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SUSTAINABLE SUPPLY CHAINS AND CARBON CREDITS: PATHWAYS TO GREEN BUSINESS GROWTH

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ABSTRACT
Sustainability is steadily gaining momentum in Pakistan as both organizations and the government increasingly recognize the significance of green business practices. This paper reviews the current state of green business in the country, with particular emphasis on renewable energy, waste management, sustainable agriculture, and corporate sustainability initiatives. Despite these advancements, several challenges persist, including financial constraints, regulatory gaps, and limited awareness of green technologies. Examines the role of government support, collaboration with the international community, and growing consumer interest in sustainable business models. Addressing these challenges and capitalizing on emerging opportunities could enable Pakistan to position itself as a regional leader in sustainable supply chains and carbon credit-driven business growth.
Keywords: *Green Business, Sustainable Supply Chains, Carbon Credits, Climate Change Mitigation, Carbon Reduction Strategies, Environmental Policy, Pakistan.*

INTRODUCTION

Climate change remains the most pressing challenge for sustainable business and global supply chains (Akanwa et al., 2019). In line with Hardin's (1968) concept of the "tragedy of the commons," the excessive exploitation of shared resources and unchecked carbon emissions from industrial and commercial activities continue to accelerate environmental degradation (Anukwonke, 2015). Anthropogenic emissions ranging from energy-intensive production processes to global logistics networks have altered the Earth's atmospheric composition, creating severe consequences for ecosystems, businesses, and human well-being (UN Environment, 2019).

The Intergovernmental Panel on Climate Change (IPCC, 2014) warns that rising carbon emissions linked to business operations and supply chains will lead to "severe, pervasive, and irreversible impacts" across economic and ecological systems. These impacts manifest directly through extreme events such as storms and heatwaves, indirectly through disruptions in water supply, disease ecology, and air quality, and diffusely through long-term shifts in biodiversity and agricultural output (Butler, 2014; Melillo et al., 2014).

The evidence of global climate change ranging from ocean acidification to sea-level rise, underscores the urgency of integrating green business practices into supply chain management (Vaughan et al., 2013).

For corporations, climate-related risks translate into rising costs of raw materials, disrupted energy and water security, transportation vulnerabilities, and declining agricultural productivity. Furthermore, businesses face heightened exposure to natural disasters, supply disruptions, and reputational risks as stakeholders demand low-carbon, resilient, and transparent supply chains (UN Global Compact, 2011; UNEP, Oxfam, & WRI).

Sustainable supply chain strategies such as carbon footprint reduction, renewable energy integration, circular economy models, and green procurement are therefore critical for mitigating risks, ensuring long-term competitiveness, and aligning corporate growth with environmental stewardship.

Human-driven activities have been a dominant force behind the steady rise of greenhouse gas (GHG) concentrations for more than 150 years (IPCC, 2007). Historical records show that atmospheric carbon dioxide levels climbed from roughly 277 ppm in 1750 to 403.3 ppm in 2016 and further to 405.5 ppm in 2017 (World Meteorological Organization, 2016, 2018). The visible consequences of these emissions have intensified global concern, with projections indicating that temperatures could increase by 0.2°C each decade, pushing the world past the Paris Agreement's 1.5°C threshold as early as the 2040s (Haustein et al., 2017; Leach et al., 2018).

This alarming trajectory has pushed policymakers and businesses alike to explore strategies that minimize carbon footprints and accelerate the global shift toward carbon neutrality (Schellnhuber, Rahmstorf, & Winkelmann, 2016). International frameworks, including the UNFCCC, Kyoto Protocol, and Paris Agreement, have introduced mechanisms such as carbon credits and trading, which position markets as key instruments for reducing atmospheric carbon (Gupta, 2011; Thorpe, 2020).

