CHAPTER 6

Sustainable Supply Chain Management in Sub-Saharan Africa

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Summary

The imperatives of globalisation demand that organisations and governments of various countries adopt sustainable supply chain practices for reduced impact on their ecosystems but beyond their immediate economic needs and necessities. Besides digitisation, sustainable supply chain management has received growing consideration. It has become a reference topic of discourse within and without the academic milieu, especially in sub-Saharan Africa. For some countries in sub-Saharan Africa, the

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relevance of a sustainable supply chain is engendered by the three pillars of economic, societal and environmental benefits inherent in the supply chain ecosystem. A sustainable supply ecosystem should aim to drive value-added and transformation across the networks that bespeak what leaders and enterprise responsibly stand for, and what societal exigencies require for a sustainable global supply chain.

In this twenty-first century, as the sub-Saharan African continent makes advancement amidst rapid innovation and digitisation with a tandem growth of markets, environmental impact, the relationships with suppliers in the various value chains and customers are evolving with growing expectations for countries in sub-Saharan Africa. The intricacies inherent in the traditional supply chain management concept have shifted focus from the sole economic dimension to overall sustainability. This evolving trend has led to the reconfiguration of traditional supply chain management processes that has begotten current production and consumption patterns. Hitherto, this paradigm shift has exemplified a value-added approach towards organising a sustainable value chain ecosystem in which resource inputs and wastages, emissions and energy leakages are minimised by slowing, closing and narrowing material and energy flows. Here lies the conundrum emerging globally as an organising principle that may subsume the tenets of a sustainable supply chain involving multiple economic, political and social stakeholders who can muster their effort to preserve the earth from the brink of environmental catastrophe. To this end, businesses and governments in sub-Saharan Africa are striving to design and produce products geared towards transforming customers' lives, providing employees with a healthy and enriching workplace and preserving the future for future generations. Like other developing and developed climes, sub-Saharan Africa has its share of this struggle among governments, organisations and multinationals operating in this continent amidst its growing population. To this end, this chapter's discourse will focus on the nature and characteristics of the traditional supply chain model, emerging sustainable supply chain focused on global warming, barriers inhibiting sustainable supply chain practices, environmental safety issues and societal concerns among consumers; what strategies organisations and governments in sub-Saharan Africa should adopt to enhance green operations practices; emergent opportunities organisations can leverage to access clean energy, amidst competing demand for issues of environmental degradation and increasing incidents of insecurity across the African continent.

Introduction

The green supply chain has evolved; it has continued to evolve, and it will continue to evolve regarding its impact on the global ecosystem and the environment. Supply chain management has metamorphosed in its essence by leveraging lean supply chain and digitisation; its extent of sustainable impact on the environment holds the key to the emerging imperatives that would sustain the future. For the developed countries, the emergence of the green supply chain is already having its impacts in several ways; while for the developing countries, especially in sub-Saharan Africa, there is a yawning gap to be closed: this gap entails, to a large extent, its immediate impact on the environment emanating from operational activities of organisations and governments existing in sub-Saharan Africa.

Nature and Characteristics of the Traditional Supply Chain Model in Sub-Saharan Africa

The traditional supply chain is a one-way logistics operation that converts raw materials to finished goods through manufacturing then delivers to customers; this model has, hitherto, existed in Africa, with some modifications in tandem with local vagaries. However, in some sub-Saharan African countries such as Nigeria and Kenya, the last mile logistics as a critical part of the traditional supply chain is evolving in most organisational value chains (FIA Foundation, 2020). The emergence of the last-mile logistics has helped cushion the inherent challenges arising from a robust infrastructural framework deficit in some sub-Saharan African countries. Thus, some of these organisations in the supply chain framework have had recourse to the local initiative as presented by the last mile to resolve the inherent challenges in moving from the traditional supply chain to the sustainable supply chain management architecture.

The traditional supply chain process optimises the purchase of raw materials from suppliers, engages in manufacturing, transforming the raw material into finished goods and then distributing to consumers (Beamon, 1999). The general strategy of traditional supply chain management is to align end-to-end business processes with market demand to create a competitive advantage over rivals (Taghikhah et al., 2019) and generate economic returns. Operational excellence in traditional supply chain focuses on the total cost reduction of supply chain operation, time

management in gaining operational efficiency, shortened delivery time of orders, enhance customer services, upgrade the quality of products, product customisation, supply chain resilience, increased total income and elimination of asset exposure to risk (Goetschalcks & Fleischmann, 2008). And the development of new technologies, highly automated systems and high-speed communication routes are geared towards ensuring these objectives are achieved (Christopher, 2016; Taghikhah et al., 2019). The economic implication and the control of finished products have usually been the traditional supply chain; the ecological or environmental impact is hardly considered (Deshmukh & Vasudevan, 2014; Taghikhah et al., 2019). The high waste generation and the inefficient use of natural resources in the orthodox supply chain design necessitate the need for a sustainable supply chain model that finds a synergy between industrial productivity and environmental protection (Deshmukh & Vasudevan, 2014). Figure 6.1 explains the structure of the traditional supply chain.

