstein, Norway, and Switzerland [Source: The Conference Board, 2022]

CBAM and Global Supply Chain

Consider CBAM to be a climate fee at Europe's borders. From aluminium and fertilisers to steel and cement, imported products will now bear a carbon price tag that mirrors the EU's tough climate policies. While CBAM today applies to only a tiny fraction of global trade – some 0.37% by value – its effect is disproportionate. As noted by the OECD, European firms are rapidly adapting, importing goods from cleaner-producing countries. This trade diversion is reducing global emissions and reducing the threat of "carbon leakage," whereby industries relocate production to countries with fewer climate regulations. [3]

Let's visualise through the table where emissions are highest in CBAM-affected industries and outline the green pathways that can be pursued to stay resilient in global trade.

Key Stages in Value Chain	Emission Sources	Green Strategy
Aluminum Industry <ul style="list-style-type: none"> Bauxite mining Alumina refining (Bayer) Electrolytic reduction (Hall-Héroult) Casting/rolling Packaging & distribution 	<ul style="list-style-type: none"> Energy use & CO₂ from mining machinery High electricity demand in refining Carbon-intensive electrolytic reduction 	<ul style="list-style-type: none"> Use renewable power (hydro) in smelting Boost recycling
Fertilizer Industry <ul style="list-style-type: none"> Natural gas, phosphate, potash extraction Haber-Bosch & chemical processing Packaging & distribution 	<ul style="list-style-type: none"> Methane leakage from gas Energy-intensive Haber-Bosch process Fossil fuel use in mining & transport 	<ul style="list-style-type: none"> Energy-efficient production Organic fertilisers Precision agriculture
Cement Industry <ul style="list-style-type: none"> Limestone, clay, gypsum extraction Clinker production (kiln heating) Grinding & blending Packaging & distribution 	<ul style="list-style-type: none"> Fossil fuel use in mining CO₂ from clinker calcination Energy use in grinding & transport 	<ul style="list-style-type: none"> Alternative fuels Carbon Capture & Storage (CCS) Energy-efficient kilns Use of fly ash & supplementary materials

India and CBAM

- European Commission views CBAM as central to climate and trade policy.
- Economic concerns for India: CBAM sparks debates on equity & efficiency
- Disproportionate impact: Hits emerging economies yet to reach peak emissions
- Transition challenge: Net-zero targets vs. heavy reliance on carbon-intensive production
- Technology gap: Limited access to advanced tech & infrastructure for emission cuts



India and CBAM

- Tripling renewable energy capacity by 2030.
- Launching a Carbon Credit Trading System (CCTS) for low-carbon growth.
- Converting energy taxes into carbon price equivalents for exports.
- Using I-RECs to offset CBAM costs & fund clean energy.
- Seeking EU support to compensate firms for clean energy procurement.

So, what's for the future?

As the world counts down to full CBAM implementation, this much is clear: the global economy is moving toward a new reality in which carbon transparency and sustainability are an integral part of the global supply chain. Firms that move now—recasting supply chains, building low-carbon alliances, and adopting robust data disciplines, won't just avoid future costs and regulatory traps but will also stake out leadership roles in the new green economy. The CBAM can be Europe's program, but its radiating impact is worldwide, announcing that the future lies in global decarbonization of the supply chain.



Climate's Bill: Supply Chains at Billion-Dollar Risk

-Shreya Mishra 

In 2024, global natural disasters yielded an economic loss of at least \$368 billion. This was a consequence of Hurricanes- Helene and Milton in the U.S. combined with massive flooding across Europe [1].

While **natural disasters** arrive as sudden catastrophes, it is known that **climate change** amplifies the intensity of such events. Yet, beyond these **headline-making disasters**, lies a deeper **fundamental threat**. Climate change, which is manifesting as global warming, rising sea levels, erratic rainfall and storm patterns, **erodes industrial stability** through daily disruptions. The combined impact of **operational inefficiencies, resource scarcities and infrastructure strains** translate into **long-term economic vulnerabilities** far more than the costs incurred because of acute disasters. Industries are small focal nodes of the larger global network of economies. While an industry may focus on a few core physical assets (factories, warehouses, equipment, machinery, etc.), its full operation relies on a **complex web of extensive supply chains (SCs)** [2]. These SCs bridge economies, traversing geographical, fiscal, and trade boundaries, integrating the core assets with essential supporting infrastructure (power, water, transport, etc.) to **facilitate interactions among producers, manufacturers, distributors, and customers** [3].

The functionality of SCs relies on the interactions among these constituent elements, which are highly volatile, given that a **disruption** caused at any node can yield a **domino effect** of consequences across the entire chain. This **systemic fragility** exposes SCs to collapse from disruptions of geopolitical conflicts, economic shocks, infrastructure failures, resource scarcities, and environmental threats. In today's evolving global industrial ecosystem, climate change and **extreme weather events** emerge as one of the most prominent **causative** and indisputable factors that amplify **SC vulnerability** and threaten its stability and resilience, leading to **costs** that are projected to reach up to **\$120 billion by 2026** [2].

Climate-related risks can cause disruptions in the SC at any point. The changing weather and climatic patterns **destabilize raw material sourcing, triggering shortages and inflated costs.**

Extreme climatic events such as droughts, heatwaves, and floods disrupt manufacturing processes, bringing the SCs to a complete halt. Transportation networks suffer due to similar reasons, **degrading efficiency** and severing critical trade routes. This **impacts distribution**, causing regional logistics imbalances and **inventory losses**. The consumption and demand patterns of customers **rely on the fluctuating costs of goods and services** that are a **consequence of the instability of the climate**-induced market. Moreover, in the era of globalization, industries operate on the interconnectedness of SCs across the world. Thus, a climate catastrophe in any one country has the potential to create cascading havoc across multiple industries, affecting multiple economies as a whole [2].

Global Supply Chains are at risk due to Climate Change! [4]

2025	 Los Angeles	 Wildfires disrupted port operations and slowed supply chains.
2024	 South Asia & Spain	 Severe floods hit transport, agriculture, and automotive supply chains.
2023	 Canada/U.S	 Wildfire smoke reduced solar output and delayed flights.
2023	 Panama Canal	 Droughts and El Niño dropped water levels, restricting global trade routes.

With the increased **occurrences of extreme weather events** at a **frequency of once every three weeks** (a significant jump from the **previous recurrence time of once in every four months** [5]) and taking into consideration that we are a developing nation, India is vulnerable to the escalating impacts of climate change.

The **Annualized Average Loss (AAL)** from extreme weather events and slow-onset hazards has been estimated at **\$93 billion**, which is 3.35% of India's GDP as reported by UNESCAP in 2019 [6].

Since climate change has far-reaching impacts and consequences on businesses, infrastructure, and economies across the world, the **Confederation of Indian Industry (CII)** carried out a **physical climate risk assessment** to evaluate the susceptibility of Indian industries to natural disasters and market fluctuations arising from such events [7]. The assessment was carried out for India's automobile manufacturing capital, Tamil Nadu [8], and it was revealed that the industrial units face very high climate risks with a concerning low adaptive capacity [6]. A direct correlation was demonstrated between the manufacturing units, warehouses, and distribution centers, and their distance from the coasts and ports, which are frequently exposed to cyclones [7].

Industry managers, professionals, and stakeholders are acutely aware of the growing impact of climate change on global SCs. A study modelled the climate-driven risks on SC performance and surveyed 62 managers from different industries to investigate their awareness and experience of the perceived risks of climate change to SCs [9]. Expectedly, extreme weather events were attributed to be the most influential factor that affected SCs, with the 'supply' function being most impacted.

With the projected trends of climate change, it becomes increasingly important to prioritize climate risk management and build SC resilience. The CII built a pilot climate risk management framework that addresses the climate risks posed to Tamil Nadu's automobile industry and caters to Maharashtra's agri-food processing and Odisha's iron and steel industries [6].

Key Recommendations of the CII Report

Strategies to Build Climate-Resilient Industries



Policy and Collaborative Recommendations

- Support for MoEFCC's National Adaptation Plan (NAP)
- Dialogues between industry consultants and domain experts for collaborative solutions
- Policy recommendations with short- and long-term actions



Physical and Financial Interventions

- Outlined physical and financial interventions
- Proposed physical interventions: flood barriers, wind-resistant infrastructure, water conservation measures
- Access to extreme weather and climate projection data for climate risk assessment



Worker Safety and Occupational Health

- Emphasized occupational health and safety mechanisms to promote a worker-centric industrial environment

India's commitment to achieving **net-zero emissions** by **2070** goes **beyond decarbonization**—it demands building a robust, **climate-resilient industrial network** that can confront the reality of climate change. Devastating floods, prolonged droughts, and rising heat stress expose the fragility of globally interconnected production networks and compel industries to confront a critical paradigm: adaptability is the new competitive necessity. Only by **embedding climate resilience into the very foundation of SCs** can India and all economies secure their industries against systemic collapse and realize sustainable growth.

Another Bill received
from Mother Nature LTD.

(Extreme environmental event incoming...3,2,1)

Financing Sustainable Supply Chains

The trillion-dollar transformation is reshaping how we move goods around the world

- **Khushi Gangwal** 



The morning coffee that we sip every day is linking us into a financial revolution, transforming commerce across the world.

Here's how: the Ethiopian farmer who is cultivating the beans may have obtained the credit through sustainability-linked financing. The Brazilian processing plant might have been financed by the Green bond obligations of renewable energy. Even the freight carrying the coffee across the Indian Ocean might have been funded with new transition instruments designed to decarbonise hard-to-abate industries.

How is this happening, and what are these financial tools? The question lies in why businesses are all in a rush to embrace them. The solution is with a basic change in the calculation of risk and reward in contemporary finance. This is not only a question of coffee but a reality of a 6.7 trillion-dollar transformation.

*Companies are not adopting **sustainable finance** out of the goodness of their corporate hearts but because it is one of the smartest things that they can do in business. [1]*

Three revolutionary financial instruments fuel this transition, and each one will address a part of the sustainability puzzle. So, how do they all work- and why are they revolutionizing everything?

The Mechanisms of the Financial Instruments Driving Change

Green Bonds: Value Created by Transparency

Consider green bonds as conventional corporate bonds but with a twist: each rupee increase must go to only operations that are useful or beneficial to the environment, and we must be totally transparent as to how the money is being spent and the outcome of the spending.

Typically, green bonds are aimed at financing clean projects. What happens to those companies that need finance to revamp whatever they are doing? That is where another kind of tool comes in.

Sustainability-Linked Loans: Performance-Based Financing

These tools are the stepping stones of finance to performance-based pricing. The cost that companies will borrow will vary in terms of meeting quantifiable sustainability objectives- achieve your carbon reduction objectives, borrow cheaper; fail to do so, and you will borrow at higher rates. It's that simple—and that revolutionary.

It generates immense convergence between monetary results and environmental outputs.[3][4]

How about those industries where transformation is not easy? That just can not turn a switch and go sustainable tomorrow. That is where the third and most innovative tool enters the stage.

Transition Bonds: Funding Industrials Transformation

Sustainability businesses are not something every enterprise can revert to overnight. Carbon-intensive industries require patient capital where investors appreciate that the transition to a low-carbon world cannot be done in a year or two but over years of concerted investment.

Transition bonds confront a messy truth: some industries need time to transition out of high-carbon production and into low-carbon operation, and that transition must be financed as well.

The result? Industries that seemed impossible to decarbonize are now attracting massive investment for transformation initiatives that seemed unthinkable just five years ago.[3]



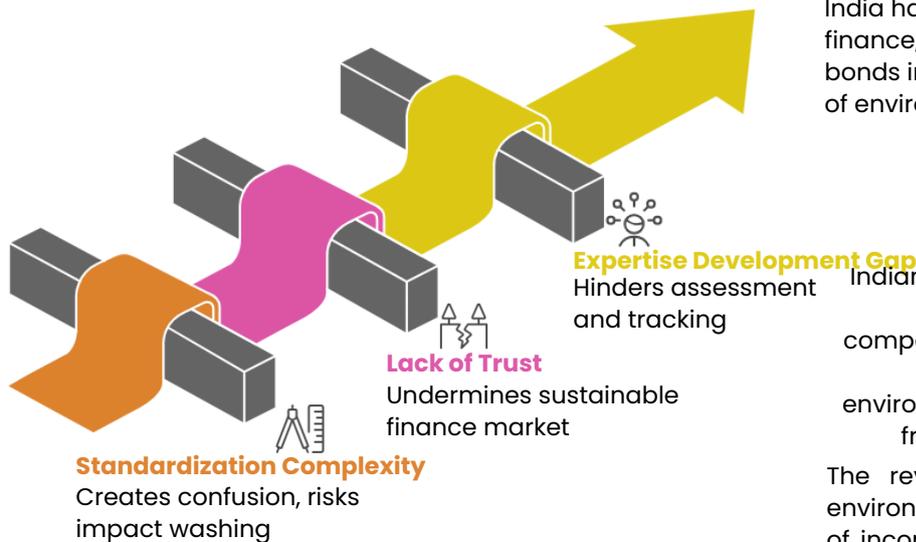
The Network Effect, The Cascade of Change

The cascading effect is the most potent feature of sustainable finance.

Such a cascade effect occurs due to the interdependent incentives produced in the context of sustainable finance. As soon as one business is willing to pursue sustainability goals using these financial lending resources then they require their suppliers to assist them in fulfilling the objectives, in turn, requiring sustainability demands to trickle down across the supply line. [5]

Though such worldwide trends are redefining business all over, India is becoming a very experimental laboratory of green finance. The approach that the country has had to offer provides an example to the rest of the world.

Critical Implementation Issues



The Strategic Opportunity

The most influential pathways start with innovations.

Technical Innovation: Designing the next generation of instruments. Opportunities to create blockchain-based platforms that automatically make checkups of environmental impacts could change the landscape. These systems can help reduce greenwashing, reduce transaction costs, and supply regulators, investors, and consumers with transparent and verifiable data that can fundamentally reshape accountability in global supply chains by embedding embedded smart contracts that automatically enforce compliance.[4]

Systems Integration: Connecting bridge finance, sustainability, technology, and policy. Assisting in the development of regulation schemes that would foster innovation, but also do not lower standards. A powerful system integration is the taxonomy of sustainable finance in the European Union, which focuses capital on projects that fit the rigorous environmental standards—inspiring the development of green technologies without the need to water down standards.[9]

Market Creation: Targeting unattended areas and unexploited possibilities. Developing fintech to encourage access to sustainable capital by SMEs. These are the Opportunities that we could tap in the ever-changing scenario to yield maximally. And what then will a successful look be? What kind of world are we creating with these financial innovations?