For green businesses, carbon credit systems provide an opportunity to balance profitability with responsibility, allowing firms to invest in renewable technologies, sustainable supply chains, and energy-efficient practices. These mechanisms also promote innovation, as businesses adopt greener processes to remain competitive while reducing emissions (Sherma, 2020). Likewise, both individuals and organizations are increasingly directing capital into green investments that actively improve carbon footprints and support sustainable development (Smith, 2020). Since corporate operations and supply chains are significant contributors to global GHG emissions, companies must embed flexibility and accountability into their business models. Achieving net-zero emissions requires integrating sustainability into procurement, production, logistics, and distribution, making supply chains a central driver of low-carbon transformation. Examining the principles of carbon credits and their role in green businesses highlights not only their environmental relevance but also their potential as a sustainable, market-driven solution for the transition toward a carbon-neutral economy.

2.1 Green Business

Growing awareness about the unsustainable nature of traditional economic growth marked by rapid resource depletion and environmental degradation has fueled global interest in green business since the early 20th century. To fully grasp the scope of this concept, it is necessary to examine its economic, social, and environmental dimensions. Green business is commonly described as an enterprise that integrates sustainability into its operations and outputs. Scholars highlight various perspectives: some emphasize the production of environmentally friendly goods and services, while others focus on sustainable practices that reduce ecological harm, support natural systems, and improve human well-being while maintaining profitability. A central theme across these views is that green businesses adopt renewable resources, environmentally responsible sourcing, and socially accountable practices, embedding environmental considerations into all areas of operation.

The literature further positions green business as a model that balances profitability with ecological and social responsibility. Rather than pursuing revenue alone, these businesses explicitly account for environmental concerns in their strategies, supply chains, and organizational policies. This redefines the traditional objective of business from profit maximization alone to a broader purpose that incorporates human health, community welfare, and long-term sustainability. The benefits of green business practices are both economic and social: they can lower operational costs, reduce environmental risks, improve employee well-being, and enhance productivity, all while protecting ecosystems. In this context, green business is understood as a deliberate approach to commerce in which profitability is pursued through

environmentally sound policies and strategies that support sustainable development.

2.2 Carbon Credit

Rising carbon emissions have triggered significant environmental and health challenges, drawing global attention to the urgent need for mitigation strategies. The scale of the issue is reflected in the financial value of carbon markets. For example, in 2016, approximately 10 million metric tonnes of CO_2 equivalent were transacted within the United States carbon market, valued at an estimated $28 million (Hamrick & Gallant, 2017). Earlier, in 2008, the total global trade in carbon credits amounted to nearly US$120 billion, of which US$119 billion was attributed to regulated markets and around US$704 million to voluntary markets (Hamilton et al., 2009). These figures highlight the massive scale of carbon emissions and the growing reliance on market-based mechanisms to address them.

A carbon credit represents a tradable unit, granting its holder the right to emit one tonne of carbon dioxide or an equivalent amount of another greenhouse gas. Credits are generally categorized into two forms: Certified Emission Reductions (CERs), generated under compliance frameworks, and Voluntary Emission Reductions (VERs), created through voluntary initiatives. Each credit earned corresponds to a reduction of one tonne of CO_2 equivalent and can be used to offset emissions elsewhere. When such credits are generated through emission-reduction projects and subsequently traded, carbon markets are formed.

Essentially, carbon markets operate as economic systems that assign monetary value to carbon emissions and reward activities that sequester carbon or reduce greenhouse gas release (Forest Carbon Credit, 2018). These markets can be divided into compliance markets and voluntary markets (Takeuchi, 2012). Compliance markets are governed by binding international and regional agreements such as the Kyoto Protocol, the European Union Emissions Trading System (EU ETS), the Western Climate Initiative (WCI), New Zealand ETS, the Regional Greenhouse Gas Initiative (RGGI), and the Tokyo ETS. In contrast, voluntary markets cater to entities seeking to offset emissions beyond regulatory obligations, with mechanisms such as the Chicago Climate Exchange (CCX), the Gold Standard (GS), VER+, and the Voluntary Carbon Standard (VCS). Currently, the EU ETS stands as the world's largest permit-based trading platform, while the Clean Development Mechanism (CDM) remains the most significant credit-generating programme (Takeuchi, 2012).