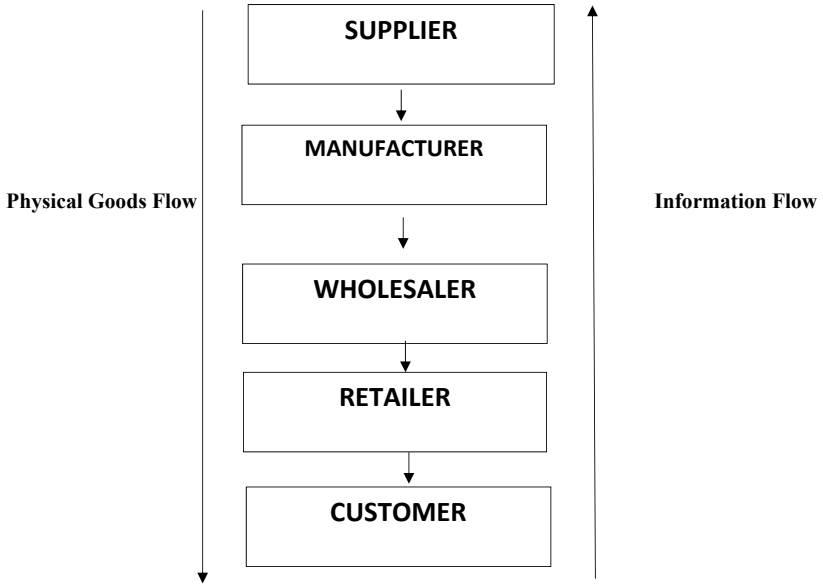

Fig. 6.1 Traditional Supply Chain Structure (Deshmukh & Vasudevan, 2014)

Environmental Safety and Societal Impact Among Consumers

Severe destructive changes around the world such as depletion of natural resources, damage to the ozone layer, loss of agricultural land, environmental pollution, global warming and decrease in biological diversity lead to deterioration in the ecological balance (Çankaya & Sezen, 2019; Tina et al., 1997); these incidents which have plagued the environment in recent times are primarily a result of productive and industrial activities. Taghikhah et al. (2019) posit that today's growing economy presents two critical factors that have accelerated the environmental deterioration worldwide; overconsumption and overproduction. Consumers and producers have contributed considerably to the socio-environmental crises due to their unsustainable consumption and production patterns based on conventional resource depleting ways of doing things (Taghikhah et al., 2019). Although increased media coverage attributed to the issues of environmental degradation caused by the impact of unsustainable manufacturing and consumption practices has led to an increase in the number of consumers actively seeking out and adopting energy-efficient products. But in reality, only a few consumers are making a conscious effort at green purchases. Efforts have been made to alleviate unsustainable production through technological solutions, such as developing alternative fuels. And it appears to have remarkable gains in conserving resources and reducing pollution. But unsustainable consumption patterns and consumers' lifestyle choices have to be changed if this solution is holistic (Taghikhah et al., 2019; Tina et al., 1997). Adopting environmentally sound behaviours by the consumer cannot be overemphasised in achieving a green supply chain. Behaviours include reliance on public transportation, household waste recycling, using recyclable or reusable packaging, consuming environmentally safe products like items manufactured with postconsumer plastics or paper, installing energy-efficient light bulbs and investing in detergents with constituents that are biodegradable, non-polluting and not containing synthetic perfumes or dyes. Such sustainable consumption choices can empower consumers to take steps to prevent further environmental damage and facilitate the long-term goal of protecting and preserving our natural habitat (Tina et al., 1997).

Emerging Sustainable Supply Chain with Increased Concern for Global Warming

The emergent aspects of sustainable supply chain management have witnessed rapid growth for at least twenty years; however, it was not until the last decade that this evolution of supply chain did attract relevance (Fahimnia et al., 2015). Accordingly, many organisations in sub-Saharan Africa within the supply chain ecosystems are beginning to develop operational archetypes for being carbon–neutral, zero-waste and energy-efficient to reduce the harmful impact on the environment and global planet. Increasingly, organisations have leveraged on green initiatives and innovations towards having recourse to a reduction of emissions, wastes and energy consumption as an alternate means of building a safer planet; these attempts of organisations have been fraught with the challenges of identifying economic and environmental metrics hinged on world-class supply chain performance (Fahimnia et al., 2015).