Draft Framework of India's Climate Finance Taxonomy

[Click to read](#)

Government of India
Ministry of Finance,
Department of Economic Affairs

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The Sustainable Finance Leadership of India

India has become one of the world leaders in sustainable finance, introducing the program of sovereign green bonds in 2023 and developing the extended regulations of environmental commoditization.[6]

Innovation in India is more than just importing the current instruments. The nation has developed completely new frameworks, making access to sustainable finance democratic.

Indian Green Credit Program 2023 is the most extensive environmental commoditization in the world. In comparison to the traditional carbon credits, which only target emissions, the system takes eight different environmental activities into consideration, which range from afforestation and sustainable construction.[7]

The revolutionary aspect of it is that it makes all environmentally friendly developments a possible source of income. It has become extremely possible to literally cash in on green efforts, so that businesses have created a potent economic incentive to practice sustainable operations.

The economic returns of investment in sustainable manufacturing support the economy in more ways than one by generating direct employment, as well as spillover effects in innovation, improving export competitiveness, and realizing environmental health cost savings.

Nonetheless, with this promise, we have to be realistic of the challenges to come. The change is not only coming rapidly it is also posing new challenges, which we have to address.

DID YOU KNOW?

The sustainable finance market, which is expected to have a 23 percent growth rate by 2030, has shortage of human potential.

The Defining Question

With 385.1 billion green bonds issued only in the first half of 2024 (TodayESG, 2024), we are experiencing the structural repositioning of financial markets according to planetary limits. There is the equipment available, funds are in plenty, and urgency is not a business.

What we pour in our morning coffee will be the same, but the unseen money plumbing to get that coffee to our cup is changing at lightning speed. The question will not be whether it will be a revolution that affects us—it will. What the future holds lies in the decisions we make today. We are no longer passive consumers in global commerce—we are potential co-authors of its next chapter. The financial choices made today will determine not only who gets capital, but who gets clean air, secure livelihoods, and a livable planet. Are systems of commerce going to further drain people and the planet, or can we develop systems that create value to both? The response is taking shape as we speak, and each one of us will be interested in the result.

Edited by: Muskan [in](#)

Designed by: Paresh Kumar [in](#)

Sustainability

IN THE FASHION SUPPLY CHAIN



Sustainable
Raw Materials



Ethical
Manufacturing



Consumer
Engagement



Smart Logistics



End-of-Life
Circularity



Reuse/Recycle

Fast & Green

The Consequence of Chic: The Cost of Fast Fashion

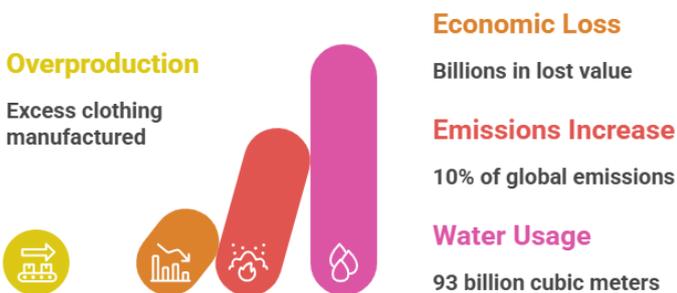
-Pujeet Jha

The fashion business, in its present manifestation, is symptomatic of a larger disease; the capitalist urge to expand. Driven by insatiable hunger it brags of its speed, volume and size; the fashion industry's constant greed for new styles harms not only our planet but also its people to an extent where a cleanse is crucial.

This endless desire for the newest fashion trends often created by the industry itself, has ironically led to a huge amount of excess. Behind the industry's glamorous image lies a harsh truth: it is inefficient, polluting, and incredibly wasteful.

The scale of the problem is magnanimous. In 2023 alone, the fast fashion industry produced between 2.5 and 5 billion excess pieces of clothing, totalling a mind-boggling **\$70 to \$140 billion lost value** (McKinsey & Company, 2024). This overproduction is not only an economic blunder but an ecological disaster. The sector accounts for as much as 10% of world greenhouse gas emissions and uses around 93 billion cubic meters of water each year (UN Environment Programme, 2018). The severe consequences of this situation have finally prompted regulators to step in. A key example is the European Union's upcoming ban on incinerating unsold products, set for 2026. This move will compel brands to face the direct consequences and results of their environmentally damaging actions (McKinsey & Company, 2024).

Fast Fashion's Overproduction Impacts Environment



The general trend cycle of fashion has accelerated to breakneck speeds. Perceived obsolescence is the driving force for this change, the consumer is made to believe the clothes they already have aren't good enough, sowing the seed for overconsumption leading to "want" taking over the actual need. Currently the design-to-market process has been reduced to merely two weeks.

The pressure these places on the supply chain is unimaginable. In a business-as-usual scenario, the fashion sector would use up more than 25% of the global carbon budget by 2050. Textile manufacturing, which is extremely energy intensive, accounts for nearly 70% of total emissions (McKinsey & Company, 2024).

The economic consequences of this overproduction are equally dramatic. It creates wild discounting, undermines profits and dilutes brands. This volatility leads to stocks being mismanaged; the supply chains aren't able to forecast the requirements across multiple sizes leading to routine "out of stock" signs. It is estimated that this mismanagement caused by ultra-fast cycles have led to as much as 20% profit loss on average (McKinsey & Company, 2024), and when we talk about an industry valued at 1.84 trillion USD, it adds up to billions in losses.

Weaving a New Model: Strategies for a Sustainable Fashion Future

To these growing pressures, the industry is coming to a critical turning point. A radical shift is needed, away from the linear **"take-make-waste" model** toward one that is circular, resilient, and transparent. It is not a matter of incremental change or greenwashing; it is a matter of an across-the-board rethinking of the systems that regulate how fashion is designed, made, sold, and valued. The following strategies, which are backed by new technologies and innovative policies, are the recipe for this new model.

Part I: Radical Supply Chain Reconfiguration:

- **Strategic Nearshoring and Diversification:**

Excessive dependence on a handful of manufacturing centres has made supply chains brittle and exposed to geopolitical shocks. A strategic nearshoring movement—shifting production closer to end markets—is gaining traction. This approach reduces lead times by 3 to 5x, lowering inventory levels, and can cut emissions from transportation by up to two-thirds (McKinsey & Company, 2024). In addition, sourcing diversification to emerging production hubs across Latin America and Eastern Europe enhances resilience and supports local economic development. Location choice also directly influences sustainability; for instance, fabric manufacture in Pakistan, relying less on coal, has a carbon footprint that is half that of production in China (McKinsey & Company, 2024).

- **From Transactional Connections to Co-Creation Partnerships:**

The brand-supplier relationship has to make a shift from one that is purely transactional to a strategic partnership. What this entails is more than just ordering and asking for lower prices; genuine co-creation requires co-investing in green technologies like installing renewable energy facilities on factory campuses and sharing data openly to enhance planning and minimize waste. Companies such as Patagonia have long advocated for this practice. Promoting close partnerships between the company and suppliers in order to maintain ethical labour conditions and environmental compliance proves that an open supply chain is feasible and profitable (Chouinard, 2005).

Part 2: Technological advancement

Technological solutions can be leveraged to enforce accountability and transparency.

- **AI-Powered Demand Forecasting:**

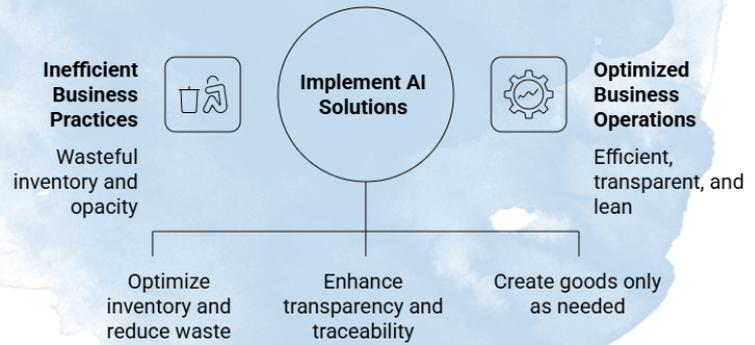
One of the most significant drivers of waste is inaccurate demand forecasting, this is due to the rapidly changing micro-trends and increasingly short product cycles, factors like social media tie back into the concept of perceived obsolescence creating a system that is difficult to forecast by even the sector itself. Artificial intelligence and machine learning can revolutionize this process. By analysing vast datasets including real-time sales, social media trends, and even weather patterns—AI models can predict demand with far greater accuracy. This allows brands to shift from a "push" model (making clothes and hoping they sell) to a "pull" model (making what customers actually want). This data-driven approach can reduce excess inventory by 5-15% and improve stock-out situations by 15-25% (McKinsey & Company, 2024).

- **Digital Product Passports (DPPs):**

A cornerstone of the EU's new Eco-design for Sustainable Products Regulation, DPPs are set to pierce the veil of corporate opacity. A DPP will act as a digital record for each garment, tracing its journey from raw materials and manufacturing processes to repair and recycling information. Accessible via a QR code or similar tag, DPPs empower consumers to make informed choices, facilitate a circular economy by providing crucial data for repair and recycling, and hold brands accountable for their sustainability claims (European Commission, 2022).



Revolutionizing Business with AI



- **On-Demand Manufacturing:**

Emerging technologies like advanced 3-D knitting and digital printing are enabling a shift towards on-demand production. Instead of producing large batches of clothing, items can be manufactured only after a customer places an order. This mode virtually eliminates overproduction and inventory waste for certain product lines, representing a paradigm shift from mass production to mass personalization

Part 3: Closing the Loop Through Circularity

A truly sustainable industry is one where waste is designed out and materials are kept in use for as long as possible. This requires a commitment to circular design and infrastructure, moving beyond the profitable linearity of disposability.

- **Designing for Disassembly and Recycling:**

The Ellen MacArthur Foundation emphasizes that circularity begins at the design stage. This means designing garments to be easily disassembled at their end of life. This involves favouring mono-materials over complex fibre blends that are difficult to recycle, and using components (like buttons and zippers) that can be easily removed and reused (Ellen MacArthur Foundation, 2017).

- **Investing in Advanced Recycling:**

While mechanical recycling has its place, scaling advanced, or chemical, recycling is critical for a circular textile economy. These technologies can break down complex textiles, like polyester/cotton blends, into their original molecular building blocks, which can then be used to create new, high-quality fibres. This creates a closed-loop system, reducing the need for virgin resources.



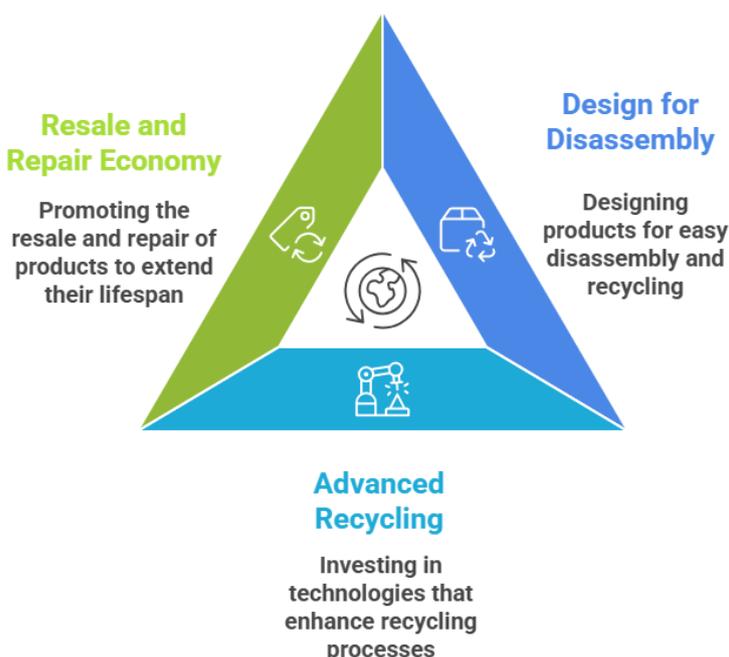
- **Embracing the Resale and Repair Economy:**

The second-hand market is on fire, expected to hit \$350 billion by 2028 (McKinsey & Company, 2024). Innovative brands are not only watching this happen but also taking part in it. By providing **in-house repair services**, creating their own **authenticated resale platforms**, and encouraging customers to bring back old clothes, brands can develop new streams of revenue, increase customer loyalty, and own the entire life cycle of their products.

Across the world, second-hand stores and reselling websites are doing well with more consumers focusing on sustainability, affordability, and uniqueness. Social media and online marketplaces have further driven this growth, which has made second-hand shopping a global mainstream culture in numerous nations.

This has been reflected strongly in India's larger urban areas of New Delhi, Mumbai, and Bangalore. Indian customers, particularly younger generations, are accepting resale due to its environmental aspects and value proposition in an inflation-aware market. Homegrown resale sites such as Kiabza, CoutLoot, and Relove, as well as domestic thrift shops, have made second-hand fashion convenient and desirable. Indian brands are also taking note by incorporating repair options and resale programs, leveraging this changing market to increase the product lifecycle and foster deeper customer loyalty.

Strategies for Circular Economy



Part 4: The Power of Policy and Collective Action

Individual brand efforts, while important, are insufficient to transform an entire industry that thrives on a race to the bottom. Systemic change requires robust policy frameworks and pre-competitive collaboration.

- **Extended Producer Responsibility (EPR):**

EPR policies shift the financial and operational responsibility for the end-of-life management of products to the producers. In the context of fashion, this means brands would be required to fund and organize the collection, sorting, and recycling of used clothing. France has already implemented an EPR scheme for textiles, providing a model for how policy can drive the development of circular infrastructure where the market has failed to do so (Ademe, 2023).

- **Collaborating for Scale:**

The industry's most significant challenges, such as decarbonizing the supply chain and scaling sustainable materials, are too large for any single company to solve alone. **Pre-competitive collaboration** is essential. This involves brands, suppliers, innovators, and even competitors working together through industry alliances to **co-invest in large-scale projects**, such as the development of renewable energy in manufacturing hubs or the establishment of advanced recycling facilities. A planned offshore wind project in Bangladesh, supported by major fashion players, is a prime example of this collective action, projected to cut annual emissions by 725,000 tonnes (McKinsey & Company, 2024).