2.3 Green Economy

The concept of a green economy is closely linked to the ideas of *low-carbon development* and *green growth*, both of which emphasize not only the expansion of economic output but also sustainable progress. Barbier (2013) argued that economic development and environmental policies cannot be treated as separate domains, as the two are fundamentally interconnected. Consequently, the green economy framework integrates economic efficiency, social equity, and environmental sustainability into a unified approach.

International organizations such as UNEP, OECD, and the World Bank have each defined the green economy in ways that highlight its role in reshaping economic activities for more inclusive and environmentally responsible growth (Borel-Saladin & Turok, 2013). According to UNEP (2011), the green economy aims to enhance human well-being and reduce inequalities while simultaneously lowering ecological risks and addressing resource scarcity. Similarly, the African Development Bank (2013) emphasizes that it requires balancing the responsible use of non-renewable resources with the sustainable management of renewable ones. The OECD (2011) further stresses that economic growth must be accompanied by the preservation of natural assets and ecosystem services, which are critical to long-term prosperity.

Nevertheless, scholars caution that a green economy should not be equated with simple GDP growth driven by "green stimulus" initiatives, as such growth alone does not guarantee the fundamental transformations in resource use, consumption patterns, and emission reductions necessary to curb environmental degradation (Lucien et al., 2017). In contrast, the shift toward greener economic models is not inherently a constraint on growth; rather, it can generate opportunities for innovation and long-term resilience (Schmalensee, 2012).

Ferguson (2014) highlighted the diversity of green economy discourses, categorizing them as weak, transformational, or strong, depending on how they address the relationship between environmental outcomes and GDP measurement. While debates persist, most perspectives converge on the view that the green economy employs principles of economic

rationality and market mechanisms to address the overexploitation of environmental resources associated with industrial and commercial activity.

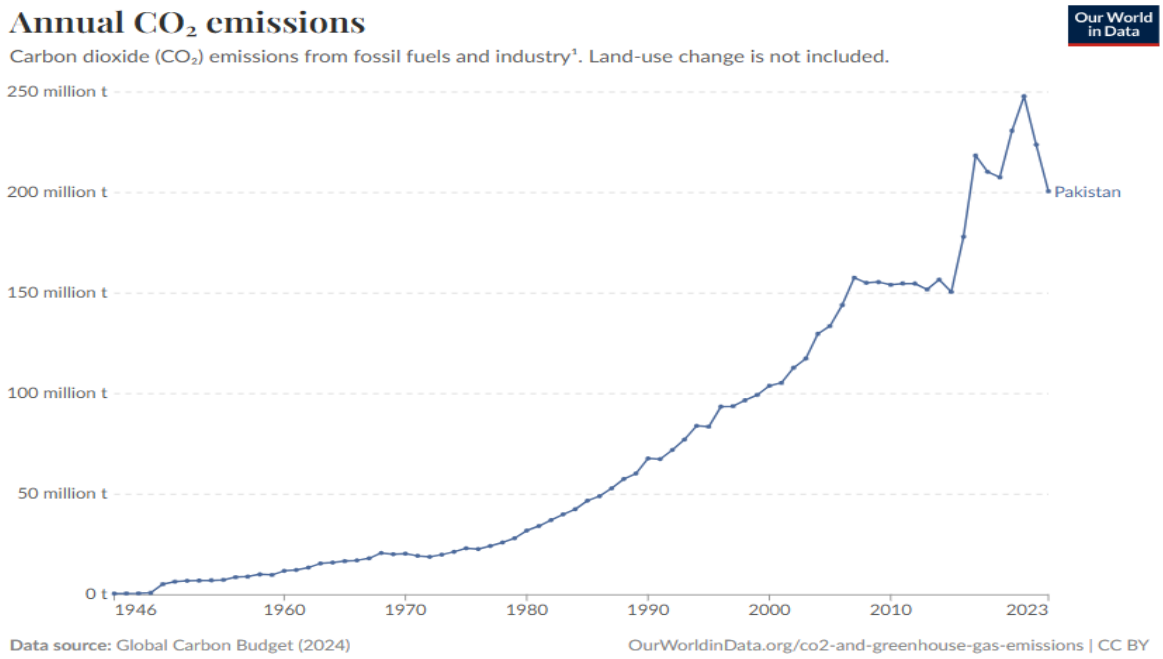
Green businesses, therefore, cannot be separated from the principles of the green economy. By embedding sustainability into supply chains, adopting renewable energy, and implementing low-carbon strategies, such businesses contribute to both ecological protection and economic advancement. The growing pressures of climate change, global recessions, and social inequality (Davies, 2013) have intensified calls for a systemic transition toward green economies—a concept originally articulated by Pearce et al. (1989) as a blueprint for aligning environmental stewardship with economic development.

