The roles of green supply chain practices on supply chain resilience, environmental performance, and sustainability :( Evidence from textile companies in Ethiopia)

BY

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**Abstract**

The study aims to investigate the roles of green supply chain management practices in environmental performance, supply chain resilience, and sustainability issues. The impacting levels and burdens of traditional supply practices in production, distribution, and processed consumption on performance and sustainable developments have been investigated. The comparisons of traditional supply chains with green supply chain management practices on agility, sustainability (economic, social, and environmental), and impacts on environmental performances were studied. The results show that green supply chain management practices have the highest and most significant positive impact on environmental performance and sustainability, which then indirectly leads to improved income generation and environmental performance. Also, there is the highest significant positive relationship with supply chain resilience in terms of improving agility, flexibility, and business improvements as a whole. Periodization and ranking of the possible indicators of environmental performance, firm sustainability, and green supply chain practices were done. Also, the findings indicate that research related to green supply chain strategy and sustainability issues has not been widely disseminated or popularized in the developing nation scenario. It further reveals that textile industries predominantly operate based on traditional supply chain practices rather than actively embracing the concepts and principles of green and circular supply chain strategies. Both qualitative and quantitative methods have been used to gather data through a survey. Purposive sampling was used, and the study has been analysed using survey data from a sample of seven selected textile industries in Ethiopia. The SPSS tool, correlation analysis, AHP, and descriptive statistics were mainly used for the analysis and exploration of the investigations. These results significantly expand literature inceptions and shed some further spark on the sustainability miracle. The study recommends that supply chain member organizations adopt circularity-based green supply chain strategies as a mechanism for agility, flexibility, supply chain sustainability, and manufacturing performance as a whole.

**Keywords:** Supply Chain Resilience, Textile and Apparel industry, Circular Supply Chain, Green Supply Chain, Sustainability

**Introduction**

Supply chain integration is the strategic integration of intra- and inter-organizational processes that measures the degree to which supply chain partners work together to achieve mutually beneficial outcomes (Dametew and Ebinger, 2016). It is the degree to which an organization strategically collaborates with its partners and manages intra- and inter-organizational processes in order to achieve efficient and effective flows of products, services, information, money, and decisions (Dametew et al., 2019; Abdulah Rakhman, 2016). Enormous research (Rakhman et al., 2016, Hatani et al., 2013, Huo, 2012, Rehme, 2012) was also conducted on the impacts of supply chain strategies on manufacturing industry performance and competitiveness. Effective and efficient supply chain integration provides well-defined flows of products and services, information, money, and decisions in order to provide maximum value to the customer at low cost and high speed (Dametewa, 2019; Flynn et al., 2009). However, a key challenge for companies working in global supply chains is the balance between achieving a competitive advantage and acting sustainably while fulfilling their different stakeholders’ expectations in order to preserve reputation, legitimacy, and credibility (Omai, 2018).

In the case of the traditional supply chain, sustainability issues along the supply chain might lead to a decrease in performance and competitiveness (Dametew et al., 2019; Olze, 2017; Gábriel, 2016; Imam, 2010). Because the traditional supply chain flows along a single path and has been traditionally defined as a one-way, integrated manufacturing process wherein raw materials are converted into final products, then delivered to customers (Dametew et al., 2019; Sarbani Daud, 2019), Due to recent changing environmental requirements affecting manufacturing operations, increasing attention is given to developing environmental management (EM) strategies for the supply chain (Moujan & Akbar Alam, 2017; Dametew, 2015). Sustainable supply chain management (SSCM) is the management of supply chain operations, resources, information, and funds in order to maximize supply chain profitability while at the same time minimizing environmental impacts and maximizing social well-being (Oelze, 2017). With the increasing complexity of the supply chain, it is becoming difficult to monitor environmental regulation to overcome environmental damages. It is critical to the need for continuous change in design; green strategies throw out supply chain segments. Green supply chain management comprises several closed-loop supply chains instead of open-loop supply chains that provide sustainability and green innovation (Dametew et al., 2019; Gábriel, 2016). Green Supply Chain Management (GSM) can affect different companies to different degrees, depending on the company’s nature and situation (Stremlau, 2016).

Green supply chain integration is defined as integrating environmental thinking into supply-chain systems including product design, material, manufacturing processes, warehouse, and delivery of the final product to consumers in order to achieve a greener supply chain and maintain competitive advantage (Mochamad Agung Wibowo, 2018; Gábriel, 2016). According to Cascini (2015), this shows that green supply chain management is an overarching philosophy that includes the pursuit of eco-efficiency for all supply chains as a common overall goal for all involved.

The ultimate goal of green supply chain practices in supply chain segments is to work together to improve their environmental performance and enhance competitive advantage. In current business practices, environmental thinking in supply chain management has found its way to critical issues for business performance and sustainability. (Sarbani Daud, 2019). Sustainability ensures the needs of the present without compromising the ability of future generations to achieve their own expectations.