CONCLUSION

The future of fashion is not a choice between style and sustainability, it is the recognition that the two are intertwined in their path forward that requires a bold reimagining of the industry's core tenets, moving from a model of extraction and waste to one of regeneration and value. The choice is stark, we can continue down the path of hyper-consumption, a path paved with waste and inequity, or we can collectively dismantle the old machine and weave a new model. A liveable future depends on us addressing the very system that dresses us.

From Linear to Circular: Redesigning Supply Chains for a Zero-Waste Future

— Harshita Gupta

The traditional model of international supply chains has historically been driven by a linear approach of "extract, make, use, and discard." This "take-make-dispose" behavior dates back to the Industrial Revolution and was one time glorified for its ability to drive economic growth and mass manufacturing. For decades, it allowed industries to respond to ever increasing consumer demand while driving technological innovation and trade expansion. But in the twenty first century, its shortcomings and environmental price tag have become impossible to avoid. More than two billion tons of waste are now produced every year globally, with the majority of this going to landfills or contaminating air, water, and land. The inefficiency of such wasteful processes also has a staggering monetary cost sticker—put at \$163 billion annually—while speeding up the consumption of finite resources, exacerbating climate change, degrading ecosystems, and eroding biodiversity (World Bank, 2018; McKinsey & Company, 2016).

If nothing is done, the linear model will continue to exhaust natural resources, push more ecological instability, and exacerbate climatic disruption. These mounting pressures have resulted in a paradigm shift towards a more sustainable alternative: the circular economy. A circular economy, unlike linear systems, attempts to redesign the whole lifecycle of materials and products so that they are used for as long as they can and waste and pollution are reduced to a minimum. At its best, a circular supply chain is a **closed-loop system** where materials are continuously **recovered, recycled, remanufactured, and reused instead of being thrown away once** (Ellen MacArthur Foundation, 2019). This method not only has substantial environmental advantages but also has serious economic and strategic benefits for companies and societies.



The shift to circularity starts at the design stage of a product. Conventional products tend to be hard to repair, take apart, or recycle, in essence trapping valuable materials in a waste stream. Circular products, on the other hand, are designed right from the beginning with durability, modularity, and fixability. Their design also focuses on recoverability so that the materials can be reintroduced into subsequent cycles of production with little loss of quality. IKEA illustrates this strategy in its **preference for manufacturing furniture using renewable or recyclable materials, configured to be simple to disassemble and reassemble (IKEA, 2021)**. This design ethic lengthens product life and saves resources by recycling end of life products as valuable inputs.

Yet, design is just the beginning. The circular economy relies on efficient systems for recovering materials when products have exhausted their useful life. Companies have started using take back programs, reverse logistics, and collaborations with recycling businesses to recycle materials into production.

Subaru, for example, has had **zero waste manufacturing facilities since 2004** by scrupulously sorting and recycling all factory scrap (Subaru of America, 2020).

Unilever has already achieved over \$1 billion in savings by minimizing waste and water consumption and has pledged that all of its plastic packaging will be reusable, compostable, or recyclable by 2025 (Unilever, 2020).



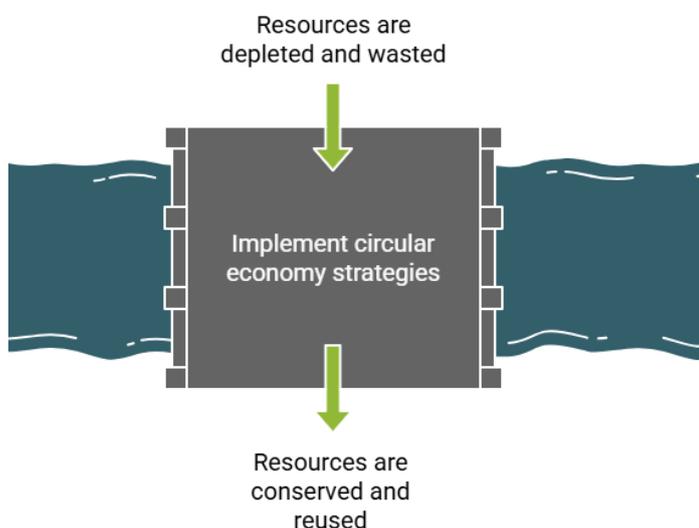
The change does not come without difficulties. Shifting to circular approaches means business needs to re-think procurement, logistics, customer relationships, and operations. Heavy investment is frequently necessary in technologies that allow tracking, sorting, and recycling on a large scale. Industry-wide collaboration is also needed to support efficient reverse logistics and secondary materials markets. Consumer education is also critical, as take back schemes and refurbished products programs rely on the engagement of the public (Patagonia, n.d.). For most companies, circular implementation begins at the periphery, with pilot initiatives or product lines, before rolling out throughout operations. However, there is hope: **circular economy approaches can unleash \$4.5 trillion of economic value and reduce global use of natural resources by almost 28% by 2030** (World Economic Forum, 2019).

The environmental gains of this switch are both significant and quantifiable. Circular practices greatly minimize waste production by extending the life of materials and goods. Universal application can cut landfill waste by half in key sectors by 2050, resulting in cleaner air and water, and healthier communities (Ellen MacArthur Foundation, 2019). By enhanced recycling, reusing, and sustainable product design, greenhouse gas emissions worldwide can be reduced by as much as 39%, with carbon-reliant industries like cement, aluminum, steel, plastics, and food being reduced by almost 50% (Material Economics, 2018). In **India alone, the transition to circular approaches can reduce emissions by 44% by the year 2050** (NITI Aayog & EU Delegation to India, 2021).

Decreasing demand for virgin materials also relieves pressures on land, water, and biodiversity. **Steel recycling can lower emissions by 58% per tonne and consume around 40% less water than primary production** (World Steel Association, 2019). In renewable industries, **retrieving materials from abandoned solar panels may satisfy 20% of mineral demand** from 2040 to 2050 (IEA, 2022). In addition, circular practices like **regenerative agriculture**, composting, and reforestation contribute directly to the restoration of ecosystems, responding to the reality that resource exploitation causes about 90% of all global biodiversity loss (UNEP, 2019).

Continuing on the present linear path, on the other hand, would heighten environmental degradation. Consumption of resources may be doubling in the mid-century timeframe, putting intolerable pressures on nature. Amounts of waste would surge sky high, choking down cities and hastening climate danger. In comparison, circularity turns ecological risks into long term resilience and regeneration opportunities.

Transitioning to a Circular Economy through Collaboration and Policy



Some sectors have particularly high impact opportunities for circular change. The construction and demolition sector, for instance, generates massive material flows but recycles just 20–25% of waste; modular design and material recovery could transform this. The **steel and metals sector** can minimize mining waste by as much as 97% via scrap recycling. In agriculture, organic waste valorization and nutrient recycling can transform waste streams into soil enriching products such as **biochar** and clean energy. Electronics production can adopt **urban mining and modular design** to recycle valuable rare earths. Renewable technology industries such as batteries and photovoltaic cells are good candidates for closed loop recovery of materials to minimize reliance on foreign critical minerals. The same applies in the areas of municipal waste and wastewater recycling, transport systems with vehicle recycling and car-sharing, and even tyre production, where enhanced recycling could assist in the reduction of microplastic pollution.



CONCLUSION

The way forward requires collective, decisive action. Companies need to map material flows, analyze where waste is created, and incorporate waste to resource options. Cross sector collaborations are vital in constructing joint recovery systems. Governments need to encourage circularity through policy mechanisms, recycling infrastructure investment, and public education. Also key is open measurement and disclosure of progress, which will facilitate accountability while businesses move towards closed loop systems.

In total, the circular economy is more than an intangible vision of sustainability—it is a tangible roadmap to reconciling economic development and environmental stewardship. By moving beyond the inefficient linear system, industries can protect resources, restore ecosystems, lower emissions, and build enduring economic value. The decision is timely: adopt circularity sooner rather than later, or risk accelerating ecological and economic crises. The benefits of action are great; the penalties for inaction, incalculable.

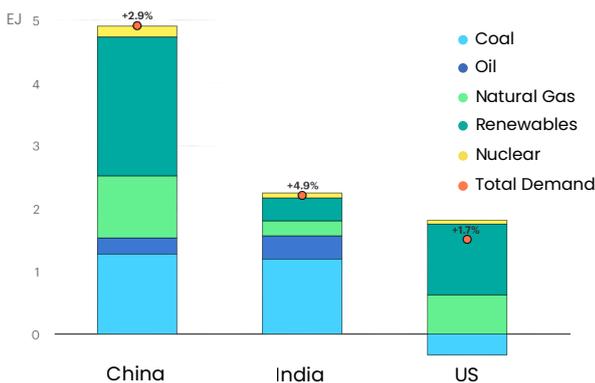
Building Sustainable Supply Chains for Renewable Energy Technologies

- Manish Kudale

As the world continues its transition to cleaner energy, renewable energy production is projected to increase significantly, with estimates suggesting that solar and wind energy will become the top sources of electricity globally within the next few years, driving further reductions in reliance on coal and natural gas [2].

As of 2024 global energy consumption reached a record high of 15981 Mtoe, reflecting a 2.2% increase from the previous year, driven mainly by emerging economies like China & India. Despite the dominance of fossil fuels (which provided 61% of global electricity), renewable energy sources accounted for 30% of global electricity generation in 2024, with wind and solar contributing 15% combined [1].

Change in energy demand in selected regions, 2023-2024 (IEA)



The Hidden Cost of Raw Material Sourcing

One of the biggest **sustainability challenges** in renewable energy supply chains lies in the sourcing of raw materials. Technologies like solar panels, batteries, and wind turbines require a range of materials, including lithium, cobalt, and rare earth metals. While these materials are essential for clean energy production, their extraction can have **severe environmental and ethical consequences**.

For instance, cobalt, a critical material used in lithium-ion batteries, is primarily mined in the Democratic Republic of Congo under dangerous conditions that have raised concerns over **child labor and environmental degradation** [3]. Mining activities often result in **deforestation, soil erosion, and water pollution**, which are exacerbated by weak regulatory oversight. [4] As demand for renewable energy technologies increases, the pressure on these materials grows, posing significant risks to both the environment and human rights.

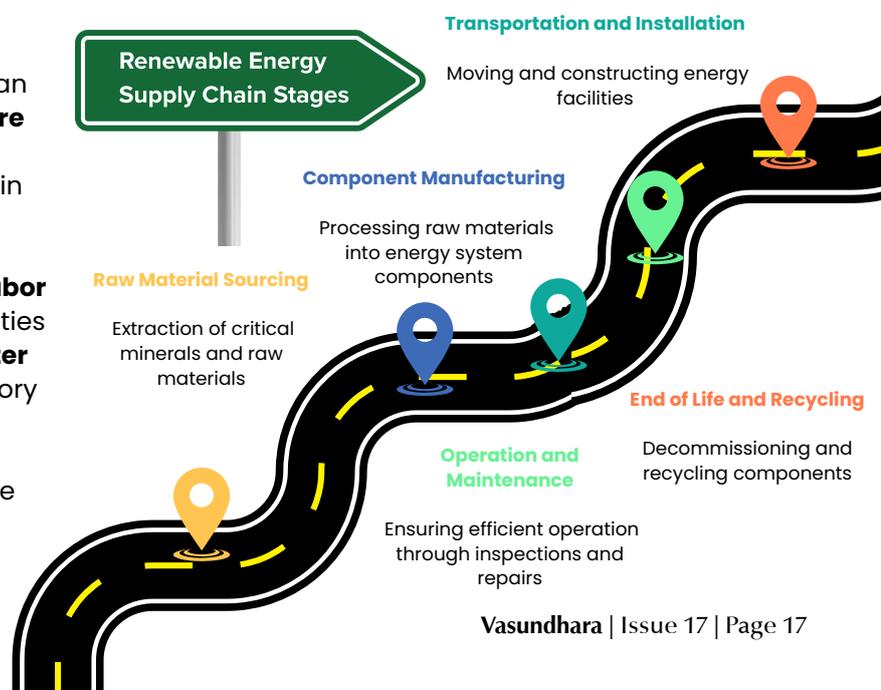
Energy-Intensive Manufacturing Processes

While renewable energy technologies like wind turbines and solar panels are designed to reduce carbon emissions, **manufacturing** solar panels and wind turbines **involves substantial energy use** because of the high-intensity processes required—such as purifying silicon, producing wafers, and extracting rare earth elements for photovoltaic systems, along with the large-scale fabrication of steel, fiberglass, and composite materials for turbine structures. Typically derived from fossil fuels, leading to **carbon emissions** that counteract the green benefits of the end product.

The carbon emissions generated during the manufacturing process, also called **embodied carbon** remains a major cause of concern.” For example, producing a solar panel can require 3–4 MWh of energy to produce 1 kW of panels, which currently relies heavily on coal-based electricity in some regions (IRENA, 2020). Although the energy produced by these technologies is clean, the **carbon footprint** during their **production** still presents a challenge for the industry.

The Need for Transparency in Supply Chains

A critical issue in renewable energy supply chains is the lack of transparency. Many companies rely on complex, global supply chains, making it difficult to track the source of raw materials or monitor the environmental and social impacts throughout the production process.



End-of-Life Management and Waste Disposal

The environmental challenges don't end once renewable energy products are installed. At the end-of-life stage, many renewable energy technologies, including wind turbine blades, solar panels, and batteries, poses **significant waste disposal challenges**. Like wind turbine blades are difficult to recycle, and many are sent to landfills, where they can remain for decades. As solar panels and batteries reach the end of their useful lives, their disposal becomes increasingly important. Without proper recycling infrastructure, valuable materials like silicon, aluminium, and cobalt can go to waste, and harmful chemicals may leach into the environment.



One effective strategy is the adoption of a circular economy model, where renewable energy technologies are designed with recyclable materials and built to be easily disassembled. By recovering valuable materials like silicon, cobalt, and aluminium from used products, companies can significantly reduce the need for new resource extraction and lower waste. Although this comes with a challenge of resource requirements for recovery processes of solar panel due to adhesives used such as Ethylene Vinyl Acetate (EVA) which can be dealt by economics of scale.

Managing Scope 3 Emissions in Renewable Energy Supply Chains

One of the most challenging aspects of green supply chain management (GSCM) in the renewable energy sector is managing **Scope 3 emissions**—emissions that occur throughout the entire supply chain, including from suppliers and customers. Scope 3 emissions often constitute the largest portion of a company's carbon footprint, and for renewable energy technologies, these emissions can come from raw material extraction, transportation, and manufacturing processes.