Recently, environmental impact has been accorded prominence regarding the three pillars of sustainability relating to economy, society and environment as a significant hinge of sustainable supply chain management (Piya et al., 2020). According to this school of thought, carbon emission as a consequence of industrial production and market consumption inherent in most value chains is, to a large extent, responsible for global warming; this situation warrants the need for organisations and governments to undertake holistic measures aimed at combating climate change in a bid to attain a sustainable, low-carbon environment. Amongst other global imperatives, ensuing operational demands not only the adoption of greener manufacturing practices for internal concerns as per reduced carbon footprint (CFP) but external value chain inherent in the supply ecosystems (Piya et al., 2020). The implication of climate change acceleration and increased global warming leads to disruption of the ecosystem and natural disasters witnessed globally. However, the search for a best practice geared towards managing this supply chain imbalance vis-à-vis disruption has become a change impetus (Fahimnia et al., 2015). This school of thought posits that there is a need for organisations in sub-Saharan Africa to build operational resilience into their supply chain architecture.

Globally, in most operating terrains in sub-Saharan Africa, there is an emergent need for a realistic supply chain greening imperative that

requires a paradigm shift beyond a static stance towards a dynamic evaluation based on a supply chain greening with an operational configuration of multiple systemic states. This emergent situation requires a balance between amplifying sustainability that elicits a balance vis-à-vis resilience that addresses a global imbalance. From both global and regional perspectives, organisations operating in sub-Saharan Africa need to balance sustainability and resilience towards achieving a sustainable platform that would spawn a dynamic imperative where supply chain be leveraged for multiple systemic variables and stakeholders, especially for developing countries in sub-Saharan Africa.

Barriers to Sustainable Supply Chain Practices in Sub-Saharan Africa

There are two primary reasons why the subject of sustainability in supply chain management has garnered increased corporate attention in recent times (Sajjad et al., 2015). The first reason stems from the firm's need to achieve competitive advantage through cost reduction, operational efficiency improvements and upholding a good reputation. Firms competitive advantage in recent times has gone beyond corporate practices of organisations and actions they take within their premises to include how well sustainability is enhanced through a well-managed partnership with other stakeholders in the supply chain (Sajjad et al., 2015). The second reason has been for the sake of societal legitimacy; businesses are taking deliberate steps in responding to stakeholders growing interests and concerns in terms of the triple-bottom-line of environmental, social and economic (Amaeshi et al., 2008; Sajjad et al., 2015). The changing landscape necessitates a change of approach to supply chain management to take sustainability more seriously than ever before. Corporate firms in diverse service industries have announced initiatives to go green in products sold or production processes (Tay et al., 2015). Despite the commitment of managers to invest in sustainable initiatives, there are militating constraints that prevent its success. There have been considerations on the conflict and reactions of diverse stakeholders, including employees, customers, suppliers, governmental agencies and regulators and other stakeholders, in supporting green initiatives. Stakeholders' management policies like high return on investments, high-quality products and prolonged profitability discourage the investment in green

initiatives (Tay et al., 2015). These competing objectives create a barrier to sustainable supply chain practice.

There are barriers to operating a sustainable supply chain; these barriers are either internal or external. The internal barriers related to constraints such as financial constraints, lack of knowledge and awareness and inadequate top management support (Ageron et al. 2012; Giunipero et al., 2012; Sajjad et al., 2015). While external barriers are forces coming from outside the firm's environment that hinders corporate ability to undertake sustainable supply chain practices, they include lack of performance measures for a sustainable supply chain, insufficient consumer demand for sustainable products and services and lack of support from government (Sajjad et al., 2015; Seuring & Müller, 2008; Walker et al., 2008).

Internal Barriers

These are factors stemming from within an organisation hindering their ability to embrace sustainable supply chain practices:

1. ***The support and commitment of management***
   This is pivotal to introducing a sustainable supply chain management strategy in a company. The conflicting priorities of the green supply chain, such as high return on investments, high-quality products and prolonged profitability, influence leadership's commitment to sustainable supply chain strategy. Lack of a supportive corporate structure and process, and a commitment to management sustainability, will limit the sustainability initiatives that will emerge from such organisations. Investments in green industries are capital intensive, and prices for green products are very high, leaving both leadership and customers discouraged from taking sustainable options. The trend has been a significant bottleneck emanating from most governments and institutions in sub-Saharan Africa; even with the increasing global concerns, most leadership frameworks in sub-Saharan Africa are yet to adopt sustainable green supply chain management practices.
2. ***Financial constraints***
   The cost associated with implementing a sustainable supply chain management strategy is quite huge. The developing cost of infrastructure, processes and systems for the supply chain increases operations cost, which is relatively higher when compared to traditional

supply chain cost. Due to financial constraints, companies find it challenging to practice a sustainable supply chain. According to a study in the UK public sector, a leading barrier to sustainable procurement practices is financial constraint (Walker & Brammer, 2009). Traditional supply chain strategy, fundamentally entrenched in the short-term and with poor environmental attributes, is an obstacle to sustainable supply chain practices. A conventional strategy with lower upfront cost encourages the purchase of cheaper products with lower efficiency. With the issues of corruption and inept bureaucratic reforms that are yet to be addressed by most African governments, little or no financial support has apportioned to emerging problems occasioned by a lack of sustainable supply chain management practices.