Supply chain sustainability includes programs of environment, economic development, suitable places from local to global, and institutions of government, continuous civil society, business, and industry to each project their interests, hopes, and aspirations onto the banner of sustainable development (GÁBRIEL, 2016, Robert W. Kates, 2005). On the other hand, sustainable development concepts concern the substitutability of resources and economic growth (GÁBRIEL, 2016; Cascini, 2015). This includes capital: social, natural, and man-made. Also, sustainable development has been elaborated on by different researchers and scholars (Stoddart, 2011, Cerin, 2006, Dernbach, 2003, and Dernbach, 1998). Therefore, the ultimate goal of sustainability is to achieve the long-term stability of economic development, resource utilization, and environmental friendliness through the integration of knowledge, technology, and resource infrastructure throughout the organizational and manufacturing processes.

Besides, sustainable manufacturing is defined as linking systems and processes to generate high-quality services and goods while also being more sustainable in product use and minimizing waste, which leads to environmental degradation (Issam A. R. Moghrabi, 2023). On the other hand, the most significant impacts on the environment, business, and society from the processes companies use in traditional supply chains occur to greater extents (Sarker, 2019; Dametewa et al., 2019). To overcome environmental challenges, supply chain member organizations should engage their business processes within green, clear, and sustainable production and supply chain processes. Thus, supply chain segments, stakeholders, and related companies extend their commitment to responsible business practices by integrating fair working conditions and good environmental practices throughout the supply chain. The best way to ensure the development of sustainable products is to look at a product’s environmental impact throughout its entire life cycle and take action where the environmental pressures are greatest or improved. For this purpose, green supply chain management is a strategy for sustainable development in today’s competitive markets that aims to simultaneously achieve financial benefits and reduce environmental risks (Mochamad Agung Wibowo, 2018). It is not only about environmental legal compliance but also about strategic, continuous environmental and economic improvements in the supply chain. Therefore, the introduction and adoption of green strategies are considered the most efficient and cost-effective way to reduce environmental pressure without compromising economic competitiveness. Thus, it has great importance to look at environmental improvements, social issues, and satiability issues in supply chain practices. Because environmental supply chain management is a key part of a sustainable business strategy. This study aims to investigate the impacts of green supply chain practices on environmental performance, supply chain resilience, and sustainability throughout the business process.

Green supply chain management is an integrative approach to the planning and control of the physical flow (products and services), resource finance, and information between all stakeholders in the supply chain segments (suppliers, producers, distributors, and customers) by integrating environment thinking into supply chain management to optimize all processes in the supply chain (Dametew, 2019; Oma, 2018; Young, 2001). However, globally dispersed and non-integrated supply chain processes, including chemical, metal, apparel, and textile, have been a cause of many of the most insistent environmental impacts, such as climate change, natural resource reduction, and the release of hazardous chemicals (Omai, 2018; Olze, 2017; Gábriel, 2016). As well, most developing nations, including Ethiopia and Kenya, face the challenge of sustainability in raw material supply due to inadequate supply of locally produced raw materials, traditional supply chains, quality problems, and innovation incapability (Omai, 2018; Moujan & Akbar Alam, 2017; Dametew, 2015). These problems include not only sustainability issues but also having a significant impact on the natural environment, infringement on workers’ rights, heavy consumption of energy and water, and stagnating revenues from exports (Omai, 2018). Furthermore, in the existing business process, environmental pollution is the main problem that mankind faces in everyday activities, and the major emission of toxic gases is from the manufacturing industries and traditional supply chain systems (Issam A. R. Moghrabi, 2023; Dametew and Ebinger, 2016). Traditional, fragmental supply chains and the potent combination of industrialization, urban development, and mass consumption trends are exacerbated by foreign companies operating with little regard for the impact on the local environment (Dametew et al., 2019; Onuoha et al., 2016). The issue of sustainable development and environmental pollution has also been present since the beginning of life, but today it is a serious problem that threatens the survival of humanity.

Furthermore, modern societies face growing concern about global environmental issues, and developing countries are experiencing complex, serious, and fast-growing pollution problems of their own (Mochamad Agung Wibowo, 2018). During the traditional supply chain process in the case of manufacturing industries, excessive waste generation is an indication of inefficient production processes, low durability of goods, and unsustainable consumption patterns (Mochamad Agung Wibowo, 2018; Olze, 2017). Particularly in most developing nations, the manufacturing industry, cities, administrative towns, and health centers generate a higher amount of waste, and these are serious challenges and problems facing the implementation of waste management systems and strategies (Omai, 2018; Dametew, 2015; Young, 2001). Likewise, in most African countries, including Ethiopia, fragmented supply chains, poor production practices, and insufficient sustainability concepts result in a higher amount of waste generation through each business process. These results have inadequate, improper handling of generated waste and traditional supply chain processes and cause serious hazards to the environment, health, and economy (Dametew et al., 2019; Dametew, 2015; Imam, 2010). There were research gaps concerned with the sustainable management of supply chains in a developing nation scenario, but due to the universality and complexity of the issue, there are still various research gaps. Thus, it is critical to introduce sustainable and waste minimization strategies and principles through the integration of green supply chain management practices. Because waste minimization is considered to be the highest level to reach in the waste management hierarchy, it achieves environmental, social, and economic benefits by reducing waste and costs at the same time. Therefore, the main purpose of this study is to investigate the impacts of green supply chain management practices on environmental performance, supply chain resilience, and sustainability so as to contribute to the sustainable development agenda of 2030 and improve the global competitiveness of developing firms.