The Threat of Greenwashing

As the demand for sustainable products grows, so too does the temptation for companies to engage in greenwashing—making exaggerated or misleading claims about the environmental benefits of their products. In the renewable energy sector, greenwashing can mislead consumers into believing that a product is eco-friendly when it is not as currently their production energy requirements are made by Non-renewable sources.

Innovative Solutions to Create a Truly Sustainable Renewable Energy Supply Chain

Despite these challenges, several innovative solutions are emerging to address the sustainability issues in renewable energy supply chains. **Renewable Energy Green Supply Chain Management (REGSCM)** [5] integrates **sustainable practices** at every stage—from sourcing and production to distribution and end-of-life management.

FUN FACT



Volvo is issuing a “battery passport” for its EX90 electric SUV, using BLOCKCHAIN via Circular, to trace the origins, recycled content, components, and carbon footprint of the battery from mine → manufacturing → assembly.

Furthermore, blockchain technology is being implemented to enhance supply chain transparency, Blockchain technology employs a decentralized, immutable distributed ledger to record each transaction and material handoff in real time, ensuring data integrity and non-repudiation. This enables end-to-end traceability across the supply chain, facilitating verifiable audit trails, enhanced transparency, and stakeholder trust. Allowing companies to track materials from source to end product, ensuring that they meet ethical and environmental standards. This technology can help address challenges in raw material sourcing, ensuring that companies are sourcing responsibly and meeting global sustainability goals [5].

Another crucial solution is the integration of **distributed energy systems (DES)**, such as **microgrids** and **peer-to-peer (P2P) energy trading**. These systems let communities produce, store, and exchange renewable energy within their own area, reducing reliance on large power grids, cutting down energy waste, and making the grid more reliable.



BEST PRACTICES

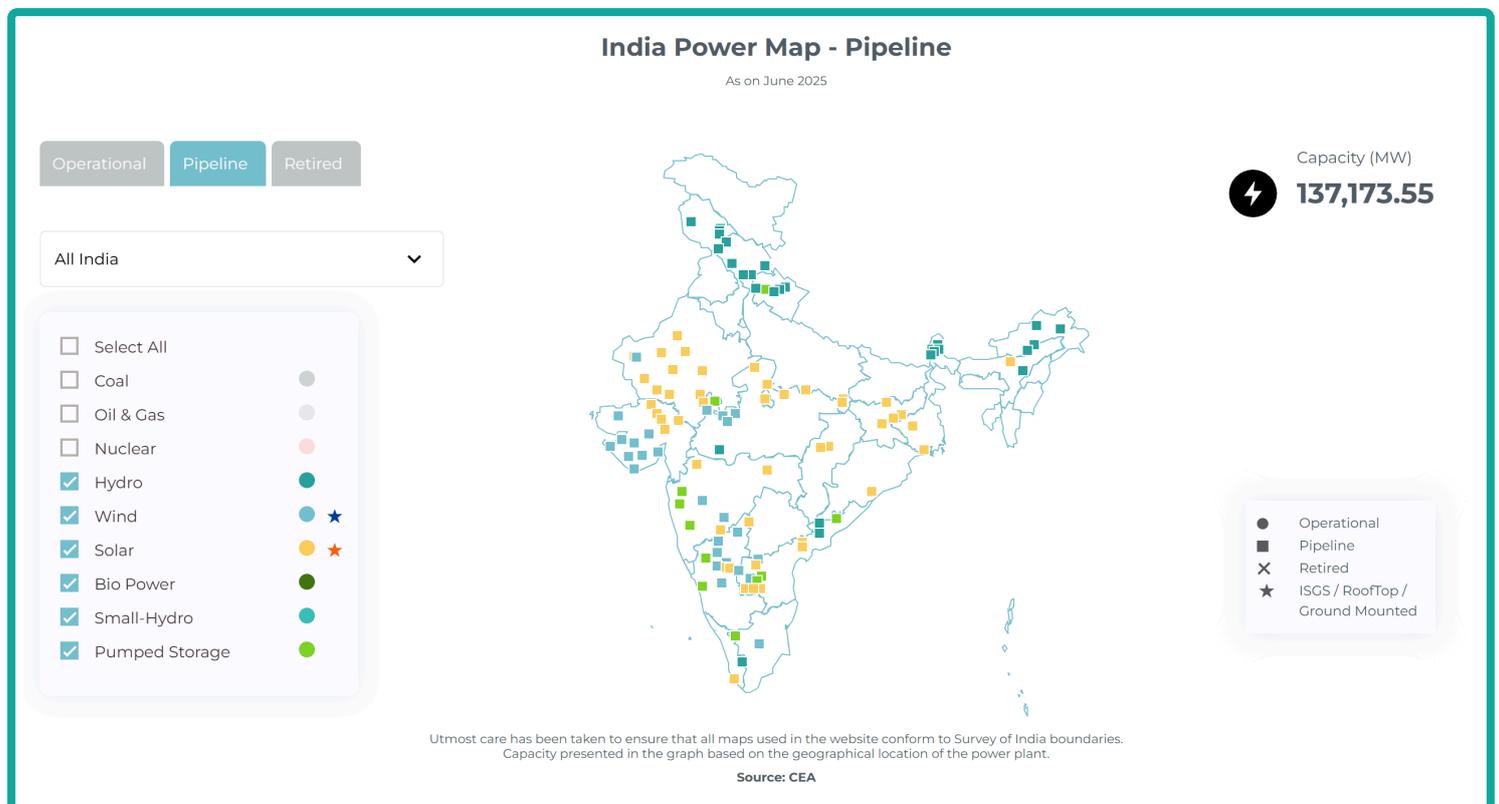
For example, in Brooklyn, New York, the Brooklyn Microgrid Project uses solar panels installed on residential rooftops, battery storage, and blockchain-based P2P trading platforms to allow neighbours to directly buy and sell excess renewable energy to one another, reducing dependence on the central grid and improving local energy resilience.

Through **blockchain, P2P energy networks** [6] can be securely managed, enabling **prosumers** to sell surplus energy directly to their neighbours or the grid, making the energy system more efficient and transparent.

In parallel, **green financing mechanisms**, such as **green bonds** and **impact investing**, are crucial in supporting renewable energy innovations. These financial tools provide the capital needed for small- and medium-sized enterprises (SMEs) to scale sustainable practices and technologies.

Governments also play a vital role by offering incentives, subsidies, and policies that encourage the adoption of green supply chain practices such as incentives provided by China for solar panel manufacturing, ensuring that the entire renewable energy industry moves toward a more **sustainable** and **resilient future**.

A sustainable renewable energy transition depends not only on clean power generation but also on transparent, ethical, and low-impact supply chains for solar panels, wind turbines, and batteries. This means tackling the environmental and social costs of raw material extraction, reducing the high embodied energy from fossil-fuel-based manufacturing, and embedding circular economy practices to recover and reuse critical materials. Blockchain-enabled traceability can verify responsible sourcing, while distributed energy systems and green financing can strengthen resilience and accelerate adoption of sustainable practices. By integrating these measures, renewable energy supply chains can become closed-loop, transparent, and socially responsible from extraction to end-of-life.



Navigating Scope 3 Emissions

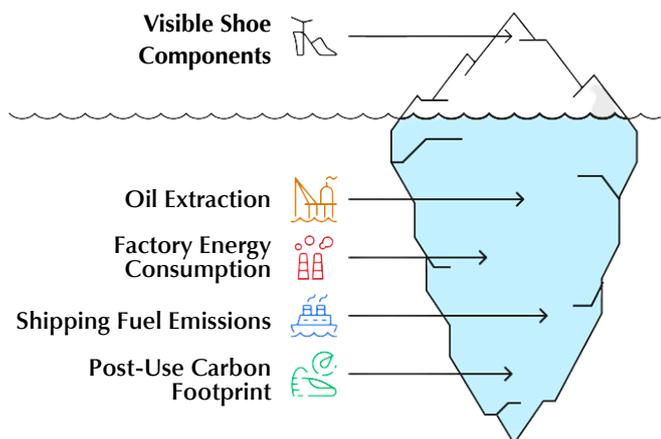
Strategies for greener supply chains demands collaboration, innovation, and shared responsibility between businesses, suppliers, and customers

— Kashish Saini

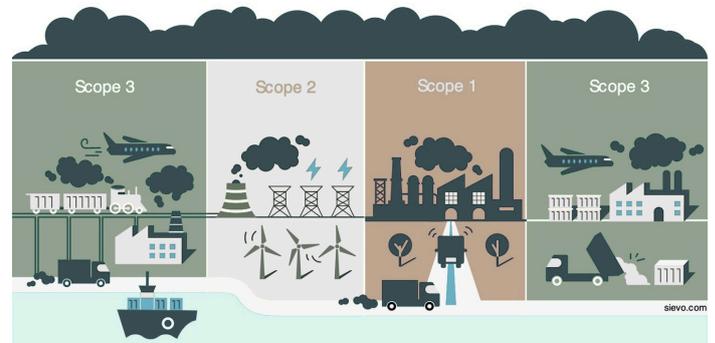
Take a look at your running shoes. What do you see? Fabric, foam, rubber? What you don't see is the **global stream of emissions** they carry- from oil used to make synthetic rubber, to energy powering the factory, to bunker fuel burning in the container ship crossing the ocean. From sourcing to shipping to what happens after use, every step leaves a **carbon footprint**. These unseen contributors constitute what businesses call **Scope 3 emissions**, a major part of the climate puzzle that companies are only beginning to address.

Every product's journey contributes to climate change through greenhouse gas emissions. To understand and manage these emissions, companies usually divide them into three types- Scope 1, Scope 2 and Scope 3- depending on where and how they occur. While Scope 1 and Scope 2 emissions encompass **direct and indirect emissions** from an organization's operations, Scope 3 emissions account for the ones that occur in the **value chain**, beyond a company's control.

The Unseen Carbon Footprint



Scope 3 emissions, also called **life cycle emissions**, are the result of activities from assets not owned or controlled by the reporting company, but that which the organization indirectly affects in its value chain. These emissions usually happen **upstream**, i.e., before the product reaches the company, or **downstream**, i.e., after the company sells the product. A few examples of Scope 3 emissions include emissions from purchased goods and services, transportation and distribution, waste generated, and the use and disposal of products sold.



Scope 3 emissions usually happen upstream (before product reaches company) or downstream (after sales)

While Scope 3 emissions are indirect, they represent **over 75%** of a company's total emissions [1]. That means, even if the company reduced emissions from its direct operations and switched to renewable electricity, it would still be responsible for significant emissions happening outside its walls. These come from suppliers, logistics providers, product use and disposal- all **linked through the supply chain**.

When it comes to addressing Scope 3 emissions, businesses face **numerous hurdles**. First, accurately identifying and measuring these emissions requires **extensive data collection** across a company's entire value chain. It requires a lot of cooperation to measure emissions at every stage and to decide which activities must be included. In addition to this, companies often have **limited direct control** over the emissions generated by their supplier partners, customers and end-users which makes it **difficult to enforce emission reduction strategies**.

Furthermore, **modern supply chains** are global and complex, stretching across different geographies, regulatory environments, and levels of environmental commitment. This **complexity** makes tracking emissions difficult. In addition, a **lack of awareness** and engagement among stakeholders often slows progress, as many fail to recognize their role in managing Scope 3 emissions. Overcoming these hurdles requires **collaboration, transparency**, and continuous efforts to educate and align all stakeholders in the value chain.



Being the maximum and most challenging portion of a company's carbon footprint, there is an urgent need for comprehensive strategies to address Scope 3 emissions. By focusing more on collaboration, technology and data transparency, companies can come up with more effective strategies to address Scope 3 emissions.

One of the most effective ways for companies to tackle Scope 3 emissions is by partnering with sustainable suppliers who use low-emission materials or renewable energy, which helps them reduce emissions across their value chain. Businesses can also support suppliers in adopting environmentally friendly processes through incentives and resources.

BEST PRACTICES

Walmart supports its suppliers through **Project Gigaton** by giving them access to a Sustainability Hub, a toolkit offering step-by-step guidance, resources, and tracking tools to help suppliers reduce emissions in areas like energy, packaging, and agriculture.

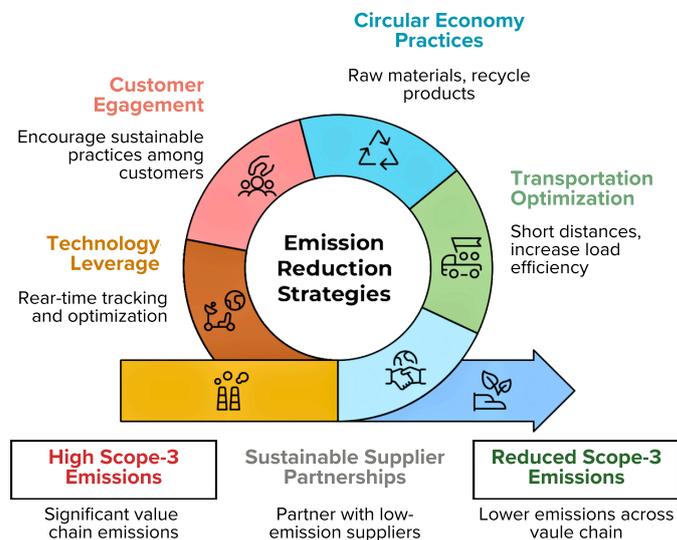
Companies can also build supplier engagement platforms that can help them track supplier emissions and provide insights for smarter, sustainability-focused sourcing decisions. Through its **Supplier Clean Energy Program**, **Apple** is striving to tackle Scope 3 emissions by helping its suppliers to shift to 100% renewable electricity by 2030 [2].

In addition, companies can reduce the impact of transportation, a major contributor to Scope 3 emissions, by shortening travel distances, route optimization, and increasing load efficiency. Switching to low-emission transport modes, like rail or electric vehicles, will also make a difference.

Implementing **circular economy** practices is another strategy that can help reduce Scope 3 emissions and minimize waste by reusing materials and recycling products at the end of their lifecycle. Companies can adopt circular design principles, seeking to reduce emissions by creating products that are easier to recycle, remanufacture, and repurpose. This approach



can remarkably reduce downstream emissions in categories like end-of-life treatment of sold-products. The American clothing brand **Patagonia**, for instance, offers programs like **Worn Wear** for buying and selling used Patagonia items. It also uses a high share of recycled materials- for example, 36% of cotton or 90% of nylon [3].