3. ***Lack of knowledge and awareness***
   Lack of training and understanding of supply chain players on green supply chain practices can be a barrier to sustainable supply chain strategy. The infrastructure, systems and processes of the traditional supply chain model are different from a sustainable supply chain. And there is a superior level of expertise required to operate a green initiative model. While the traditional model utilises forward logistics, the green supply chain leverages reversed logistics. The absence of necessary knowledge skills within several organisations and the cost of specialised sourcing skills discourage managers from implementing the green supply chain. While most terrains in sub-Saharan Africa are endowed with rich natural resources that will have adapted to sustainable supply chain practices feasible, a large population of sub-Saharan Africa is evident of the dire consequences of the non-adaptation of sustainable supply chain management practices. However, some multinational organisations operating in these parts of Africa have started fostering some level of awareness both in the operational architecture and value chains.
4. ***Unclear organisational objectives and culture***
   The objectives of organisations are sometimes unclear; thus, there is every tendency to compromise sustainability. Sustainability should be ingrained in the corporate philosophy of the organisation; it should go beyond a process or product to a culture that drives the organisation to authenticity. Organisations whose focus on sustainability is only on process and products are likely to permit unstainable practices in other functional areas of their operations.

This is a barrier to fully implementing the green initiative, especially for small and medium enterprises in sub-Saharan Africa.

5. ***Resistance to change***
   Resistance to change is a significant barrier to operating a green supply chain. When an organisation is averse to innovation, introducing sustainability practices will come with uncomfortable and disruptive changes, which necessitate learning new skills and adopting new ways of doing things. Organisations' resistance to change poses a barrier and makes it impossible to shift to sustainability. In some countries in sub-Saharan Africa, there has been subtle resistance to adopting sustainable supply chain management either by default or lack of political will on the governmental and non-governmental infrastructure in most instances.

External Barriers

Similar to what is obtainable in developed clime, sub-Saharan African countries have had to cope with external vagaries that external factors have imposed; these factors have hitherto created obstacles to the implementation of sustainable supply chain strategy externally to the operations of most organisations:

1. ***Lack of government support***
   Wittstruck and Teuteberg (2012) posit that environmental regulations enable sustainable supply chain adoption. However, costly and rigid environmental regulations limit companies' ability to be environmentally proactive. When organisations are forced to meet stringent regulatory constraints, their capability is reduced to develop innovative technologies and solutions that enhance environmental performance.
2. ***Lack of sustainable supply chain performance measures***
   It has always been a daunting task measuring performance across the functional areas of the supply chain, cutting across the supply, manufacturing, distribution and retailing. Some challenges managers face in deploying consistent performance evaluation tools and systems across the supply chain that have impeded the adoption of sustainable supply chain strategy include insufficient understanding of geography and cultural differences, performance measures that are

not generally acceptable, and different priorities, goals and objectives of supply chain members (Brewer & Speh, 2001; Hervani et al., 2005).

3. ***Weak or low demand for sustainable products and services***
   The premium price charged by companies for selling differentiated sustainable products or services to their customers eventually discourage demand for products differentiated based on sustainability. Although, some scholars argue that no price premium is placed on organic produce and therefore sustainable (Doonan et al., 2005), customers' demand for sustainable products and services is relatively minimal (Seuring & Müller, 2008). Sustainable products and services incorporate huge upfront costs in their production, resulting in higher selling prices.
4. ***Lack of effective collaboration and integration among supply chain players***
   The challenge of getting trained suppliers and manufacturers who ensure sustainable products are made in sustainable ways onboard affects the decision to switch to sustainably sourced and manufactured wares. And also, due to the different priorities and objectives, effective collaboration and integration become very difficult to achieve. The challenge has always been how to ensure that your suppliers' and manufacturers' sense of responsibility and sustainability align with your own.
5. ***Poor communication and information technology***
   Given the sustainable supply chain structure, communication and information technology can close the gap of information flow from one player to the order in real-time. Still, the absence of an effective ICT tool can be very detrimental as the communication flow becomes fragmented. Functional players within the chain are left to operate in silos, making it difficult to measure the sustainability within the chain. This situation becomes a bottleneck as value creation is required within the value chain.

Environmental Safety and Societal Impact Among Consumers

Adopting Green initiatives is one of the issues confronting organisations in recent times. Others include lean production processes, globalisation and so on (Mollenkopf et al., 2010). The changing society is constantly