**Literature review**

**Supply Chain Management**

Supply chain management (SCM) has strategic implications for companies. The ultimate purpose of supply chain management includes the emphasis on making the customers’ demands come true effectively, the profitability of the supply chain, and also the secondary objectives of supply chain management, which include creating the ability to develop new products, minimizing the amount of time that a product passes through the supply chain and arrives at the final customer, and moreover, maximizing the supply chain flexibility to respond to changes in customers’ needs (Moujan & Akbar Alam, 2017; Mir & Seyed, Generally, supply chain management, to minimize costs at all levels of the system while supply service requirements are being supported, is a collection of opinions that are used for efficient integration of suppliers, manufacturers, and warehouses in a way that products of suitable size, in a suitable place, and at a suitable time will be produced and distributed.

**Green Supply Chain Management**

Green supply chain management” (GSCM) provides that under sustainable development pressures, organizations have to consider the relationship between the environment and activities of supply, production, distribution, consumption, and disuse (Mochamad Agung Wibowo, 2018).GSCM means that all members of the supply chain are responsible for reducing the unsustainable environmental impacts of supply chain processes to ensure long-term benefits (Gábriel, 2016). Green supply chain encompasses green purchasing, design for environment (DFE), closed-loop supply chain (CLSC) (Cascini, 2015), life cycle assessment (LCA), green manufacturing, waste management, reuse, remanufacturing, refurbishment, and reverse logistics (RL) fall under the main umbrella of GSCM within the supply chain firm (Mochamad Agung Wibowo, 2018) (Cascini, 2015). In business processes, the implementation of laws and regulations (reactive practices) in the implementation of Green Supply Chain Management (GSCM) has enabled companies to improve their performance in terms of environmental, economic, and intangible resources (Dametew et al., 2019; Mohamad Agung Wibowo, 2018; Młody, 2001). In contrast, reverse logistics practices (proactive practices) were characterized by a low level of implementation and had no significant impact on GSCM results (Gábriel, 2016; Cascini, 2015).

**Impacts of GSM**

Traditional supply chains extend from the raw material to the final product that the customer receives. However, environmental problems lead to changing processes through new operations, such as the recovery phase, to minimize the impact on the environment (Hijjawi, 2022). The concept of “green” doesn’t just mean reducing waste and pollution; rather, it strives to create a sustainable industry. The green industry takes into account energy savings, the purchase of materials, the processing, packaging, delivery, and marketing of the product, as well as reuse, recycling, utilization, and the waste cycle. According to Mohamad Agung Wibowo (2018), green product design includes green material management, green production processes, green sales, and green marketing.

**Green Design**: It is an ecological design practice that encourages environmental awareness (Fortes, 2009). The main idea of ecological design was to minimize environmental destructive effects by integrating itself with living processes. Subsequently, green design activities (design for reduced consumption of hazardous materials, for reuse, and for resource efficiency) have great importance for OEMs since they're chargeable for the look of the tip product of the availability chain (Gábriel, 2016). When it comes to supply chain management, green purchasing makes sure that logistics managers are in charge of their environmental effects even when they collaborate with other parties. One method to guarantee that your supply chain is sustainable is to work with vendors who adhere to industry-recognized environmental performance criteria (Hijjawi, 2022; Imam, 2010). Green design emphasizes the ecological equilibrium between man and nature and fully takes environmental effects into consideration to attenuate damage within the whole design process (Moujan & Akbar Alam, 2017; Punit Sanghavi, 2015). The main areas and concerns of green design include products made from recycled or remanufactured materials, products that can be reused and remanufactured, products with environmentally friendly packaging, and finally, products made from organic components.

**Green Purchasing:** It is the practice of an organization's purchasing decisions that are influenced by environmental factors of the materials or goods to be purchased. Comply with the environmental safety standards put in place by the purchasing organization, which include reducing waste sources, promoting recycling, conserving resources, and changing out materials. In terms of purchasing, selecting the correct supplier is crucial to attaining a company's environmental goal, but it is insufficient to enhance environmental performance; more significantly, adopting a strategic and collaborative understanding with suppliers is seen as crucial.

**Green Manufacturing and Green Operations**

Green operations can be defined as those operations or processes that help in reducing or eliminating non-ecological raw materials or data, which in turn help in preserving the ecosystem (Punit Sanghavi, 2015). As well, green operations incorporate the activities connected to all aspects related to product manufacture and remanufacture, usage, handling, logistics, and waste management once the design has been finalized (Cascini, 2015). During the concept of green operation in the automobile industry, green manufacturing and re-manufacturing methods can be implemented. However, green manufacturing can be defined as reducing environmental pressure by using appropriate technology and materials. As well, re-manufacturing is recycling-integrated manufacturing. Recycling can be used to obtain unfinished goods and raw materials that can be re-used to reduce waste tremendously (Cascini, 2015; Punit Sanghavi, 2015). It provides for implementing energy-efficient technologies and practices in manufacturing processes, warehousing, and transportation to reduce carbon emissions. Green packing and considerations of green distribution are also parts of green manufacturing. Green manufacturing practices are important components of GSCM practices that contribute to a firm’s sustainability.