Furthermore, downstream Scope 3 emissions, such as ones related with the use and disposal of products, can be controlled by encouraging sustainable practices among customers. For instance, companies in the **electronics sector** can provide guidance on **energy-efficient usage**, or packaging companies can introduce recycling programs for **waste reduction**.

Taking a step further, companies can leverage technology for real-time tracking and optimization. From **IoT-enabled sensors** that render real-time data to AI-driven insights that identify emissions hotspots, advanced technologies allow companies to gather granular data across complex supply-chains, which is necessary for **identifying and optimizing emission sources** effectively.

Conclusion

Addressing Scope 3 emissions is not just an environmental necessity but also a pathway to building resilient and sustainable supply chains. Since these emissions occur across the value chain, tackling them demands collaboration, innovation, and shared responsibility between businesses, suppliers, and customers. Companies that integrate transparency, circular economy practices, and technology into their supply chain management can significantly reduce risks, cut costs, and future-proof their operations. Managing Scope 3 emissions is more than just compliance - it is about shaping supply chains that are both competitive and sustainable, ensuring long-term value creation for businesses & the planet alike.

Why So Serious



Companies when it comes to actually taking the steps for supply chain sustainability



RAISE YOUR VOICE
NOT THE SEA LEVEL



MAKE
LOVE ♡
NOT
CO₂

Biodiversity Risk also a Supply Chain Risk ?

How nature and biodiversity loss is affecting global businesses? - Pradnya Kurdukar

Various geopolitical and climate events such as COVID-19, extreme weather events such as excessive rainfall and droughts are impacting businesses, including the supply chain, making supply chain sustainability a material issue for companies. Businesses are dependent on biodiversity in some way, thus it is vital for businesses and economies to understand biodiversity-related dependencies and risks. Biodiversity is the foundation upon which ecosystems flourish, offering key ecosystem services include provisioning, regulating, cultural and supporting services, pivotal to global economy.

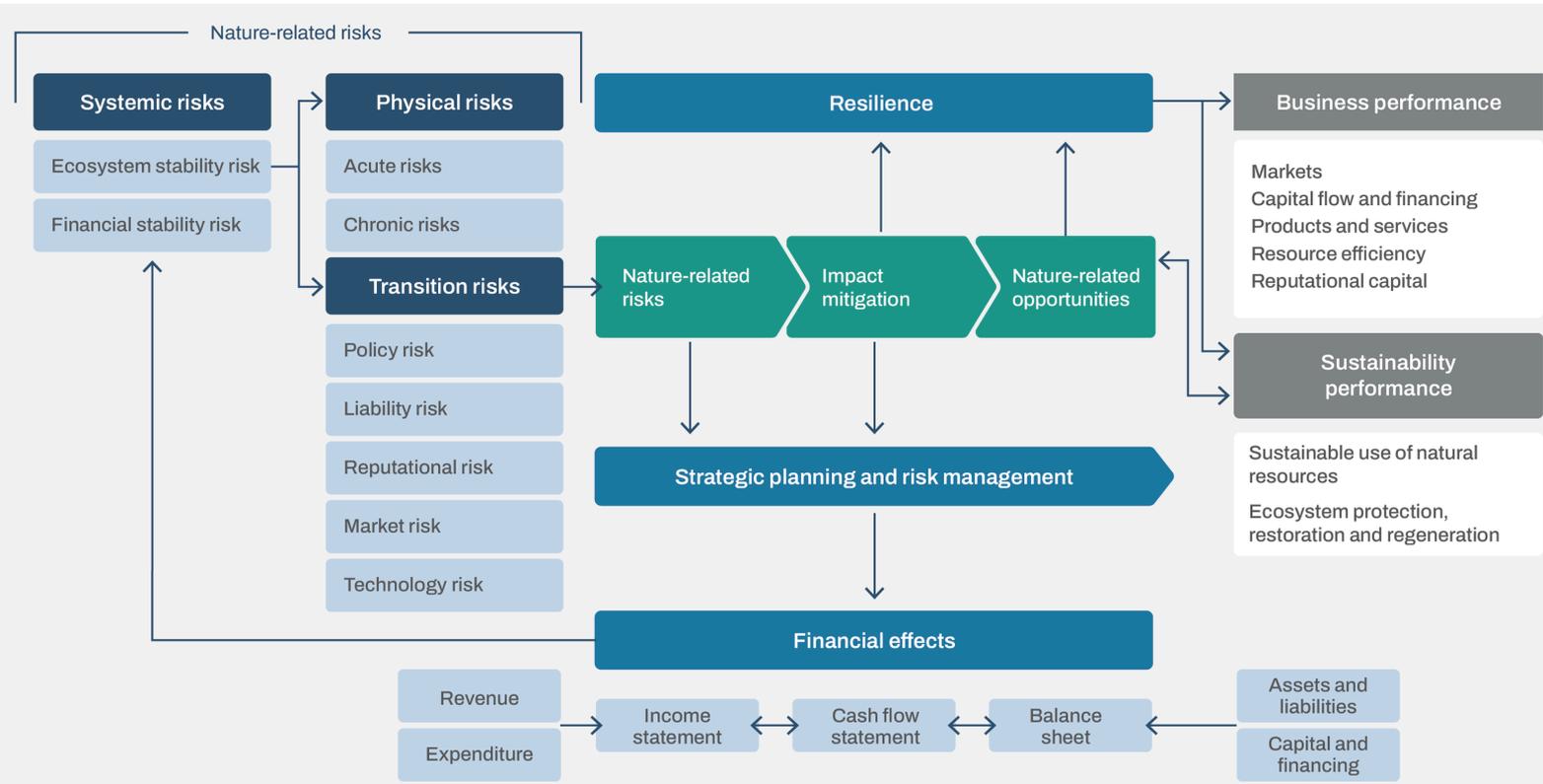
Though researchers are debating around sixth mass extinction in the history of earth's biodiversity, the current discourse brings forefront the issues of biodiversity loss on central stage. It is claimed that unlike previous five mass extinctions, the sixth mass extinction is driven by man-made activities.[1][2] Global Risks Report by World Economic Forum highlighted 'biodiversity loss and ecosystem collapse' as one of the top 10 risks, particularly in long-run.

United Nations Kunming-Montreal Global Biodiversity Framework has now included target 15 as - 'Businesses Assess, Disclose and Reduce Biodiversity-Related Risks & Negative Impacts'. It encourages businesses to regularly monitor, assess, and transparently disclose their risks, dependencies and impacts on biodiversity, including with requirements for all large as well as transnational

companies and financial institutions along their operations, supply and value chains and portfolios. [3] Such recent developments have led companies facing increased scrutiny over reporting their sustainability initiatives, biodiversity management and conservation. Several instances show biodiversity as vital component of their corporate sustainability strategies.

The Value of Biodiversity and Its Precipitous Decline IPBES has highlighted five major drivers of biodiversity loss, namely Land-use and sea-use change, Overexploitation of animals, plants, and ecosystems in general, Climate change, Pollution of soil, water, and air and spread of invasive species [4], [5]. World Economic Forum estimates that \$44 Trillion of value generation, representing more than 50% of global GDP is dependent on nature, biodiversity and its supporting services [6]. This suggests that all businesses are directly or indirectly dependent on biodiversity ecosystems for their profitability.

Business supply chains rely on nature for direct inputs like water, pollination, soil fertility, and biodiversity loss can lead to resource scarcity, value chain disruptions or increased operational costs. It is estimated that decline of ecosystem functionality is costing the global economy more than \$5 trillion a year in terms of lost natural capital [7]. Thus, it is imperative understand biodiversity as both a risk and an opportunity.



Source: TNFD 2023 - Links between nature-related risks and opportunities, business performance and financial effects for an organisation



Unlike climate change, biodiversity exhibits complex dynamics of cause and effect [7], where relationships between diversity loss and their causal factors are not linear. Thus, tracking a business's biodiversity footprint requires holistic, comprehensive approach.

Understanding DIORs of Biodiversity and Supply Chain Sustainability:

In today's complex world where climate change and biodiversity loss are wicked problems, understanding the interplay between businesses, supply chains, nature and biodiversity is the first step before management of their issues. The World Business Council on Sustainable Development has suggested **DIOR Framework – Dependencies, Impact, Opportunity and Threats**, to understand interplay of Biodiversity and Supply Chain Sustainability.

The DIORs can be of universal nature or be region, biome and/or sector-specific. Around one-third of the GDP of India (33%) and Indonesia (32%) is generated in sectors that are highly dependent on nature [9]. Example, in textile sector, Cotton, wool, and viscose which are key fashion fibres are often linked to habitat degradation, soil depletion, and pesticide overuse. Academic view suggests four major value chains, namely Food, Energy, Infrastructure and Fashion responsible for over 90% of man-made pressure biodiversity [7].

The increasing trend of eco-conscious customers is shaping consumer behavior, causing reputational risks. For example, speciality oil and fats manufacturer AAK was impacted financially due to reputational loss, as a result of practices linked to deforestation. Despite AAK's commitment to sustainable palm oil, media reports on deforestation practices impacted their stock price [10], [11]. The ongoing criticism on world's largest meat producer JBS impacted its stock price, due to breaking its Amazon deforestation pledges [11],[12].

How Biodiversity and Food Supply Chains are co-dependent?

Our global food system is the primary driver of biodiversity loss, with agriculture alone being the identified threat to nearly 76% species at risk of extinction [13]. The Land-based (Agri-food and forest) system impacts 72% of species under threat by contributing to water and soil pollution, deforestation, land degradation and habitat destruction[14]. These sectors exert pressure on biodiversity through land and sea use change, overexploitation of resources, pollution, climate change, and by introducing invasive species. Each of the above value chains source raw materials, transform and distribute products and influence consumer behavior which has biodiversity implications. Provisioning services like pollination are vital for thriving food supply chains. The annual market value of additional crop production directly linked with pollination

services is estimated at \$235bn-\$577bn (in 2015 US\$) worldwide [4]. It is estimated that Pollinator-dependent crops contribute to 35 per cent of global crop production volume [4]. Beyond food provisioning, they are contributing directly to medicines, biofuels (e.g. canola and palm oil), fibres (e.g., cotton and linen), construction materials (timbers) etc [4]. Various food supply chains are directly dependent on biodiversity. Agriculture depends on pollinators, genetic crop diversity, healthy soils, pest-controlling species. Fisheries rely on aquatic ecosystem health and diverse marine species. Forestry depends on forest biodiversity for wood, non-timber products, and regeneration. Pollination, water filtration, nutrient cycling, climate regulation, and soil fertility underpin agricultural, beverage, textile, and energy value chains [15], [16], [17], [18], [19].

Few corporate sustainability reports from the food and beverage industry show provisioning services like biomass (crops, milk) and genetic resources as material topics, linked to sustainable sourcing goals [19], [20], [21].



INTERESTING FACTS

Agriculture has historically driven 70% of losses in terrestrial biodiversity and been the single biggest contributor to the deforestation of natural habitats.

(reference - WWF (2021) Farming with biodiversity – Towards nature positive production at scale; FAO (2021) Agricultural expansion drives almost 90 percent of global deforestation.)

75% of global food crops depend on animal pollination

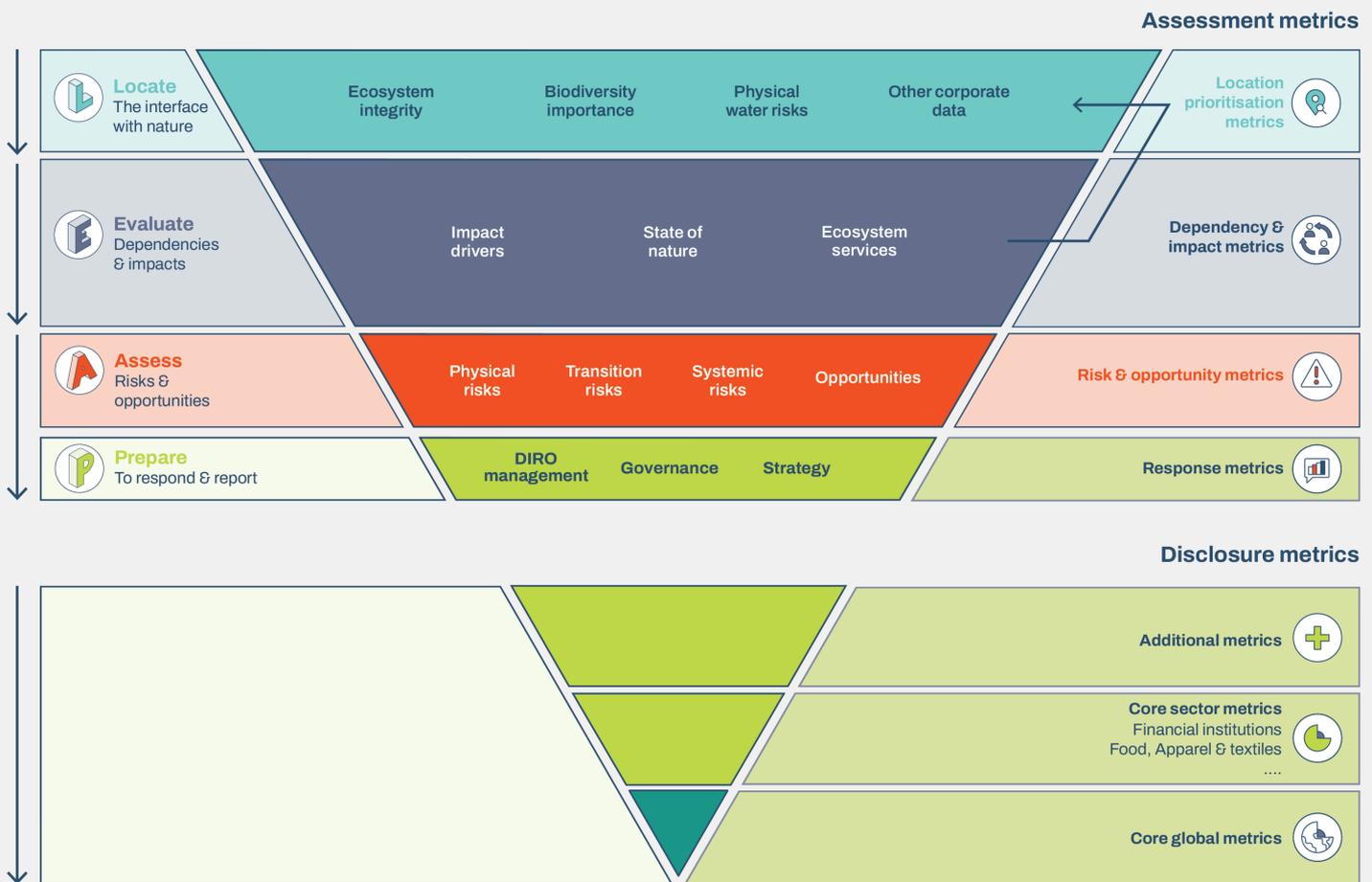
(Source - IPBES (2016) Pollinators vital to our food supply under threat.)