placing expectations on organisations to operate responsibly. The public's increasing concern on the overall condition of the environment in recent times has been on the impact of manufacturing and production operations, perceived as enemies to environmental protection (Beamon, 1999). Severe harm is caused to the environment due to unsustainable processes of traditional manufacturing and production. Unsustainable practices in manufacturing and production limit the earth's ability to compensate and recover what is used. Aside from waste generation, disruptive ecosystem activities and exhaustion of natural resources also affect the earth (Beamon, 1999; Fiksel, 1996). The shift towards sustainability in production and manufacturing systems are vital given the current trends of environmental degradation in the process and the increasing emphasis on green-focused practices. Green initiatives are geared towards reducing emissions that pose hazards to the environment, getting rid of the consumption of wasteful resources, recycling and health risks minimisation and environmental footprint throughout the entire product life cycle (Marhani et al., 2013). Beamon (1999) posits that the first step towards achieving this will be to extend the structure of the current traditional one-way supply chain to a closed-loop that combines both the traditional supply chain (forward logistics) with reverse logistics, incorporating environmental concerns about reduced waste and resources. The extended supply chain will entail designing a supply chain operation for end-of-life product and packaging recovery and for recycling or reuse (Beamon, 1999; Deshmukh & Vasudevan, 2014). Extending the supply chain presents a more environmentally sustainable option in supply chain management and creates a balance between economic and environmental performance. It essentially considers all environmental effects of products and processes within the supply chain known as product and process stewardship. According to Lamming and Hampson (1996), the concept of product and process stewardship is a situation where the environmental effects of production and manufacturing process and the environmental impact of goods from the point of raw materials extraction, to its use by consumers down to the final disposal of those goods are recognised and managed by organisations.

Adopting an extended supply chain (reversed logistics) will introduce green management practices. This is a process whereby after the product is allowed to go through its traditional life cycle, the used product is retrieved from customers and subjected to further processes, those components that are still fit for reuse are directly sent to the retailer, but

those components that are not useful are passed on to be dismantled. In the process of final dismantling, parts that are still useful are sent for remanufacturing, and parts that are not considered beneficial are disposed of or recycled to constitute raw material for manufacturing an entirely new product (Deshmukh & Vasudevan, 2014). In the green supply chain, process materials are efficiently utilised, waste is prevented and environmental impacts are reduced. The Extended supply chain processes are explained in Fig. 6.2.

Green manufacturing processes have their roots in environmental management and supply chain management. The influence and relationships between supply chain management and the natural environment are managed adequately. It is a practice designed to reduce the environmental footprint and minimises health risks, prevent pollution, reduce toxic substances from the background throughout the entire product life cycle (Dües et al., 2013; Womack & Jones, 1997). Green manufacturing processes include the following stages: product design to material sourcing and selection, manufacturing processes down to product delivery and end-of-life management of the product (Çankaya & Sezen, 2019). The need to make many organisations adopt the green supply chain management practices in their businesses reveals environmental sustainability.

Several organisations realise the value of adopting green supply chain management practices to their business operations and relationships with suppliers and consumers. Deshmukh and Vasudevan (2014) proposed that green supply chain management has emerged as a new systematic environmental model in supply chain management with elements like environmental management systems, eco-design, product stewardship, industrial ecology, extended producer responsibility and life-cycle evaluation. The evolving initiatives would add value to the green supply chain community and help curate the emerging imperatives in the green supply chain ecosystem.

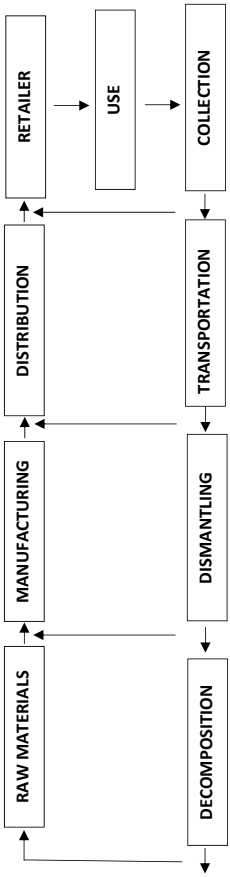

Fig. 6.2 Redefined Basic Structure of Traditional Supply Chain (Deshmukh & Vasudevan, 2014)

How Organisations, SMEs and Governments in Sub-Saharan Africa Can Adopt Sustainable Supply Chain Strategies

Opportunities abound in myriad ways for organisations, SMEs and governments in sub-Saharan Africa adapt sustainable supply chain strategies. This evolving trend has been succinctly demonstrated in some sub-Saharan African countries such as Kenya. Like most developing countries in sub-Saharan Africa, Kenya has contended with substantial environmental issues inherent as part of its supply chains, mainly due to the incidents of needs for disposal of end-of-life products for international organisations and developed countries (Bilala & Odari, 2018). However, this situation is exacerbated by the infrastructural gaps to mitigate the impacts of such an environmental conundrum. Despite these emergent challenges as occasioned by Kenya's supply chain architecture, the manufacturing sector that forms a component of its supply value chain constitutes a significant contributor to its gross domestic product due to the vital presence of solid manufacturing firms (Bilala & Odari, 2018). Accordingly, as part of the supply chain, the Kenyan manufacturing sector includes formal and informal firms that constitute agro-industry, textiles, pharmaceuticals, construction firms, cement and metals and furniture. Despite the impact of these aspects of the manufacturing component of the Kenyan supply value chain, it has struggled to remain globally competitive by managing and sustaining its environmental and natural resource base via the use of deliberate green mitigation strategies and policy, both at local and global spheres.