**Green Distributions and Green Logistics**

Transportation movement between a source and a destination is crucial to logistics activities, and the activities involved are substantially to blame for greenhouse gas (GHG) emissions in the environment. This serious flaw in environmentally friendly logistics will be aided by the effects of air pollution and the achievement of transportation economies of scale (Issam A. R. Moghrabi, 2023; Robert W. Kates, 2005). Green logistics are a practice that must be adopted if this is to be successful. In order to ensure that the manufacturing and distribution of goods are done in a more sustainable way by taking into account ecological and societal challenges, green logistics techniques involve the integration of activities necessary for moving items across the supply chain. This reduces the use of resources, energy, and fuel, as well as the rate at which carbon dioxide is released into the environment. **v. Life Cycle Assessment (LCA):** It is the process used to evaluate the environmental impact at every stage of the production of a product or service. A globally accepted method for evaluating how economic activity affects the environment is life cycle analysis (LCA). LCA helps corporate choices as input to building, process, and product design; supply chain, waste management, and pollution research; and labeling of product declarations in education throughout the supply chain process.

Green Practice through Waste Management and Sustainability The traditional environmentally conscious perspective argues that “greening” is good for society (Kevin Watson, 2004). While environmental management systems (EMS) seek to make companies simultaneously more competitive and environmentally responsible, In Europe, there are quite a variety of waste management priorities for the total municipal solid waste stream (MSW), from those heavily weighted towards land fill to those weighted towards incineration. The average amount of MSW generated in Europe is 520 kg per person per year and is projected to increase to 680 kg per person per year by 2020 (European Environment Agency, 2008). In the UK, total usage of plastics, both in households and commercial settings, is up to 40 kg per person per year, although it is only 7-8% by weight but, on the other hand, has a larger volume by proportion in MSW (Waste Watch, 2003). Recycling is a waste management strategy, but it can also be directed toward implementing the concept of industrial ecology, in which there are no wastes but only products in the natural ecosystem (Frosch and Gallopoulos, 1989; McDonough and Braungart, 2002; Imam, 2010). Environmental sustainability practices involved in the supply chain are an attempt to reduce the environmental burden by bringing about collaboration through shared responsibility in order to maintain effective environmental sustainability (Dametew, 2015; Kevin Watson, 2004). Better environmental performance can be achieved by adapting techniques that emphasize waste reduction and redesigning processes and products to reduce environmental impact. This is achieved by adopting and implementing green supply chain management (GSCM) throughout the supply chain segments.

**Supply Chain Performances, Resilience, & Sustainability**

A key challenge of supply chain performance for organizations is the balance between achieving a competitive advantage and substituting sustainably while fulfilling their different stakeholders’ expectations in order to preserve reputation, legitimacy, and credibility. Normal supply chain performances have been measured with various performance indicators, including flexibility, quality, price, innovation, and sustainability issues (Dametew et al., 2019).

Economic, social, and environmental issues constitute operational risk, including inconsistent and poor product quality or supply chain disruptions to the manufacturing company. These results on sustainability issues along the supply chain might lead to a decrease in performance and competitiveness (Oelze, 2017). Environmental sustainability is the ability to maintain natural resources and protect them for future generations. Environmental thinking was applied in supply chain management and the whole process of operations for sustainable development (Sarbani Daud, 2019). However, a common and ambitious definition of sustainable development is “development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Also, supply chain resilience is "the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function. Maintain continuity in the face of unforeseen occurrences to respond to interruptions and recover from them, functioning at the appropriate degree of interconnectedness. A robust supply chain has to build resilience so that it can swiftly revert to its initial form in the case of unanticipated, un-favourable outcomes. This plays an important role in dealing with disruptions in a highly turbulent business environment and has received a fair amount of attention from industry and academia. Green and sustainable supply chain practices have become a striking issue in recent research for enhancing the environment and social wealth. It is critical to consider a tactical and strategic approach to managing sustainability issues throughout supply chain processes.

**Benefits of Green Supply Chain Adaptation**

As a result of environmental challenges, the shortage of natural resources, technological revolutions, and demand-supply uncertainty, the integration of supply chains should take environmental and sustainability issues into account. Green adaptation has a number of competitive advantages, including lower prices, greener products, and better supplier integration. At the GSC national level, it can create markets for green products and improve supplier adoption of environmental issues. Greening the supply chain can help a company's competitiveness by lowering costs. A green supply chain is also important at the national level for the government to achieve international competition in the country's industrial sector (Javaid & Shoeb, 2015). Companies will reap tremendous benefits, according to Zewdu (2019), if they improve their manufacturing activities in addition to their sustainability performance. Financial advantages include lower operating costs, higher revenue, lower administrative costs, lower capital costs, and a higher stock market premium. (Md. Maruf Sarker, 2019, Javaid & Shoeb, 2015) claimed that through the implementation of green sourcing and procurement, green manufacturing, green packaging, green warehousing, green distribution, and green transportation companies can control air pollution, reduce waste, and improve the quality of their products.