Each year, approximately one-third of all food produced for human consumption in the world is wasted.12 Upstream food loss, which includes production, post-harvest handling and storage, represents 54% of total waste.

(Reference - TNFD)

How can Biodiversity Management Strategy be aligned for Supply Chain Sustainability?

Prior to the management of biodiversity as material topic, we need to identify the potential areas of intersections of biodiversity and supply chain. TNFD (Task Force on Nature related Financial Disclosures) has developed LEAP approach in analyzing nature-related risks and opportunities for businesses [14], [22]. LEAP Approach suggests 4 key steps as – a) Locate your interface with nature, b) Evaluate your impacts and dependencies, c) Assess most material risks and opportunities d) Prepare response and report.



TNFD Disclosure Metrics Guidance [Source: TNFD]

Till 2024, nearly 500 organizations have committed to voluntarily reporting of TNFD recommendations. TNFD Approach follows four pillars, namely –

1. **Governance** – Governance processes, controls and procedures, used to monitor and manage nature-related issues, namely Dependencies, Impact, Risks and Opportunities
2. **Strategy** – Approach used to manage nature-related issues, disclosure of how nature-related issues are integrated into organizational oversight by board and management.
3. **Risk and Impact management** – Processes used to identify, assess, prioritize and monitor nature-related issues.
4. **Metrics and targets** – Performance in relation to nature-related issues, such as progress made towards any targets set.

Organizations can further use Biodiversity Consultancy and OECD's Biodiversity Impact Metric (BIM) to analyse the extent to which their sourcing is driving biodiversity loss. WWF's Biodiversity Risk Filter can be further used for risk identification. Several sector-specific agreements and standards, certifications such as, the Soy Moratorium, Forest Stewardship Council, Regenerative Organic Certification, Rainforest Alliance integrate biodiversity and nature in the key criteria for certification, thus enabling ethical sourcing and sustainable supply chains.

Conclusion

With increasing awareness on environmental issues and a growing number of eco-conscious consumers' purchasing behaviour, impacts on nature by businesses pose reputational consequences for companies, affecting brand value and market share. Increasing stakeholders' concerns about corporates' impact on nature, impetus to sustainable finance supporting integration of biodiversity conservation as a business strategy, adopting nature-positive practices can be a great opportunity for organizations towards profitability as well as corporate sustainability. Empowering producers, value chain partners and consumers to transform supply chains is imperative.

IBBI (India Business and Biodiversity Initiative) is a business-led initiative that serves as national platform for business, to promote sustainable management of biodiversity by businesses.



22 May is celebrated as International Day for Biological Diversity, to increase understanding and awareness of biodiversity issues

Ethical Workforce Practices

Advancing Fairness in Global Supply Chains

- Ananya C G 

Image Source: Myanmar Labour News

In a conversation on sustainable supply chains, often the discussions tend to have a carbon tunnel vision; a vision that focuses on emissions, not the systems and structures which are actively protecting and promoting climate destroying industries [1]. A myriad of other problems plague the modern supply chains—**exploitative labour practices** being chief among them. Issues such as forced labour and unethical work practices and suppression of workers' rights remain widespread, particularly in industries that rely on low-cost, outsourced production.

Trade liberalisation has accelerated economic growth—but has come at the cost of ethical labour practices. Although globalisation could have potentially lifted multitude out of poverty, nations competing for foreign investments tend to relax regulations on labour wage, safety and rights, thus creating a system where **workers bear the hidden cost of cheap goods**.

Best Practices

Decent work rests on the fundamental question of how a supply chain is designed and managed. Not only do supply chains shape employment and working conditions in crucial ways, but they influence the business models and management practices that pattern dynamics of labour exploitation [2] [3].

In the fast fashion industry, which has been criticised for perpetuating exploitative labour practices in developing countries and where brands outsource production to factories with poor working conditions, low wages and minimal regulatory oversight [5]. The devastating and evitable incidents of the Tazreen Fashion Factory fire and the Rana Plaza collapse stand as testaments to the poor working conditions and the failure in addressing workers' safety and well-being [6]. Another case of disregarding ethical labour practices in the fashion industry has been that of UK-based fashion retailer Boohoo, where there are several years of claims of exploitative sweatshop labour and concerns that workers were being forced to labour in unsafe conditions during the Covid-19 pandemic [7].

Carbon Tunnel Vision; a vision that focuses on emissions, not the systems and structures which are actively protecting and promoting climate destroying industries.

These patterns of exploitation depict how deeply entrenched **vulnerabilities are across resource-based industries**, cutting across both agriculture and extractives. In the small-scale mining sector, miners are subjected to illegal employment, hazardous working conditions, lack of protective equipment, and widespread informality without legal or social protections [9].

The agricultural industry is identified as a high-risk sector due to its labour-intensive nature, high elasticity of labour demand, low industry legitimacy, and heavy reliance on temporary, informal employment [8]. According to the International Labour Organization (ILO), **child labour** is common in the agricultural sector and is particularly widespread in countries where cocoa is grown. A key allegation in the accounts from West Africa was that children were not only forced to work and mistreated on cocoa farms but were also trafficked by cocoa farmers and their agents.

While labour exploitation is an inherent and a general risk in today's capitalist system that is fuelled by a vast pool of young people [4] which ultimately leads organisations to strive for **efficiency gains by reducing costs for inputs** (such as raw materials, capital and labour), there are industry sectors and world regions where workers have historically and still are more vulnerable to exploitation.



The same source mentions that the majority of artisanal miners in Brazil- Garimpeiros (approximately 99%) -operate without any form of legal permit, which often translates into exploitative and unsafe working conditions. The lack of protective equipment, coupled with the widespread use of mercury without safeguards, exposes workers to severe health risks.

Despite the prevalence of such exploitative practices in sectors like agriculture, mining and textile, responses from corporations have relied largely on few voluntary mechanisms rather than actionable change.

One of the most prominent among these is the adoption of **Corporate Codes of Conduct (CoCs)**. CoCs are **voluntary commitments** adopted by corporations to promote responsible business practices and build an ethical organisational culture. They typically aim to guide employee and supplier conduct, promote compliance with labour standards, and avoid legal risks [10]. However, often the MNCs gain reputational benefits from **“doing good”** [11]— through enhanced brand image, consumer trust, and positive media visibility— **whereas suppliers bear the compliance cost with minimal reward and limited resources** [12].

This imbalance raises questions on the sincerity and effectiveness of these codes, and the dynamic between the MNCs and their suppliers **undermines the intended purpose of CoCs** and exposes the limits of voluntary self-regulation. In this respect, one initiative that aims to go beyond CoCs, is the Better Work programme of the ILO and International Finance Corporation [13], which, following inspections, delivers training to both workers and managers on core labour issues including **freedom of association, collective bargaining, health and safety, fair wages, non-discrimination, and working hours**, with summary reports sent to the factories’ multinational customers. Regarding working hours, Better Work acknowledges that tackling widespread illegal overtime requires structural reforms, overall productivity improvements, and shifts in the demands and purchasing practices of corporates.



Technology plays a central and growing role in the creation of global supply chain transparency.

While there is no single technology recommended, a curation of a combination of several technologies such as **blockchain** (which allows firms to increase SCT by enabling traceability and transparency of products and information as they move through the supply chain [14]), **artificial intelligence** (through real-time monitoring and anomaly detection), and **radio frequency identification (RFID)** & the **Industrial Internet of Things (IIoT)** are cutting-edge techs that could improve fairness and transparency in the supply chain.

Several studies [15] [16] suggest that close collaboration between multi-tier supply chain partners is essential to achieve sustainability targets. Collaborative activities include **information sharing, dedicated investment and joint relationship effort**; the corporates also need to recognise fairness as a driver of sustainable supply chain management by ingraining social responsibility through consistent, **respectful & equitable** treatment of all partners, including lower-tier suppliers [17].

In essence, establishing ethical and supply chains requires more than surface level codes or scattered interventions. The system demands a shift in the way corporations engage with their supply networks especially those most vulnerable to exploitation. Businesses must move beyond compliance by enforcing systemic reforms and focusing on fairness, transparency and long-term collaboration, in order to reshape the systems that enable exploitation. Only through shared responsibility, equitable treatment, and genuine partnership can supply chains become engines of both economic and social sustainability.

Foundations of Ethical Workforce



Fairness
Ensuring equitable treatment and opportunities for all employees.

Respect
Valuing individual dignity and fostering a culture of mutual understanding.

Honesty
Maintaining transparency and integrity in all communications.

Responsibility
Holding individuals accountable for their actions and decisions.

Compliance
Adhering to all applicable laws and regulations.



Localized Supply Chains

A Key to India's Vision of a Developed Nation by 2047

- Mugdha Sahu

India's ambitious vision to become a developed nation by 2047, marking the centenary of its independence, hinges on transformative economic strategies. The Viksit Bharat @2047 initiative, spearheaded by NITI Aayog, aims to propel India to a \$30 trillion economy with a per capita income of \$18,000-\$20,000 [1]. A critical pillar of this vision is the development of localized supply chains, which can enhance economic resilience, reduce dependency on global markets, and foster sustainable growth. By prioritizing localized supply chains, India can leverage its demographic dividend, bolster manufacturing, and ensure inclusive development, positioning itself as a global economic powerhouse by 2047.

Global supply chains, while efficient in a stable world, have proven vulnerable to disruptions, as evidenced by the COVID-19 pandemic and geopolitical tensions like the Ukraine crisis. These events exposed the risks of over-reliance on foreign suppliers, with global supply chain bottlenecks causing delays and cost spikes [2]. India, with its strategic push for self-reliance through initiatives like Atmanirbhar Bharat, is well-positioned to address these vulnerabilities. Localized supply chains, which emphasize domestic production and regional sourcing, reduce exposure to international volatility, ensuring stability in critical sectors like electronics, pharmaceuticals, and automotive manufacturing.

Localization aligns with India's goal of increasing its manufacturing sector's contribution to GDP from the current 15% to 25% by 2047 [3]. The National Manufacturing Mission, launched in 2025, aims to achieve a manufacturing GDP of \$7.5 trillion by 2047, creating millions of jobs and strengthening global competitiveness [4]. By fostering localized production, India can capitalize on its vast domestic market of over 1.4 billion people, with a projected middle class of 500 million by 2050, driving demand for locally produced goods [5].

Localized supply chains are a catalyst for job creation, a critical factor in harnessing India's demographic dividend, with over 40% of its population below 25 years [5]. The National Skill Development Mission and initiatives like the Production Linked Incentive (PLI) scheme are equipping the workforce for new-age manufacturing in sectors like semiconductors, renewables, and telecommunications [3]. For instance, the PLI scheme, expanded to 14 industries, has attracted investments worth \$20 billion in electronics manufacturing alone, creating over 200,000 jobs since its inception in 2020 [6].

Moreover, localized supply chains enhance economic resilience by reducing import dependency. In 2023, India's imports were valued at \$854 billion, with critical materials like semiconductors and pharmaceuticals heavily reliant on foreign suppliers [7]. By localizing production, India can cut import costs, improve trade balances, and redirect resources toward infrastructure and innovation. The government's focus on securing domestic production of 30 critical minerals, such as lithium for EV batteries, underscores this shift toward self-reliance [8].

Sustainability is a cornerstone of Viksit Bharat @2047, with India targeting a 90% green grid capacity and net-zero emissions by 2070 [9]. Localized supply chains support this vision by reducing the carbon footprint associated with long-distance logistics. For example, India's logistics sector, projected to grow to \$320 billion by 2025, is adopting eco-friendly measures like 40 air cargo terminals and 35 multi-modal logistics facilities to streamline domestic supply chains [2]. These initiatives align with the National Logistics Policy of 2022, which has reduced transport costs by 15-20% through improved connectivity [2].

The push for green manufacturing further strengthens localized supply chains. India's National Hydrogen Mission aims to make the country a hub for green hydrogen production, leveraging its abundant solar resources [10]. By localizing production of green technologies like EV batteries and solar panels, India can reduce reliance on imported fossil fuels and position itself as a leader in sustainable manufacturing. The chemical sector, a key focus area, is adopting AI-driven molecular design and bio-based production to enhance sustainability, targeting a 10% share in global value chains by 2047 [11].



Dr. S. Jaishankar addressing South Indian community of Delhi, sharing the vision of "Viksit Delhi, Viksit Bharat"

Unveiling the dimensions of Localization in Manufacturing



Robust infrastructure is vital for localized supply chains. India's National Infrastructure Pipeline, with investments exceeding \$1.4 trillion, is modernizing roads, railways, and digital networks to support efficient domestic logistics [5]. For instance, the country's road network, the second largest globally, has doubled in highway mileage since 2014, improving connectivity between industrial hubs and rural areas [10]. Investments in special economic zones and sector-focused industrial parks further facilitate localized production by providing dedicated infrastructure for high-tech industries.

Technology is another enabler of localization. The adoption of Industry 4.0 technologies, such as AI, IoT, and digital twins, is transforming India's manufacturing landscape [11]. For example, the electronics sector, bolstered by the National Policy on Electronics (NPE) 2019, has positioned India as a global hub for semiconductor and component manufacturing [6]. By integrating these technologies into localized supply chains, India can achieve precision, quality, and timeliness, making it a reliable partner in global value chains (GVCs) [4].

To realize the potential of localized supply chains, India must adopt a multi-pronged strategy. First, continued investment in infrastructure and logistics is crucial. The government's plan to develop integrated logistics hubs and dedicated power supplies for industrial parks should be accelerated [4]. Second, upskilling the workforce through initiatives like the New Education Policy and multi-skilling centers will ensure readiness for advanced manufacturing [5]. Third, fostering public-private partnerships, as seen in the collaboration between CII and local bodies, can drive innovation & job creation [4].