The development of green supply has yet to impact the Nigerian supply chain ecosystem significantly. Like other developing economies in sub-Saharan Africa, Nigeria has benefited from the influence of environmental regulatory bodies and budding pro-green agencies marginally; however, this impact has resulted from the supply chain operations of some multinational organisations, mainly in manufacturing and telecommunications, and real estate. On the flip side, governments at different levels have ample opportunities, yet untapped, regarding the deployment of the green supply chain in driving value to their stakeholders. Albeit, some foreign corporations operating in Nigeria, among other developing countries, have leveraged on their dynamic capabilities in improving the environment via the adoption and adaptation of green supply chain management (GSCM) practices and collaboration with governments and

domestic firms in reducing environment footprint (Asif et al., 2020). The adoption of GSCM practices has not benefited developing countries from reducing carbon footprint; it has also elicited eco-friendly practices encompassing eco-design, green purchasing, green manufacturing and reverse logistics.

Comparatively, while the adoption and adaptation of GSCM practices in Nigeria and Kenya have been mainly influenced by the imperatives of organisations in the private sectors, and to some extent, at government levels, the evolution of GSCM in South Africa has its different peculiarities (Asif et al., 2020). These aspects of GSCM imply that its essence is hinged on other purposes to curb the negative impact on the environment.

Greener Manufacturing Practices for Reduced Carbon Footprint, Opportunities to Tap into Clean Energy

As composite aspects of green supply chain management, greener manufacturing practices do beget reduced carbon and tandem opportunities to elicit clean energy for both value chains and related uses. This situation has occasioned increasing marketing demands from the supply chain communities for eco-friendly products and services that have a negligible environmental impact within their operational ecosystem; the aftermath of this is needed for players in the various supply value streams to modify their operations in alignment with customers' demand (Green et al., 2019). In line with this school of thought, Green et al. (2019) submit that it has been empirically proven that green supply chain management drives both environmental and organisational performances better than traditional supply chain management because the green supply chain architecture adds some benefits to the supply chain ecosystem; these benefits include lean manufacturing processes, just-in-time inventory management processes, total quality management and less greenhouse gas emission to the immediate host communities. In addition to these tandem implications, the following benefits are experienced within the green supply chain management and community:

Eco-design: Eco-design was a concept developed at the Rio Earth Summit in 1992 by the World Business Council for Sustainable Development (WBCSD) and has emerged as a critical approach for manufacturing

firms seeking to become environmentally sustainable and globally competitive (Ochieng, 2019). In eco-design special considerations are given to the environmental impacts during its design process, from the raw material extraction to the production, packaging, distribution, use, recovery and recycling (Deshmukh & Vasudevan, 2014). They are proactive steps to ensure that eco-efficient products and processes are maintained throughout the product life cycle. For a comprehensive assessment of the product life cycle, the eco-design is divided into;

- *Design for procurement and use of raw materials*: In this design, materials with low impacts, non-hazardous, non-exhaustible materials, materials having low energy content, recycled and recyclable materials, material reduction, weight reduction and reduction in the volume are selected and procured for production (Deshmukh & Vasudevan, 2014; Ochieng, 2019).
- *Design for manufacture*: This involves utilising eco-friendly processes in the organisation's production techniques, productivity is optimised, alternative production techniques are deployed, low/clean energy usage, minimal waste is generated, production processes are fewer with sterile consumables produced (Deshmukh & Vasudevan, 2014; Ochieng, 2019).
- *Design for distribution*: The distribution process is designed to be eco-efficient, ensuring that the product is transported safely from the factory to the retailer and finally to the consumer. The eco-design distribution system will involve adopting the proper transport mode, less/clean packaging and an efficient logistics system (Deshmukh & Vasudevan, 2014; Ochieng, 2019).
- *Design for product use*: In this design phase, the objective is to ensure that the products are used in an eco-friendly manner and pose no threat to the environment. What is most critical during the product use stage is energy and waste. Organisations ensure products are designed with the lowest energy consuming components that release minimal waste to the environment. The product use phase includes environmental impact reduction, low energy consumption, few/clean consumables usages, ensuring clean energy source and no energy/auxiliary material use (Deshmukh & Vasudevan, 2014; Ochieng, 2019).
- *Design for end-of-life or disposal*: The product's end-of-life process design refers to what happens after its initial product life-cycle.

> This eco-design phase ensures the reuse of valuable product components and adequate waste management. Optimising the end-of-life systems, reusing products, recycling material and cleaning incineration is the end-of-life design process (Deshmukh & Vasudevan, 2014; Ochieng, 2019).

The eco-design process empowers organisations to understand and take responsibility in utilising eco-efficient processes in creating products and services to reduce environmental impact and maintain a coherent ecological footprint as it is becoming crucial to building new solutions that are environmentally friendly and lead to minimal consumption of materials and energy (Deshmukh & Vasudevan, 2014).