**Environmental Performance and Sustainability: Digital Management System as a Mediator**

The traditional approach to operations management evaluates an organization's performance based on four main areas: cost, quality, time, and service. However, the need to introduce environmental protection measures in companies in order to achieve sustainable development has forced a redefinition of the operational function (de Burgos Jiménez, 2001). Digital technologies offer both opportunities and challenges for the sustainable development of manufacturing companies. Digitalization is expected to have significant economic, financial, and social consequences worldwide. The degree of digitalization for the environmental and sustainability performance of developed business organizations is at the highest level (Haq et al., 2023).While modern technological approaches require significant investments to exploit new opportunities and change business practices; companies in developing countries cannot use these methods to gain a competitive advantage in a highly competitive global market. Environmental performance can also be understood as the extent of the ecological impact of economic activities (production and consumption) in a specific period and in a specific economic area (country, region, or company), characterizing it as a flow variable. Environmental performance assesses the performance of national governments based on national governments' performance on specific environmental quality and resource efficiency objectives. However, evidence from environmental and competitive scenarios (Di Xu, 2020) suggests that the management information hypothesis is unlikely to systematically explain the environmental improvements resulting from information disclosure. To close this gap, further empirical research and community engagement with policymakers and stakeholders at the local level are needed.

**Hypotheses Development**

The conceptual framework developed for this study is formulated based on the concepts and strategies investigated in the literature review studies. This framework provides a framework to clarify the leading ideas, the significance of concepts, and the path for the direction of empirical study.Integration of supply chain systems from suppliers, manufacturers, and customers in the form of green purchasing, design, production, distribution, and the reverse supply chain are green supply chain integrations (Young, 2001). In this stage, green and clear supply chain integrations enhance both environmental and economic performance among supply chain partners.

**H1:***Green supply chain management strategies have a positive relationship with environmental performance and sustainability.* The effective and efficient green supply chain practices thought the supply chain segments had the highest positive impact on environmental performance and the overall chain’s performance.

**H2:** *There is a positive relationship between the impacts of supply chain segments responsibility on environmental performance and sustainability.* Organizations seek to improve their supply chain efficiency through increased integration; continuous improvement strategies can be considered a key enabler for green supply chain practices to impact sustainability and environmental performance. The integration of continuous improvement strategies has a great impact on sustainability issues and supply chain performance. Based on this, the flowing concepts have been proposed.

**H3:** *Adoption and application of continuous improvement strategies in the supply chain process have the highest positive impact on environmental performance and sustainability.*

**H4:** *There is a positive and significant relationship between supply chain circularity and environmental performance and sustainability.* Waste management in the supply chain is an essential aspect of operations that has an influence on the environment. It includes pollution, emissions, and community health hazards, among other things. (Imam, 2010) shows that waste management favours reuse and recycling before landfilling, with the idea of an environmentally sustainable society. Organizations are incorporating environmental considerations into their supply chains to minimize the environmental effect and improve performance (Saqib Ali\*, 2022). Performances on environmental and environmental supply chain management are a key part of a sustainable business strategy.

**H5:** There is a mediated *relationship between the implementation of waste management strategies and environmental performance.*

Sustainable development and environmental management depend on human activities. When man tries to satisfy his needs, the environment is well managed, the ecosystem is preserved, and thus sustainable development takes place.

**H6:** *The consideration and application of environmental management in the supply chain process have a positive impact on environmental performance and sustainability.* The challenges of sustainable development require collective efforts not only from the public sector but also from the private sector (people and firms) of society (Arim Park, 2021). Improving supply chain sustainability is an essential part of achieving the Millennium Sustainable Goals.

**H7:** *There is a significant positive relationship between clean and clear waste management and economic, social, and environmental sustainability.* Digitalization and sustainability, when combined, can deliver transformative results and create a sustainable competitive advantage for companies. Sustainability and digital transformation are not stand-alone initiatives but must be integrated into the core business strategy to drive meaningful change. The availability of digital environmental information has been found to influence the relationship between digital management's commitment to environmental sustainability and the environmental performance conveyed.

**H8:** *There is a significant positive relationship between digital management and environmental performance and sustainability.*

**Research methodology**

**Research Design and Methods**

This study has adopted a mixed research design approach involving both quantitative and qualitative research designs. The field observation and literature review on research articles, manuals, company report, and electronic-sources were employed in this study. The qualitative data was supported the quantitative data analysis and results. For the investigation list of dependant and independent variables given table.1.

**Sample size and Sampling Procedures**

The data for this study have been drawn from managers of manufacturing firms, material suppliers, retail companies, and industry experts via a mail survey that was conducted from the beginning of March 2023 to the end of September 2023. Particularly, the targeted informants for the study include supply chain managers, retail companies, manufacturing industry managers and deputy managers, logistics managers, and purchasing managers from companies. More than 630 respondents were incorporated. Both online and face-to-face techniques for the data collection were considered. The list of respondents was purposefully selected from retail, manufacturing, service sectors, and supply chain expertise. An intensive literature review was also considered for the investigations. All the items were measured on a five-point Likert scale, ranging from strongly disagrees to strongly agree. The collected survey data have been investigated and analysed using the statistical package for the social sciences (SPSS) correlation and AHP network analysis models.

**Reliability and Validity Analysis**

The questionnaire’s validity is re-structuring heralded by the review result in the pilot version. Reliable data is dependable, trustworthy, unfailing, sure, authentic, genuine, and reputable. For the result,Cronbach's alpha coefficient and composite reliability were used to examine the reliabilities among the items within each factor. Cronbach's alpha was employed to measure the internal consistency that is, how closely related a set of items are as a group. The values of alpha obtained from the tests are 0.899. The acceptable level of alpha, as a measure of the reliability of the instrument, lies between 0.67 and 1.0. The results obtained from these tests indicated that the constructs in this study were reliable and valid.