2.4 CLIMATE CHANGE ADAPTATION AND MITIGATION

Climate change has emerged as one of the most pressing global challenges, largely driven by human activities and their impact on the atmosphere (Rahman, 2012). Its consequences extend across ecosystems, human health, infrastructure, and sustainable development, making it a complex and far-reaching issue. Unlike other environmental problems, climate change progresses gradually and often remain unnoticed until it reaches a critical threshold, which has led Henderson-Sellers (1995) to describe it as a "creeping crisis."

To effectively address this challenge, two broad approaches have been identified: adaptation and mitigation. Adaptation refers to adjustments in natural or human systems undertaken to minimize the negative effects of climate change or to take advantage of potential opportunities (Klein et al., 2005). Mitigation, on the other hand, encompasses strategies aimed at reducing greenhouse gas (GHG) emissions or enhancing carbon sinks such as reforestation, renewable energy adoption, or improvements in energy efficiency (Klein et al., 2005; Rundcrantz & Skarback, 2003). The UNFCCC further clarifies the distinction by defining adaptation as the adjustment of systems to the impacts of climate change, while mitigation entails deliberate interventions to reduce or offset GHG emissions.

A key difference between these approaches lies in their timelines: adaptation often produces more immediate outcomes, whereas mitigation effects typically unfold over longer periods. However, combining the two strategies can create synergistic effects, amplifying their impact. For example, in agriculture, adaptation practices such as climate-resilient crops, when combined with mitigation strategies like low-emission farming, have demonstrated significant benefits for food security and environmental sustainability.These synergies extend to multiple fields including urban planning, architecture, and economic policy—highlighting the potential for systemic transformation. In this context, green businesses play a pivotal role by integrating adaptation and mitigation strategies into their operations and supply chains. By adopting renewable energy, sustainable procurement, and low-carbon technologies, businesses not only reduce emissions but also build resilience against climate risks. This coordinated approach positions green enterprises as vital contributors in the global transition toward climate-resilient and sustainable economies.



2.5 Supply Chain Impacts and Greenhouse Emission

From an environmental perspective, nearly every stage of human-led development brings with it some degree of ecological degradation. While individual households contribute to environmental impacts, the influence of businesses is far more substantial due to their large-scale operations and extensive value chains. Business activities generate environmental pressures through waste production, excessive packaging, hazardous material disposal, wastewater discharge, and emissions into the atmosphere. Among these, the release of carbon from fossil fuel combustion remains a critical concern, as it significantly contributes to global climate change.

The role of supply chains in this process has become increasingly important, as they represent a network of interconnected entities suppliers, manufacturers, distributors, and retailers whose collective activities have a profound environmental footprint. Supply chain operations, in particular, are major sources of greenhouse gas (GHG) emissions, arising from procurement, production, warehousing, and both inbound and outbound logistics (Paksoy et al., 2011; Ali et al., 2020). Consequently, supply chains have been identified as one of the largest contributors to global carbon emissions, linking business performance directly to climate change challenges.

In response, policymakers and regulatory bodies have begun to adopt carbon-centered frameworks as part of environmental governance (Gupta & Palsule-Desai, 2011). Within these frameworks, GHG emissions are treated as a core indicator of environmental performance. One approach has been the integration of carbon trading systems, where emissions generated across supply chains are translated into measurable costs through carbon credits. This allows organizations not only to quantify the emissions from procurement, production, and transportation but also to identify areas where reductions can be made through sustainable practices (Pishvaee et al., 2012).