Industrial Ecology: Industrial ecology is an environmental concept developed by researchers to improve environmental management. Industrial ecology attempts to induce balance and synergy between the industrial processes and environmental sustainability, such that none compromise the other (El-Haggar, 2010). Solving environmental issues while maintaining economic growth is the purpose of industrial ecology. The concept tries to simulate the natural ecosystem cycle in the industrial system. For instance, in the natural ecosystem, the energy taken from the sunlight and deposits of nutrients from the soil supports the growth of plants. Still, the plants, in turn, become food for the herbivore, which ultimately becomes the food for a carnivore. Bacteria and other organisms take up nutrients from all dead matter and produce molecules to feed new lives (Omar & El-Haggar, 2017). The global industrial economy has a similitude with the natural ecosystem cycle; they can be modelled as a highly connected network of industrial processes that begins from resource extraction from the earth and the transformation of those resources into commodities, which are bought or sold to meet the needs of humanity (Deshmukh & Vasudevan, 2014). Industrial symbiosis dealing with material and energy exchange is a branch of industrial ecology.

Environmental Management System (EMS): The comprehensive, planned, systematic and documented organisational environmental programme management is the Environmental Management System (EMS). Environmental protection is considered vital in the EMS process and therefore includes the organisational structure, planning and

resources for developing, implementing and maintaining policy for environmental protection (Deshmukh & Vasudevan, 2014). EMS creates a framework for the procedures, responsibilities and processes required to prevent adverse ecological, social and economic impacts and continuous improvement (Jain, 2015). Several processes are blended in the environmental management system, training personnel and procedures, summarisation, monitoring and reporting of specialised environmental performance information to external and internal stakeholders of the firm are adequately integrated. EMS is typically reported using the International Organisation of Standards (ISO) 14,001 to help understand the EMS processes (Deshmukh & Vasudevan, 2014).

Extended Producer Responsibility (EPR): It is also called product stewardship, a strategy by organisations to place collective responsibility on all players involved in the supply chain throughout product life-cycle management (Deshmukh & Vasudevan, 2014). This shared responsibility ensures that sustainability is provided across the entire value chain. Extended producer responsibility aims to decrease the total environmental impact of packaging, transportation and consumption. The EPR, by ensuring that the producers take responsibility for the entire lifecycle of their products, also manages the retrieval of used products, recycling and final disposal of the products, including their packaging (Nnorom & Odeyingbo, 2020).

According to Lindhqvist (2000), production processes in one of two directions are influenced by EPR, either upstream or downstream; for downstream procedures, responsibilities are shifted to downstream involving different actors in the collection, recycling and treatment processes; while for upstream approaches, incentives are provided to producers to incorporate environmental considerations in the design of their products. For instance, in cleaner production or design for recycling, the brand owner or producer makes marketing and design decisions along with the disposal cost integrated into the product's overall price (Deshmukh & Vasudevan, 2014).

Life-cycle Analysis (LCA): A technique that assesses the environmental impacts across all stages of a product's life cycle is called Life-cycle analysis (LCA). This process assesses impacts from raw material processing to manufacturing, distribution, use, maintenance, repair down to recycling (Deshmukh & Vasudevan, 2014; Itskos et al., 2016). LCAs can help organisations avoid a narrow outlook on environmental

concerns by inventorying relevant energy and material inputs & ecological releases. The Life-cycle analysis is done by assessing the potential impacts connected to identified inputs/releases and interpreting the results to enable organisations to make more informed decisions (Deshmukh & Vasudevan, 2014). This is a systematic multi-phased process that consists of four components: Goal definition/scope, Inventory analysis, Impact assessment and Interpretation;

- *Goal and scope definition*: The definition of the goal and scope of the LCA document details the objectives of the study, the functional unit, the boundaries of the system of study, the adequate data needed, the assumptions to be drawn and the limits that must be defined. At this point, the context in which the assessment is to be made is established, the boundaries and environmental effects to be reviewed are identified (Brusseau, 2019; Deshmukh & Vasudevan, 2014).
- *Inventory analysis*: In the inventory analysis, the energy, water/materials usage and environmental releases (e.g., gaseous emissions, solid waste disposal, water waste discharges) are identified and quantified. This step essentially involves the adequate study of the working systems and the analysis of the material and energy flows (Brusseau, 2019; Deshmukh & Vasudevan, 2014).
- *Impact assessment*: Impact assessment assesses the environmental detriments of energy, water/materials usage and environmental releases from a product. This phase in the LCA primarily assesses the potential human and ecological effects of items identified in the inventory analysis. The potential impacts of the recognised resources used and environmental emissions are evaluated. The methods used in this phase can be divided into two categories; Upstream and Downstream methods. While upstream processes focus on the number of resources, energy and materials used per unit of product, Downstream methods attempt to estimate the general emissions of the system (Brusseau, 2019; Deshmukh & Vasudevan, 2014).
- *Interpretation*: This is concerned with the result interpretation of the entire LCA process; results obtained from the inventory analysis and impact assessment are interpreted to determine the selection of the preferred product, process or service with a clear understanding of the uncertainty and the assumptions utilised to generate the results.