Industry leaders must also play a role by mentoring MSMEs and upgrading quality testing infrastructure to meet global standards [13]. Large companies can facilitate technology transfer and training programs, ensuring that small businesses in their supply chains are equipped for high-quality production. Finally, aligning localization with sustainability goals, such as decarbonization and circular business practices, will ensure that India's growth is inclusive and environmentally responsible [13].



Another challenge is the need for global integration. While localization reduces dependency, India must balance self-reliance with participation in GVCs to achieve its export target of \$8.67 trillion by 2047 [5]. Free Trade Agreements (FTAs) with emerging markets like Africa and Latin America can diversify export markets, reducing reliance on traditional partners [11]. Collaborative R&D in areas like quantum technology and advanced materials can also enhance India's technological edge, ensuring competitiveness in global markets [11].

Despite its potential, localizing supply chains faces significant challenges. Regulatory bottlenecks, stemming from India's complex federal structure, hinder the ease of doing business [4]. Streamlining permissions and compliance is essential to attract investment and scale production. Additionally, India's Human Development Index (HDI) rank lags due to low per capita income and life expectancy, necessitating increased spending on education and healthcare to build a skilled workforce [12].

Conclusion

Localized supply chains are not just a strategic necessity but a transformative force for India's journey to becoming a developed nation by 2047. By reducing dependency on global markets, creating jobs, and promoting sustainable growth, localization aligns with the pillars of Viksit Bharat—economic prosperity, social inclusion, and environmental stewardship. With targeted policies, robust infrastructure, and technological advancements, India can leverage its demographic and economic strengths to build a resilient, self-reliant economy. The road to 2047 is challenging, but localized supply chains offer a clear path to achieving India's vision of global leadership and inclusive prosperity.

Indian Policy landscape for Greening the MSMEs

The longer-term benefits associated with 'going green' need to be translated to the MSMEs to ensure uptake

- Devyani Srivastava

MSMEs and Sustainability – Situating the Problem (and Opportunity)

The discourse around the Indian growth experience is incomplete without acknowledging the massive contribution of the Micro, Small and Medium Enterprises (MSMEs) – a staggering 6.2 crore (as of March 2025). This large quantum is translated to an even larger carbon footprint, with MSMEs accounting for 10–15% of the total industrial sector emissions, which comes to be about 3–4% of the overall carbon dioxide emissions in India. Sustainable industrialization mandates (global and national) coupled with India's net zero goals and other environmental commitments, makes this section of the Indian industry important stakeholders in climate change mitigation discussions and strategies [1].

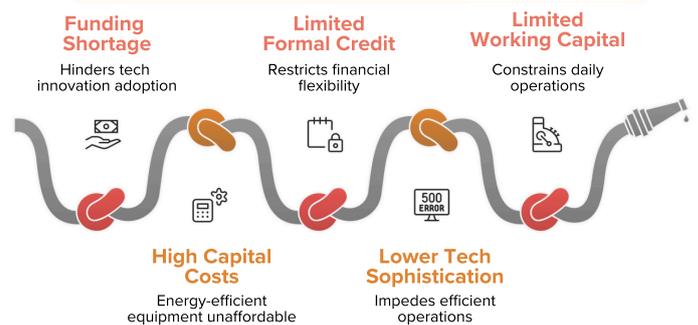
It is in this vein that the concept of **Sustainable Supply Chain Management (SSCM)**, and its integration with the Indian MSME sector assumes importance. SSCM as a concept, strives to strike a balance between economic profitability of a business and the impact of production processes on the commons, invoking environmental and social responsibilities [2].

The following statistics strengthen the rationale for prioritizing MSMEs for SSCM – Indian MSMEs produce over 6000 types of products, employ an 11 million workforce, and constitute 40 percent of the total exports. With over 6000 MSME clusters, and about 400 of them being categorised as 'energy intensive', the sector is said to consume about 25 percent of the total energy consumed by the industrial sector [3].

Indian MSMEs produce over 6000 types of products, employ an 11 million workforce, and constitute 40 percent of the total exports.

Retrofitting a traditionally energy intensive system (the MSME ecosystem, here) requires **technological innovation**, and more importantly **funds** – these are lacking among MSMEs in India. High capital costs of energy-efficient equipment, limited access to formal credit, lower technological sophistication, and limited working capital, are additional factors inhibiting the greening transition [4], [5].

Furthermore, integration of **circular economy (CE)** principles, a determinant of SSCM, is a data intensive process. MSMEs, especially in developing countries, face challenges related to data management since CE practices require dealing with complicated data sets. Data-driven decision making is an indispensable component of formulating SSCM strategies, and the absence of complementary technical expertise and cost-effective infrastructure (example, recycling facilities and sustainable logistics networks) creates barriers to CE adoption. Lack of consumer awareness is another issue [4]. The positionality of MSMEs in the CE discourse emanates from their interconnectedness across sectoral value chains, and their 'engine of growth' status across the world economy.



Despite these barriers, experts opine that the longer-term benefits associated with 'going green' are greater, and need to be translated to the MSMEs to ensure uptake. This should be complemented with appropriate subsidies, awareness campaigns, capacity-building programmes and partnerships [5].

Greening through policy – Indian landscape

SSCM is not a consideration for big firms alone. Investors and consumers, globally, are increasingly using assessment frameworks like Environmental, Social and Governance (ESG) metrics to gauge the environmental and societal impact of partner businesses in global value chains.

While not yet mandated to comply with ESG regulations or Extended Producer Responsibility (EPR) requirements, Indian MSMEs, especially export-oriented MSMEs like textiles and pharmaceuticals (MSMEs accounted for around 46 percent of India's exports in FY25), can greatly benefit from SSCM – the long-term benefits of SSCM outweigh initial investment, states experts.





The greening of market is an emerging reality, and the integration of SSCM considerations early on will aid MSMEs in enhancing product marketability, future-proofing their operations (future environmental regulatory compliances), reducing operational expenses through resource optimization (circular economy-principles integration) and unlocking newer market segments [5], [6].

The policy landscape recognizing this intersection, that is, integration of sustainability in the MSME value chain and production process, is fairly recent in India [3]. The **'Raising and Accelerating MSME Performance' (RAMP)** scheme, launched in 2022, is a recognition by policy of the centrality of MSMEs – known as the “backbone of the Indian economy”. The scheme aims to enhance their innovation, ideation, and entrepreneurial capacity through the “development of quality standards, improving practices and processes, enhancing market access, deploying technological tools and Industry 4.0 to make MSMEs competitive and self-reliant” [7].

Greening of MSME operations also figures as a priority, specifically through the **MSE GIFT** (MSE Green Investment Financing for Transformation) and **MSE SPICE** (MSE Scheme for Promotion and Investment in Circular Economy) schemes – both alluding to SSCM (See **Box 1**).

An estimated Rs.1100 crores in **'social cost of carbon'** – a conceptual attempt to quantify and estimate the economic losses owing to emission of an extra tons of carbon in the atmosphere – is also anticipated. Technical assistance for adoption of climate change adaptation and mitigation technologies, keeping in mind competitiveness requirements, is an additional factor [8], [9], [10].

The **MSME Champions scheme**, while not explicitly alluding to SSCM, is envisioned as a cluster-level technological modernization drive, with 'reduction of wastages' being an important pillar. The design vertical in particular – namely, MSME Innovation (Design), aims to create an interface for collaboration between Indian manufacturers and the design fraternity, to further cost-effective solutions for product development. The assessment criteria include energy efficiency, environmental impact, process/product efficiency, waste reduction, material optimization, and safety improvements, among others – all important features of SSCM [11].

BOX 1: Schemes alluding to SSCM

Recognizing that India is at a possible juncture of an 'economy of shortages' and suboptimal resource allocation and utilization, **MSE SPICE** (MSE Scheme for Promotion and Investment in Circular Economy) is a beginning to relinquish the conventional “take-make-dispose” business model. It is a call to bring about an enterprise-level paradigm shift through the integration of CE principles in the existing production cycle. The outcomes delineated include enabling MSEs to comply with EPR and waste recycling targets, and using CE principles to “reduce wastage, improve organizational efficiency,” [1].

MSE GIFT (MSE Green Investment Financing for Transformation), on the other hand, aims to fill the funds deficit problem gap, by providing institutional finance at concessional rates to MSEs for the adoption of clean and green technologies. Components like Interest Subvention, Risk Sharing (incentivizing financial institutions to provide funds to smaller firms on a priority basis) and Awareness Generation are expected to benefit about 12,000 MSEs.

The Ministry of MSME (MoMSME), under the MSME Innovation (Incubation) vertical, also hosts the **“MSME Idea Hackathon”** – the 5th iteration (2025) is based on “Smart and Sustainable MSMEs” with ‘Smart and Resilient Supply Chains’ being one component of the same [12].

These schemes demonstrate a policy nudge towards leveraging innovation, design thinking, financial assistance and circular economy principles to propel SSCM among MSMEs in India.

Conclusion

Policy recognition is not sufficient. The Ministry of Skill Development and Entrepreneurship can map the skill requirements for MSME's green transition and design export-oriented curriculum for SSCM adoption. Additionally, effective dissemination of these schemes, prioritising MSME clusters, capacity building, and simplifying supply chain procedures is imperative -- many MSMEs in India are export-oriented, and invariably a part of the global value chain (GVC).

Finally, demand-side management is an important piece in the SSCM puzzle, where rising eco-consciousness among consumers for 'green products' can incentivise MSMEs to invest in practices that propel sustainable production processes [13]. The MSME ecosystem in India is a vital pedal in our journey towards a green and resilient economy, and integration of a sustainable supply chain management consciousness, a start in the correct direction.



Q. What inspired you to start Kar Parivartan? What was the turning point in your career or personal life that led you to focus on circular economy and EPR?

The name Kar Parivartan means, 'Be the Change', which reflects our mission to help organizations in being their partner in driving a circular economy and sustainable business. During my previous job roles in Supply Chain and procurement verticals, I observed our country at crossroads, transiting from an informal to a formal recycling ecosystem. Policies for Extended Producer Responsibility (EPR) were emerging. With a high population growth paving way for an emerging market, I observed demand-supply gaps in waste and recycling, gaps in knowledge sharing, availability of infrastructure, conducive policies and behavioral and cultural mindsets in the mass leading to inefficient waste management. Though the government came up with EPR policies in different kinds of waste streams like plastic, e-waste, battery waste etc, there were many gaps in policy implementation. There was no unified model for connecting policy, bridging waste producers and waste processors. That was when I thought of establishing a company to act as a facilitator, to be the change, to simplify EPR and drive the circular economy and waste management efficiently.

What is supply chain sustainability? How do you see the circular economy contributing to long-term supply chain sustainability? Share some example where circular practices helped resource efficiency and long-term sustainability.

Supply chain sustainability simply means to ensure continuity. In other words, it means ensuring suppliers are engaged in providing continuous services. It's about how in the long-term, supply chain delivers value. Supply chain sustainability aims to minimize environmental and social impacts across a product's life cycle — from sourcing to end-of-life.

For example, many products contain metals, extracted from ores from natural resources, such as iron, copper or aluminium. The concept of sustainable supply chains is to make products from efficient

IN CONVERSATION

With

AJAY SOHANVI

Founder, Kar Parivartan

“*Supply chain sustainability simply means to ensure continuity, to ensure suppliers are engaged in providing continuous services. It's about how in the long-term that supply chain can deliver value.*”

raw materials – either virgin or recycled. Flow of these metals can be circular, such that the same metal is reused in manufacturing, reducing dependence on virgin materials.

In the automobile industry, for instance, End-of-Life Vehicle (ELV) policies encourage recycling of vehicle metals, advancing the circular economy. A sustainable supply chain emphasizes responsible sourcing, waste and emission reduction, energy efficiency, fair labour practices, and compliance with environmental laws. It's about making the supply chain not just faster or cheaper, but cleaner, fairer and future-ready.

Sustainable procurement is a growing focus globally.

What does it actually mean? What are some practical steps businesses can take to make their procurement more sustainable?

Climate change is real, its impacts are felt. Numerous companies are rethinking sourcing of materials, taking efforts in green procurement practices, such as reducing environmental impact, ensuring fair work practices and bringing transparency and traceability in the

supply chain. To build a resilient supply chain, the first step would be to create comprehensive policies, which rethink procurement, not solely on cost factors, but the whole-life-cost of the product or service. More time and effort need to be invested in supplier capability enhancement, understanding their current capabilities and developing customised interventions. Some underlying questions such as - are they using clean energy? What are plans to transition for use of recycled materials? Are they spending time and effort on technology and innovation? Companies need to ensure these questions are addressed and suppliers are made capable enough for greener supply chains.

With climate change happening at a faster rate, how can companies take practical steps to tackle greenhouse gases emissions, particularly those related to upstream and downstream supply chains?

Large investments are not always required- small steps can also make a difference. For example, using double-sided printing or avoiding printing altogether when unnecessary. Few companies are taking good steps. For example, Dell started using recycled plastic sourced from electronic parts which they manufacture, demonstrating circular supply chains.

Large corporations have started using renewable energy in their supply chain, especially solar power. Some corporations adopted the use of E-vehicles to reduce tail-pipe emissions in logistics, nudging employees to shift to public transport, directly or indirectly curbing climate change.

We still have challenges in awareness, innovation, infrastructure, technological improvements, which we need to focus on going ahead.

In your experience, how open are vendors and suppliers in India to adopting green procurement standards?

Though ESG and sustainability are buzzwords, sustainability is practiced in our businesses already, it's part of our culture. There are some organizations like ISM (Institute for Supply Management) which offers the CPSM certification, disseminating knowledge on sustainable sourcing, vendor selection etc. There is great momentum in this space, and a lot of my colleagues in procurement are gaining knowledge in these areas, and uplifting the capability of the sector. Frameworks for suppliers, like Ecovadis, are being widely adopted by organizations.

Private players are considering ESG not merely as compliance, but as an important factor for purchase decisions. Policies are facilitating ESG mandates. After the introduction of EPR, we are observing a shift in large players, transitioning towards use of recyclable materials in product manufacturing, or reducing use of plastic in materials, in packaging in particular.

Organizations are now, not only considering upfront cost, but whole-life cost of product. Eg, in UPS Systems in electronics, power rating of UPS for charging of batteries is important. Using energy efficient systems, we can analyse per unit energy consumption expenditure vis-a-vis the life-cycle of UPS, until it comes at end-of-life. For example, comparing UPS worth Rs 10 lakh vis-a-vis energy efficient UPS worth 11 lakh with 10-years life, the second option will give better ROI (Return-on-investment) in the long-term. Considerations like operational efficiency and environmental impact help in sustainable sourcing and procurement decisions.