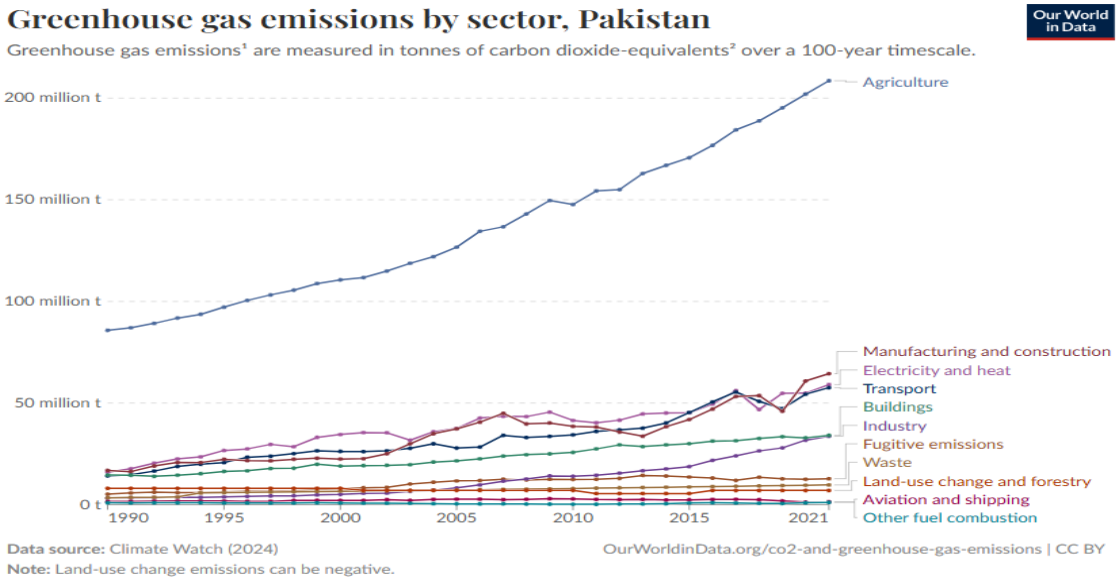
As a result, supply chain management is increasingly viewed as a strategic avenue for achieving both environmental compliance and long-term sustainability. By embedding carbon accounting and emission-reduction strategies into their operations, businesses can transform supply chains from being major contributors to climate risk into drivers of sustainable value creation.

2.6 Greenhouse Gas Emissions and Green Supply Chain

Global greenhouse gas (GHG) emissions are closely tied to economic and business activities, underscoring the central role that industries and supply chains play in shaping carbon outcomes. According to the Intergovernmental Panel on Climate Change (IPCC, 2010), electricity and heat generation mainly from fossil fuels such as coal, oil, and natural gas account for about 25% of global emissions, followed by the manufacturing and industrial sector at 21%. Agriculture, forestry, and