The analyst aim in this phase is to scrutinise the results and discuss them appropriately, giving as much precise information as possible to the decision.

Issues of Environment Degradation and Insecurity

Competing demand regarding the issues of environmental degradation and insecurity in Sub-Saharan Africa is inflicting a toll on most governmental infrastructure in this region. While the issue of ecological degradation used to be at the front burner of most sub-Saharan African countries, growing incidents of insecurity are likely to overwhelm the relevance of GSCM practices. Thus, Silvestre (2015) has suggested a need for regional collaboration among emerging economies towards adopting environmental sustainability imperatives. GSCM collaborations will engender the diligent use of scarce resources along the different value chains in sub-Saharan Africa. This situation will provide an impetus for adapting socially sustainable supply chain practices that will incorporate health and safety for organisational employees, protection against child and enslaved person labour, provision of proper working conditions, support for human rights and sponsoring community-oriented programmes (Mani et al., 2018). Also, there is a need to manage restrictive economic environments and their impacts on suppliers' operations and activities, especially in developing countries (De Morais, 2017; El Baz & Laguir, 2017; Najjar et al., 2017). Poignantly, the causes for the relative lack of progress on social issues in developing countries of sub-Saharan Africa include low awareness, low competition, low customer demand for social justice, low investor pressure, low labour union pressure, little or no government oversight and little or no societal interest in the imperatives of the green supply chain (Mani et al., 2018).

Conclusion and Recommendations

Green supply chain management may have transitioned from the fringe to the mainstream of operational flow; there exists an emergent issue that should warrant a focus on re-evaluating the exigencies emanating from a range of environmental and social problems (Mani et al., 2018; Piya et al., 2020). Despite the drive-by GSCM practitioners in some sub-Saharan African countries to foster the implementation of sustainable supply chain management practices (Piya et al., 2020; Silvestre, 2015), there is a need

to unravel the unique intricacies that would aid the implementation and adoption of successful and viral sustainable supply chains with context-specific circumstances, especially from the perspective of governance systems. Amidst growing pressure from governments, customers and environmental agencies on business organisations to reduce their impacts on the global environment and drive significant sustainable improvements (Bag et al., 2020). The lack of developmental infrastructure has necessitated this situation, low level of awareness, political instability and low purchasing power that most African countries have been saddled with, which have constituted barriers to the adoption and adaptation of sustainable supply chain practices (Eifert et al., 2005; Hain & Jurowetzki, 2018; Ikejiaku & Mordi, 2010).

According to Bag et al. (2020) and Asif et al. (2020), the following measures can be deployed globally and with particular reference to sub-Saharan Africa:

1. Leverage synergies of the digital and green supply chain to reduce the impact of GSCM on the environment. Some of these initiatives may need the support of the international organisation to provide inputs for the leaders in these countries.
2. Develop the capabilities of suppliers and customers in the GSCM ecosystem: This aspect will require the expertise of the suppliers' capabilities and other major players in the supply chain ecosystems.
3. Explore the possibilities of an intelligent GSCM strategy to reduce greenhouse emissions and attendant environmental impact. This might require the support of governmental institutions in sub-Sahara Africa towards providing an enabling environment that would foster new green initiatives as critical aspects of a sustainable supply chain architecture.
4. Develop GSCM capability of managers in sub-Saharan Africa to drive more value with less waste on the environment. An essential aspect of an evolving sustainable supply chain is the behavioural impact on its outcomes; this is fundamental for green decision matrix and sustainable supply chain leadership.

Points to Ponder

- What could be the positive and negative effects of sustainable supply chain practices in African organisations?
- Which would be the best adoption strategies for a sustainable supply chain and how would one harness its opportunities?
- What strategies should organisations and governments in sub-Saharan Africa adopt to elicit green operations practices in their supply chain architectures amidst global demand for environmental sustainability?
- How can organisations in sub-Saharan Africa transform their traditional supply chain process to a more sustainable supply chain?
- Given the demand for environmental sustainability, how can green supply chain process support organisations' need for clean energy?

Actionable Recommendations

Private leadership	*Public leadership*
Expand the share of green financing for private institutional frameworks.	Explore initiatives to overcome internal and external barriers towards adopting green supply chain practices.
Foster a collaborative initiative among private ventures in adapting eco-design and eco-efficient processes in respective value chains.	Develop the capabilities of suppliers and customers in the GSCM ecosystem towards exploring and imbibing the possibilities of an intelligent GSCM strategy to reduce greenhouse emissions.
Align with public leadership in adopting and designing industrial ecology and environmentally sustainable imperatives.	Create an enabling environment towards fostering Environment, Social and Governance (ESG) within and without the GSCM ecosystem.

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