**Result and discussion**

**Introduction**

This section comprises the analysis, investigation, discussion, and interpretation of the findings resulting from this study. The interpretation and discussion of the result have been carried out based on the data obtained from primary and secondary data and the empirical results. The theoretical facts obtained from the literature study were also incorporated into the discussion and analysis. For this study, supply chain segment responsibility (SCR), adoption of continuous improvement strategies (ACIS), green supply chain practices (GSCP), the practice of supply chain circularity (SCC),consideration and impacts of environmental management(CEM), digitalization and digital management practice (DDM), and clear waste management strategy and mechanisms (CWMS) impact on environmental performance, supply chain resilience, and sustainability were considered as the variables in the investigations.

**Data Analysis and Discussions**

All questioners were prepared on a 7-point Likert scale. The supply chain resilience, environmental performance and sustainability-influencing variables were assessed based on the primary and secondary data collected.

Table.1. List of dependent and independent Variables

|  |  |  |
| --- | --- | --- |
| List of Independent Variables | Lists of Dependent Variables | Intended Impacts |
| Supply Chain Segments Responsibility on Performances and Sustainability (SCR) | * Supply Chain Resilience (SR) * Environmental Performance and Sustainability (EPS) | Social, Economic and Environmental |
| Adoption of Continuous Improvement Strategies on Sustainability and Performances (ACIS) |
| Green Supply Chain Practices on Supply Chain Resilience and Sustainability (GSCP) |
| Effects of supply chain Circularity on Sustainability and Performance (SCC) |
| Consideration and Impacts of Environmental Management in the Supply Chain Process (CEM) |
| Digitalization and digital management practice on environmental performance and sustainability (DDM) |
| Clear Waste Management Strategy and Mechanisms for Environmental Performances (CWMS) |

***Table.2.*** *SPSS Descriptive statistical analysis on environmental performance and sustainability influencing variables*

|  |  |  |  |
| --- | --- | --- | --- |
| List Variables | Mean | Std. Deviation | Variance |
| Environmental Performance and Sustainability | 3.6801 | 1.24576 | 1.552 |
| Green Supply Chain Practices | 4.0344 | 1.38229 | 1.911 |
| Supply Chain Resilience | 3.7400 | 1.15301 | 1.329 |
| Consideration and Impacts of Environmental Management Systems | 3.5147 | 1.44990 | 2.102 |
| Adoption of Continuous Improvement Strategies | 3.3783 | 1.25322 | 1.571 |
| Digitalization and digital management practice | 3.7532 | 1.09790 | 1.205 |
| Supply Chain Segments Responsibility | 3.8417 | 1.35412 | 1.834 |
| Effects of supply chain Circularity | 3.3311 | 1.13871 | 1.297 |
| Clear Waste Management Strategy and Mechanisms | 4.2194 | 1.09847 | 1.207 |

**Table.3.** Correlations Analysis Results

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | EPS | SR | SCR | SCC | CEM | GSP | ACIS | CWMS | DDM |
| EPS | Pearson Correlation | 1 |  |  |  |  |  |  |  |  |
| SR | Pearson Correlation | .727\*\* | 1 |  |  |  |  |  |  |  |
| SCR | Pearson Correlation | .805\*\* | .673\*\* | 1 |  |  |  |  |  |  |
| SCC | Pearson Correlation | .793\*\* | .655\*\* | .670\*\* | 1 |  |  |  |  |  |
| CEM | Pearson Correlation | .539\*\* | .406\*\* | .627\*\* | .437\*\* | 1 |  |  |  |  |
| GSP | Pearson Correlation | .709\*\* | .498\*\* | .652\*\* | .480\*\* | .543\*\* | 1 |  |  |  |
| ACIS | Pearson Correlation | .587\*\* | .483\*\* | .560\*\* | .649\*\* | .591\*\* | .278 | 1 |  |  |
| CWMS | Pearson Correlation | .247 | .245 | .198 | .372\*\* | .387\*\* | .284 | .403\*\* | 1 |  |
| DDM | Pearson Correlation | .442\*\* | .414\*\* | .466\*\* | .299\* | .544\*\* | .452\*\* | .311\* | .417\*\* | 1 |
| \*\*. Correlation is significant at the 0.01 level (2-tailed). | | | | | | | | | | |
| \*. Correlation is significant at the 0.05 level (2-tailed). | | | | | | | | | | |

**The Impacts of Supply Chain Segments Responsibility on Performances and Sustainability**

With the increasing complexity of the supply chain, it is difficult to monitor environmental regulation to overcome environmental damages. It is critical to the need for continuous change of design; green strategies throw out the supply chain segments. The descriptive statistical analysis on environmental performance and sustainability influencing variables issues were investigated as Table.2. In the Table.2,result shows that the green supply chain comprises several closed-loop supply chains instead of open-loop supply chains. These close-loop supply chains should include supplier, manufacturer, distributor customers, and reverse logistics systems that contribute to sustainable developments. Empirically, the impacts of the supply chain segment on current green supply chain practices have been investigated in the following manner.