Informal networks play a big role in India's supply chains. What are the challenges and opportunities in integrating informal supply chains into the formal system?

What strategies do you suggest for formalizing them without disrupting livelihoods?

Over 95% of India's waste management sector operates within the informal economy, and there is a challenge of sourcing waste back to the recycler. Rather than replacing the existing workforce, they need to be recognized. We need to identify their talent and challenges, incentivise them financially with soft loans or microfinance and build knowledge & capacity for their formalization. There is also information asymmetry about recycling and safe working conditions which has to be worked upon.

What are your thoughts on building regional supply chain resilience, especially in the context of the post-COVID recovery? Are there sectors or regions in India you believe are particularly ready to scale circular and sustainable supply chain solutions?

With changing trade policies between countries, India and China will always remain competent. India is coming up as a manufacturing hub globally. We have to be cost competitive, and thus must have control on raw materials. For instance, in the automotive sector, China plays a dominant role in supply of magnets, and it recently introduced curbs on its supply. This is a disruption in continuity of the supply chain, as magnet is a vital component in vehicles. We have to think from a make-use-dispose-recycle perspective so as to reduce dependency, and diversify the supply chain.

What message you will give to youth, especially young entrepreneurs, who want to work on Supply Chain Sustainability?

With a pressing need for sustainable development, new job roles requiring green skills are coming up. It would be a great decision for those planning to consider this space as a career option. I would advise them to take exposure to different career pathways, understand challenges on ground and develop competencies towards solving them. Find your interest area and develop your niche into that. Always keep yourself updated with existing trends, unlearn and relearn.



MEET THE TEAM



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Vasundhara 16th Edition Launch

The launch of the 16th Edition of Vasundhara Magazine, titled "The Carbon Convolution: Sustainable Pathways to Decarbonization," was held on 19th March, 2025. Ms. Shubhi Goel graced the occasion as the Chief Guest. As part of the launch of the 16th Edition of Vasundhara Magazine, a Group Discussion on Energy Efficiency vs. Renewables was held. Ms. Goel judged the panel, offering valuable feedback and insights.



Winner speaks...



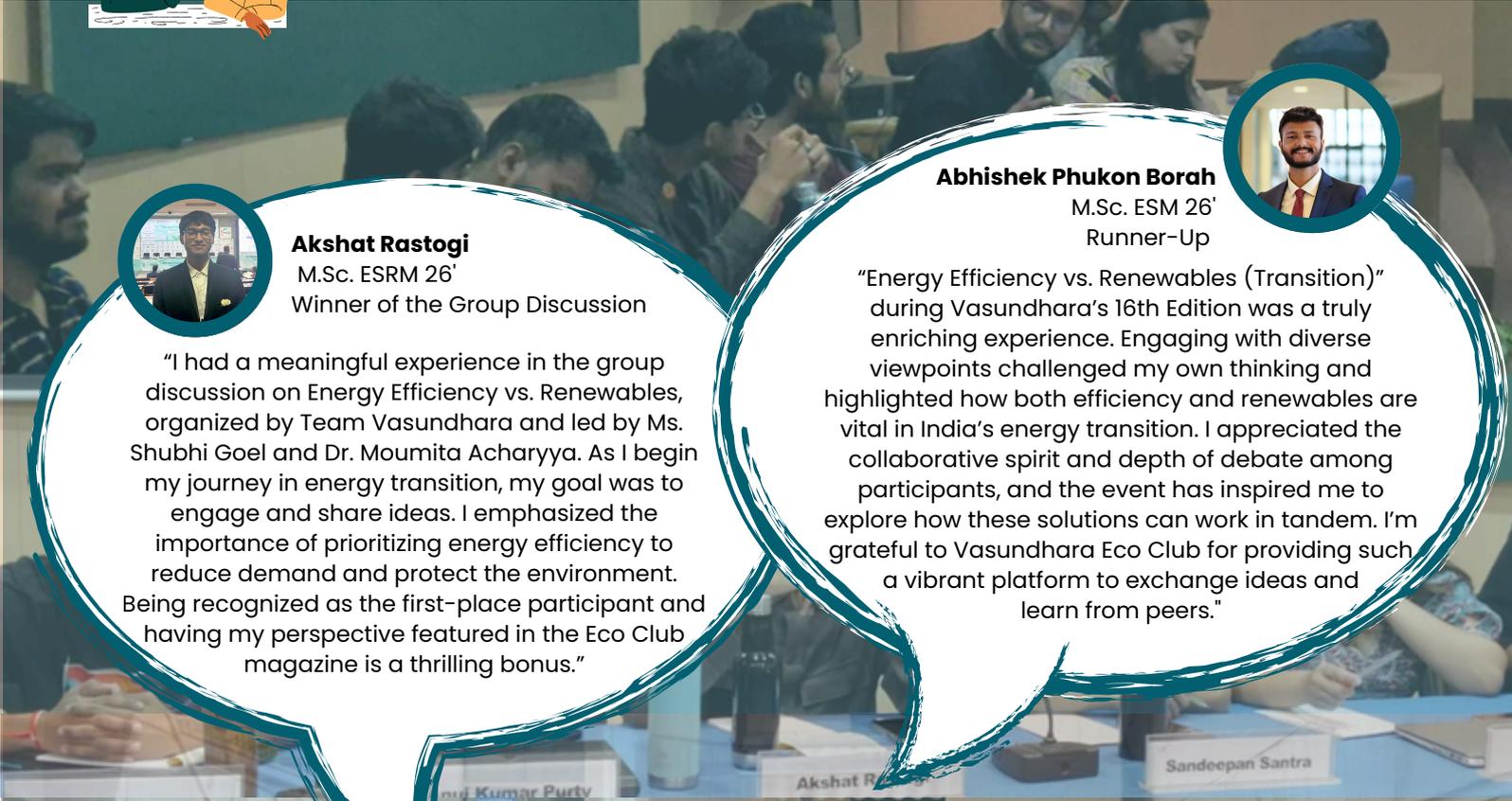
Akshat Rastogi
M.Sc. ESRM 26'
Winner of the Group Discussion

"I had a meaningful experience in the group discussion on Energy Efficiency vs. Renewables, organized by Team Vasundhara and led by Ms. Shubhi Goel and Dr. Moumita Acharyya. As I begin my journey in energy transition, my goal was to engage and share ideas. I emphasized the importance of prioritizing energy efficiency to reduce demand and protect the environment. Being recognized as the first-place participant and having my perspective featured in the Eco Club magazine is a thrilling bonus."



Abhishek Phukon Borah
M.Sc. ESM 26'
Runner-Up

"Energy Efficiency vs. Renewables (Transition)" during Vasundhara's 16th Edition was a truly enriching experience. Engaging with diverse viewpoints challenged my own thinking and highlighted how both efficiency and renewables are vital in India's energy transition. I appreciated the collaborative spirit and depth of debate among participants, and the event has inspired me to explore how these solutions can work in tandem. I'm grateful to Vasundhara Eco Club for providing such a vibrant platform to exchange ideas and learn from peers."





Insight to impact: Policy Brief Challenge (28th November, 2024)

The “Insight to Impact: Policy Brief Challenge”, organized by Vasundhara on the occasion of Aahwan 2024, witnessed thought-provoking presentations on ‘Integrating Indigenous Knowledge for Localization in Decarbonization Efforts’. The event was judged by Dr. Amit Singh, whose valuable insights enriched the discussions.



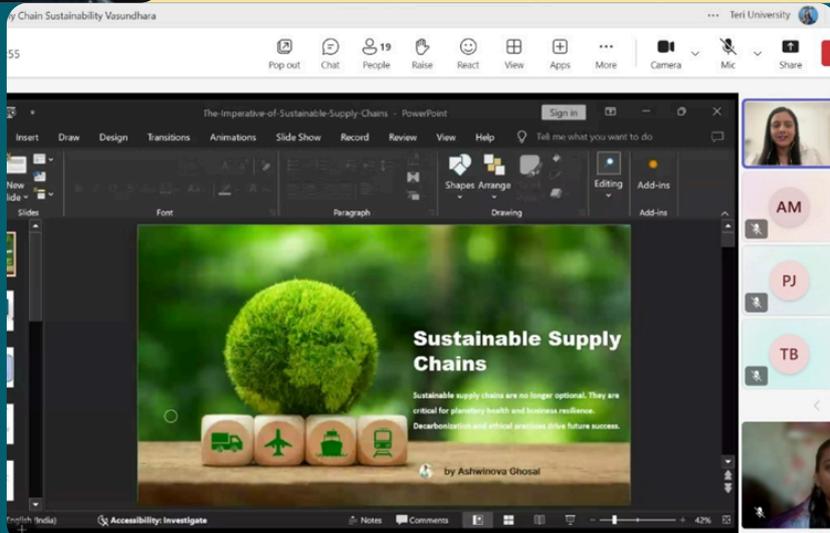
The Planet Trivia (30th November, 2024)

The “Planet Trivia: The Ultimate Battle of Climate Awareness” was organized by Vasundhara, during Aahwan 2024, focused on the theme “Sustainable Development Goals (SDGs) and Multilateralism.” The engaging quiz tested participants’ knowledge of global sustainability efforts, fostering a spirit of healthy competition and environmental awareness.



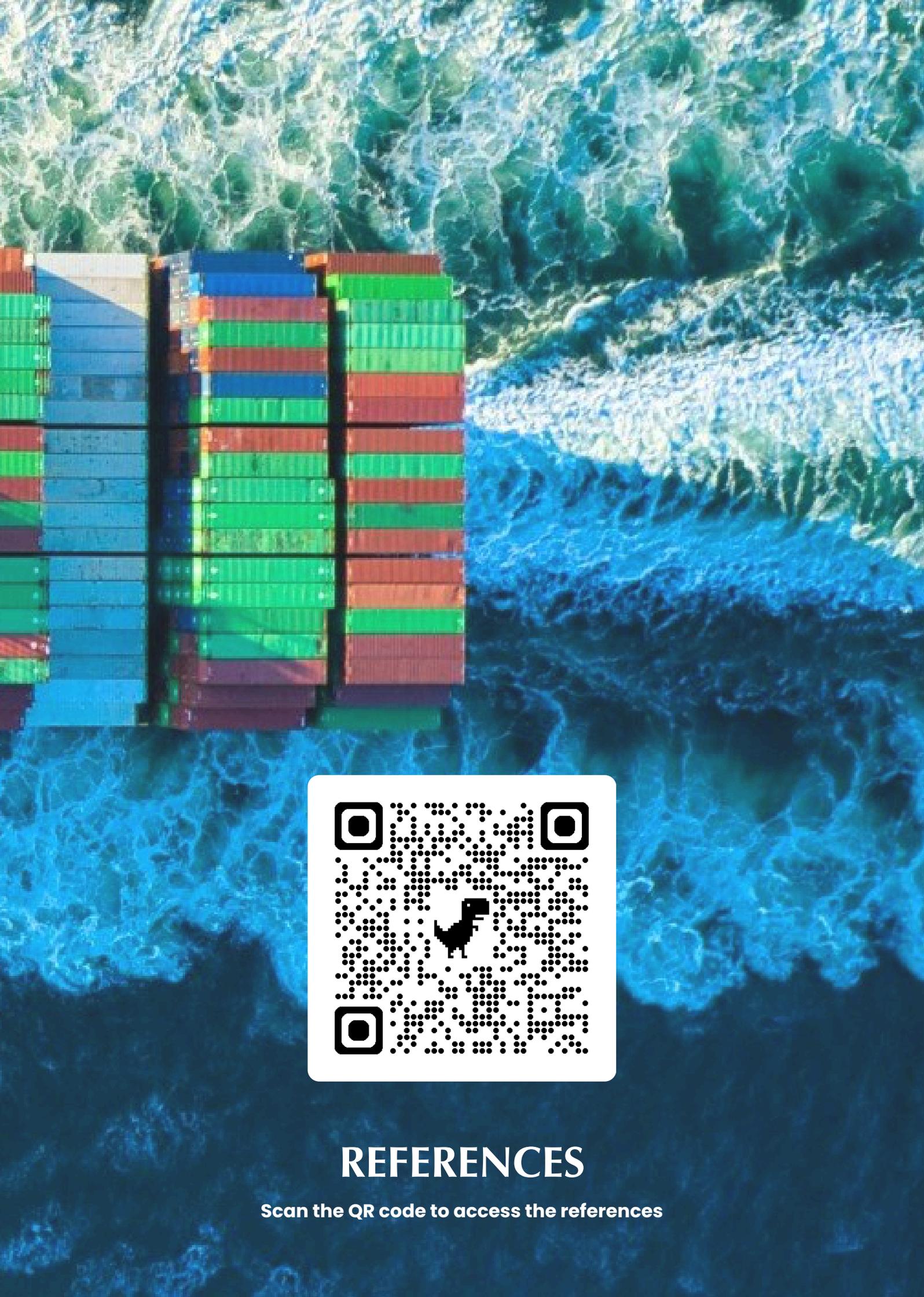
Knowledge Sharing Session: Ms. Ashwinova Ghosal on Supply Chain Sustainability (19th June, 2025)

A “Knowledge Sharing Session” featuring Ms. Ashwinova Ghosal was held by Vasundhara. She delivered an insightful talk on “Supply Chain Sustainability.” The session provided participants with a comprehensive understanding of sustainable practices across supply chains, highlighting real-world examples and actionable strategies.



Poster Making Competition (24th September, 2025)

An ICSSR-sponsored Pre-Seminar Inter-University Poster Making Competition was hosted by Vasundhara. The competition encouraged students to creatively express ideas around themes such as Mission LIFE, behavioural nudges for sustainable production & consumption, rural energy transition. Selected posters were displayed during National Seminar on Solar Energy & Sustainability for Tribal Communities at ISID.



REFERENCES

Scan the QR code to access the references



An Eco Club Initiative @ TERI SAS

FOR MORE INFORMATION:

+91 11 71800222

✉ registrar@terisas.ac.in
vasundhara.ecoclub@terisas.ac.in

🌐 www.terisas.ac.in

📍 **The Registrar**

TERI SAS, Plot no. 10, Institutional Area, Vasant Kunj,
New Delhi - 110070 - India