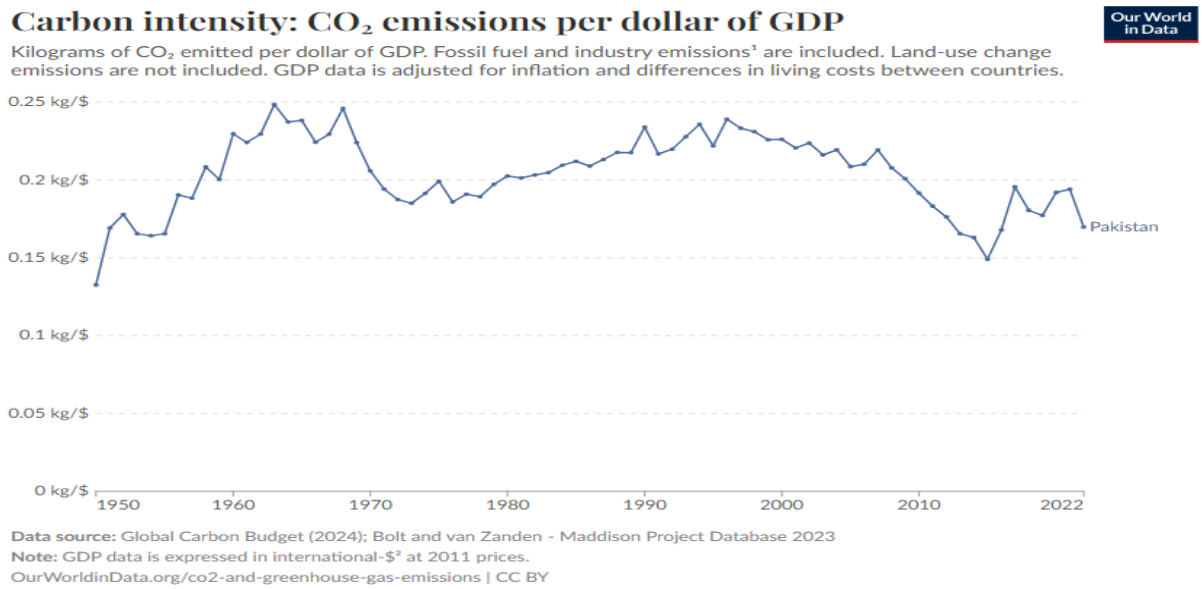
land-use changes contribute roughly 24%, while transportation is responsible for around 14%. Other significant contributors include petrochemical, metallurgical, and mineral processing activities, along with emissions from households and energy-related processes such as fuel extraction and refining. More recent estimates suggest that the manufacturing and transportation sectors together account for nearly 45% of emissions (IPCC, 2007), highlighting the critical intersection of supply chains and climate change.

Since supply chains cut across multiple stages of production, distribution, consumption, and disposal, their cumulative carbon footprint is significant. Studies show that direct emissions from firms often represent less than 15% of total emissions, while indirect emissions along the supply chain may account for as much as 80% of a product's life cycle emissions (Matthews et al., 2008; Huang et al., 2009). This makes supply chain management one of the most effective leverage points for reducing global carbon emissions and transitioning toward green business models.



1. Greenhouse gas emissions A greenhouse gas (GHG) is a gas that causes the atmosphere to warm by absorbing and emitting radiant energy. Greenhouse gases absorb radiation that is radiated by Earth, preventing this heat from escaping to space. Carbon dioxide (CO_2) is the most well-known greenhouse gas, but there are others, including methane, nitrous oxide, and in fact, water vapor. Human-made emissions of greenhouse gases from fossil fuels, industry, and agriculture are the leading cause of global climate change. Greenhouse gas emissions measure the total amount of all greenhouse gases that are emitted. These are often quantified in carbon dioxide equivalents (CO_2eq) which take account of the amount of warming that each molecule of different gases creates.

2. Carbon dioxide equivalents (CO_2eq) Carbon dioxide is the most important greenhouse gas, but not the only one. To capture all greenhouse gas emissions, researchers express them in "carbon dioxide equivalents" (CO_2eq). This takes all greenhouse gases into account, not just CO_2.To express all greenhouse gases in carbon dioxide equivalents (CO_2eq), each one is weighted by its global warming potential (GWP) value. GWP measures the amount of warming a gas creates compared to CO_2. CO_2 is given a GWP value of one. If a gas had a GWP of 10 then one kilogram of that gas would generate ten times the warming effect as one kilogram of CO_2. Carbon dioxide equivalents are calculated for each gas by multiplying the mass of emissions of a specific greenhouse gas by its GWP factor. This warming can be stated over different timescales. To calculate CO_2eq over 100 years, we'd multiply each gas by its GWP over a 100-yeartimescale (GWP100).



2.7 Green Supply Chain Management (GSCM)

It emerged as a vital strategy for aligning business operations with environmental sustainability. GSCM involves integrating carbon reduction practices across the entire value chain, from product design and raw material sourcing to logistics, consumer use, and end-of-life disposal (Handfield et al., 2001; Chin et al., 2015). This approach not only reduces emissions but also fosters collaboration, transparency, and information sharing among suppliers, transporters, retailers, and consumers (Cox, 1999; Handfield et al., 2004). By embedding sustainability into every stage of the supply chain, businesses can mitigate environmental risks, reduce waste, and support global climate targets.