**Table.4.** The impacts of supply chain segments responsibility on performances and sustainability

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Correlations** | | | | | | | | | | |
|  | | (SCR) | (SR) | EPS | (GSCP) | (CEM) | (SCC) | (ACIS) | (CWMS) | (DDM) |
| Supply Chain Segments Responsibility | Pearson Correlation | 1 | .673\*\* | .805\*\* | .652\*\* | .627\*\* | .670\*\* | .560\*\* | .198 | .466\*\* |
| Supply Chain Resilience | Pearson Correlation |  | 1 | .727\*\* | .498\*\* | .406\*\* | .655\*\* | .483\*\* | .245 | .414\*\* |
| Environmental Performance and Sustainability | Pearson Correlation |  |  | 1 | .709\*\* | .539\*\* | .793\*\* | .587\*\* | .247 | .442\*\* |
| Green Supply Chain Practices | Pearson Correlation |  |  |  | 1 | .543\*\* | .480\*\* | .278 | .284 | .452\*\* |
| Consideration and Impacts of Environmental Management Systems | Pearson Correlation |  |  |  |  | 1 | .437\*\* | .591\*\* | .387\*\* | .544\*\* |
| Effects of supply chain Circularity | Pearson Correlation |  |  |  |  |  | 1 | .649\*\* | .372\*\* | .299\* |
| Adoption of Continuous Improvement Strategies | Pearson Correlation |  |  |  |  |  |  | 1 | .403\*\* | .311\* |
| Clear Waste Management Strategy and Mechanisms | Pearson Correlation |  |  |  |  |  |  |  | 1 | .417\*\* |
| Digitalization and digital management practice | Pearson Correlation |  |  |  |  |  |  |  |  | 1 |
| \*\*. Correlation is significant at the 0.01 level (2-tailed). | | | | | | | | | | |
| \*. Correlation is significant at the 0.05 level (2-tailed). | | | | | | | | | | |

The green and close-loop supply chain practice helps in such a way that when the waste collector and retailer collect unused products from the customer, the collector and retailer will provide that unused product to the closest manufacturer instead of traveling a long way from retailer-distribution center-manufacturer. These green supply chain practices help to improve both environmental performance and sustainability issues.

**Impacts of Continuous Improvement Strategies on Sustainability and Supply Chain Performances**

Continuous improvement strategies provide a way to better communicate strategic objectives that are influenced by production process measurement and monitoring sustainable supply chain practices. Strategies for continuous improvement necessitate a sharp emphasis on locating potential improvement opportunities in the supply chain process. Also, the study provides that industry and supply chain segments can identify particular areas of their sustainability efforts that need attention through careful monitoring and review. Indicators and metrics for measuring sustainability performance are examined in this area, including those for energy usage, waste management, greenhouse gas emissions, and social equality. Integrated and sustainable continuous improvement strategies have a direct and positive impact on supply chain performance and environmental sustainability.

**Table.5.a.** Impacts of Continuous Improvement Strategies Supply Chain Performances

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Coefficients** | | | | | |
| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
| B | Std. Error | Beta |
| (Constant) | .731 | .575 |  | 1.271 | .211 |
| Supply Chain Segments Responsibility | .223 | .169 | .261 | 1.317 | .196 |
| Consideration and Impacts of Environmental Management Systems | -.092 | .131 | -.115 | -.698 | .489 |
| Green Supply Chain Practices | -.040 | .145 | -.048 | -.274 | .786 |
| Effects of supply chain Circularity | .181 | .200 | .179 | .903 | .372 |
| Adoption of Continuous Improvement Strategies | .017 | .155 | .019 | .112 | .911 |
| Environmental Performance and Sustainability | .366 | .233 | .395 | 1.572 | .124 |
| Clear Waste Management Strategy and Mechanisms | .026 | .140 | .025 | .184 | .855 |
| Digitalization and digital management practice | .139 | .143 | .132 | .967 | .339 |
| a. Dependent Variable: Supply Chain Resilience | | | | | |

**Table.5.b.** Impacts of Continuous Improvement Strategies on Environmental Sustainability

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Coefficientsa** | | | | | | | |
| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Collinearity Statistics | |
| B | Std. Error | Beta | Tolerance | VIF |
| (Constant) | -.028 | .391 |  | -.073 | .942 |  |  |
| Adoption of Continuous Improvement Strategies | .142 | .103 | .143 | 1.382 | .174 | .398 | 2.511 |
| Supply Chain Segments Responsibility | .229 | .109 | .249 | 2.100 | .042 | .304 | 3.289 |
| Consideration and Impacts of Environmental Management Systems | -.061 | .089 | -.071 | -.685 | .497 | .402 | 2.490 |
| Green Supply Chain Practices | .302 | .086 | .335 | 3.504 | .001 | .468 | 2.138 |
| Effects of supply chain Circularity | .461 | .115 | .421 | 4.006 | .000 | .386 | 2.591 |
| Clear Waste Management Strategy and Mechanisms | -.141 | .092 | -.124 | -1.526 | .135 | .645 | 1.551 |
| Digitalization and digital management practice | .107 | .096 | .094 | 1.115 | .271 | .597 | 1.674 |
| a. Dependent Variable: Environmental Performance and Sustainability | | | | | | | |