Green business principles, particularly those rooted in Deming's Continuous Improvement Model (1986), emphasize the systematic reduction of inefficiencies such as energy waste and pollution. When applied to supply chains, this model helps businesses continuously optimize their processes, cut down on excess resource use, and reduce carbon emissions. Leading corporations illustrate the power of this approach. Walmart, a global leader in supply chain management, has achieved significant cost savings and environmental gains by embedding carbon-reduction strategies in its supplier network (Plambeck & Denend, 2007). Similarly, Microsoft has pledged to become carbon negative by 2030 and to eliminate all historical carbon from its supply chain by 2050 (Smith, 2020).

These examples show how global businesses are leveraging their supply chains to transition toward carbon-conscious models. By rethinking logistics, sourcing, and energy use, firms are not only complying with climate policies such as cap-and-trade but are also positioning themselves as green business leaders. Ultimately, supply chains represent both the greatest challenge and the greatest opportunity in addressing climate change. Innovations in green supply chain management provide a pathway for businesses to balance profitability with responsibility, contributing to global carbon reduction goals and advancing sustainable development.

2.8 Global Environmental Agreements and Regulations

The growing recognition of the environmental consequences of industrialization and business operations has led to the evolution of global agreements addressing climate change, carbon emissions, and sustainable business practices. The Intergovernmental Panel on Climate Change (IPCC), established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), provided the scientific foundation for international regulations on greenhouse gas (GHG) emissions. Since then, environmental governance has increasingly acknowledged that supply chains through production, logistics, and consumption are significant contributors to carbon footprints and therefore central to sustainability transitions in global business.

The adoption of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 marked a milestone in the international

community's attempt to curb the rising levels of greenhouse gases caused by business and industrial activities. The UNFCCC emphasized the responsibility of both developed and developing nations to reduce emissions and highlighted the role of policy frameworks in guiding green business practices, carbon management strategies, and sustainable supply chain design (Gupta, 2011).

The Kyoto Protocol of 1997 advanced this agenda by introducing legally binding commitments for industrialized countries to reduce carbon emissions by at least 5% below 1990 levels by 2012. The Protocol targeted key GHGs including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases while recognizing the principle of "common but differentiated responsibilities." This principle reflected the fact that developed countries, as early industrialisers, contributed disproportionately to emissions, while developing countries required flexibility to pursue sustainable growth. Supply chains became a focal point under this framework, given that procurement, manufacturing, transportation, and waste management collectively drive a large share of carbon emissions (UNFCCC, 1998).

The Doha Amendment (2012) reinforced Kyoto by setting a second commitment period (2012–2020) with a more ambitious target of reducing GHGs by at least 18% below 1990 levels. Mechanisms such as **Joint Implementation (JI), Clean Development Mechanism (CDM), and Emissions Trading** were introduced to integrate market-based solutions into carbon reduction efforts. These mechanisms not only encouraged carbon-efficient technologies but also influenced multinational supply chains to adopt greener operations. For instance, businesses engaging in CDM projects invested in sustainable energy, waste management, and carbon-neutral logistics within developing countries, thereby reducing global emissions while strengthening green supply networks (Gupta, 2011; UNFCCC, 2012).

Overall, these global agreements underscore that green business transformation cannot be achieved in isolation but requires supply chain-wide strategies. International climate frameworks highlight carbon management across procurement, production, logistics, and consumption as essential levers for aligning businesses with sustainable development goals and achieving measurable reductions in global carbon emissions.

Policy Implications

Climate change has emerged as one of the most pressing global challenges, with far-reaching consequences for ecosystems, businesses, and societies. Addressing its causes requires integrated strategies that emphasize reducing greenhouse gas (GHG) emissions across business operations and supply chains. Scientific consensus highlights that global mean temperatures must be kept below 2°C above pre-industrial levels to avoid the most severe environmental and economic risks (IPCC, 2007).

Within the supply chain context, effective climate policies play a crucial role in driving organizational transformation, coordination, and innovation. Companies must integrate low-carbon strategies into procurement, manufacturing, logistics, and distribution networks to achieve long-term sustainability. Policies supporting carbon credit systems and trading mechanisms can encourage firms to adopt greener practices, improve accountability, and align corporate goals with emission-reduction targets (Plambeck, 2012).

Such regulatory and market-based instruments should foster business commitments to mitigate emissions at all levels of the supply chain while shifting away from short-term competitive gains that undermine sustainability. At the same time, governments and international institutions can provide enabling environments through subsidies, incentives, and awareness programs that encourage firms and consumers to embrace green business models. For firms, aligning supply chain practices with carbon mitigation not only reduces environmental risks but also enhances competitiveness, reputation, and international recognition (Paksoy et al., 2011; Ali et al., 2020).

Ultimately, sustainable policy frameworks must empower companies to redesign their business models, embrace recycling and renewable practices, and strengthen resilience against climate-related disruptions. This dual approach policy-driven and business-led can accelerate the transition toward green business practices while ensuring that supply chains become a central driver of global carbon reduction efforts.

Table 2: Major Considerations for Green Business and Low-Carbon Supply Chains

Weakness/Challenges	Opportunities/Benefits	Strengths

High costs and long processes to obtain green certifications.	Competitive advantage through sustainable branding and increased consumer demand.	Strong alignment with environmental protection and climate goals.
Lack of awareness about green business practices in developing countries.	Rising awareness among consumers creates new markets and profitability opportunities.	Positive reputation and goodwill for companies adopting green practices.
Profit margins reduced due to intermediaries in supply chains.	Government subsidies and incentives can enhance customer reach and reduce costs.	Increased consumer trust and loyalty toward environmentally responsible products.
Weak regulatory frameworks in many developing countries.	International recognition for adopting green and circular supply chain models.	Farmers, producers, and suppliers gain from fair and sustainable practices.
Significant time and investment required to transfer green practices to mainstream operations.	Long-term growth potential and resilience against environmental risks.	Strong contribution to climate change mitigation and sustainability goals.
Low public concern for environmental issues in some regions.	Policies promoting awareness can increase consumer engagement and adoption.	Sustainable supply chain practices reduce global carbon footprint and build systemic resilience.

Source: Adapted from Sujaya et al. (2019); Modified by Author

Conclusion

Anthropogenic activities, particularly industrial production and global supply chain operations, are among the major contributors to rising carbon emissions and accelerating climate change. Under Article 1 of the Kyoto Protocol, industries and multinational corporations are recognized as significant players in this process due to emissions generated across their value chains from raw material sourcing to logistics and final distribution. To remain competitive and sustainable, businesses must transition toward net-zero supply chain **models** that integrate green business practices, carbon reduction strategies, and innovations in sustainable operations. Embracing **carbon credit mechanisms** offers a dual advantage: enabling firms to offset unavoidable emissions while also incentivizing cleaner production and supply chain efficiency. This aligns with the Kyoto Protocol's flexible mechanisms Joint Implementation **(JI),** Clean Development Mechanism (CDM), and Emission Trading which provide the foundation for global carbon reduction efforts.

In practice, carbon credits act as tradable permits allowing businesses to emit one tonne of carbon dioxide (or equivalent greenhouse gases), while creating financial value for organizations that successfully reduce or offset emissions. With **Voluntary Emission Reductions (VERs)** and **Certified Emission Reductions (CERs)**, companies can participate in both compliance and voluntary markets, reinforcing their commitment to sustainability.

Transparent carbon policy framework is essential to drive sustainable business operations. Such a framework should:

- Reward organizations investing in green supply chain practices.
- Strengthen carbon markets to function as reliable, flexible, and profitable platforms.
- Encourage innovation in logistics, energy efficiency, and resource use across global supply chains.

Carbon Crediting into business strategy, organizations can achieve sustainable growth, enhance global competitiveness, and actively contribute to the global climate mitigation agenda. Ultimately, green business models that prioritize carbon neutrality in supply chains represent not only an environmental necessity but also a strategic pathway to long-term profitability and resilience.

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