According to our empirical results shown in Tables 5a and 5b, the adoption and application of continuous improvement strategies have a direct and positive impact on environmental sustainability and supply chain performance. The results show that continuous improvement is a long journey that gradually improves performance, competencies, and skills inside the business in order to continually identify and address issues relating to the company's operations. To pinpoint the precise quality issues, supply chain segments require the right tools and procedures for detection and identification of problems, which develops sustainable solutions. Based on these investigations, we conclude that they must know how to evaluate the quality of systems and products using a range of quality control methods, how to interpret results, and how to fix issues

**Roles of Digitalization on Environmental Performance and Sustainability (DDM)**

Because of their later introduction and commencement, this research discovered that the digitization of corporate operations can be detrimental to sustainability or the environment. It produces carbon emissions and air pollution because of digital technologies, which exacerbate climate change. Digitization, however, offers a great deal of potential to preserve and safeguard the environment through socially conscious actions. According to AHP results shown the figure.1., digitalization and digital management practices have higher positive impacts on supply chain resilience (53.96%), environmental performance (29.70%), and sustainability (16.34% of the supply chain process, respectively). From this result, we found that adoption and application of digital technologies have the highest positive impact on agile, flexible, and efficient supply chain processes, rather than sustainability and environmental performance.

**Figure.1.** Effects of supply chain Circularity and Digitalization and Management

The utilization of digital technologies in the green supply chain process is advantageous for green innovation and sustainable development. This is because digital transformation enables businesses to precisely access and comprehends data and information flows, leading to more efficient resource utilization, waste reduction, and pollution control. Table 3's correlation study indicates that advancements in digitalization have a direct and beneficial influence on supply chain resilience, performance, and environmental sustainability when using green supply chain practices. The impacting levels of technological advances on the economy and environmental performance have been studied in the figure .1. In this scenario, supply chain digital platforms have direct positive impacts on dynamic environmental change and the sustainability of humans. Also, Tables 3 and 4 shows that more than 44% of digitalization has a positive impact on environmental performance and sustainability, while almost 41% of digital technology impacts supply chain resilience. While 29.9% of digitization and digital management practices are related to supply chain circularity, 45% of green supply chain practices have positive impacts on digital technology.

**Effects of GSC Practices on Supply Chain Resilience and SC Performances**

This study shows that organizations may accomplish efficient and successful business processes by implementing green supply chain management strategies, as stated by the respondents. In particular, environmentally friendly supply chain methods boost brand reputation and consumer loyalty, save money by using fewer resources, comply with environmental rules, gain access to green markets, and ensure long-term sustainability. Additionally, a robust supply chain helps a company identify risks and mitigate their impact while sustaining operations and earnings. Resilience in the supply chain refers to a supply chain's and an organization's ability to tolerate interruptions and mitigate their consequences on expenses, the bottom line, and customers. Thanks to the GSCM, firms have a stronger competitive advantage and less adverse consequences from industrial processes.

According to this study, GSCM practices improve management creativity, increase output, and improve the company's standing. An organization may recognize risks and lessen their impact without compromising operations or revenue with the support of a robust supply chain. Building a resilient supply chain is essential in the complicated and unstable business climate of today, according to our respondents, and it has favourable relationships with green supply chain practices. Supply chain segments and the industrial sector must make investments to realize the resilience pillars of visibility, flexibility, collaboration, and control in order to do this. Due to the fact that these pillars greatly enhance supply chain components, for example, supply chain visibility helps carriers save costs and enhance the customer experience by managing moving inventory, providing proactive status updates, minimizing interruptions, and mitigating risks. Within the consistency ratio of 0.04 and the critical consistency ratio of 0.1, green supply chain practices have a direct and positive impact on supply chain resilience, environmental performance, and sustainability issues. This impact level was measured using various performance indicators, as shown in the Table. 6.

**Table.6.** Alternative-Main Criterion-Matrix (AHP-results)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Adoption of Continuous s Improvement Strategies | Clear Waste Management Strategy | Environmental Management System | Digitalization on and digital management practice | Effects of supply chain Circularity | Green Supply Chain Practices | Supply Chain Segments Responsibility |
| Environmental  Performance | 41.26% | 25.00% | 41.26% | 29.70% | 22.38% | 40.67% | 41.26% |
| Supply Chain Resilience | 32.75% | 25.00% | 32.75% | 53.96% | 36.95% | 22.38% | 32.75% |
| Sustainability | 25.99% | 50.00% | 25.99% | 16.34% | 40.67% | 36.95% | 25.99% |

Moreover, companies on both sides incorporate sustainable practices into their commercial operations to improve the social, economic, and environmental effects. Without a doubt, "green supply chain management" tactics have evolved into a way for businesses to lower production costs, increase revenue, and also strengthen their competitive positions. Our AHP investigations in Table 6 indicate that adopting a sustainable supply chain approach reduces the likelihood of environmental and societal problems such as shortages of water, climate change, and human rights abuses. Businesses may save money on supply chain interruptions and reputational harm by reducing these risks. Green supply chain management practices, therefore, have a positive effect on social and economic sustainability. These are methods that promote sustained economic expansion without having a detrimental effect on the community's social, environmental, or cultural elements. Thus, GSCM aids in lessening the adverse effects of industrial processes and enhances supply chain resilience, environmental performance, and the competitive advantage of businesses.

**Impacts of Circular Supply Chain on Sustainability and Performance**

It's a closed-loop system of production, distribution, and consumption built on the idea of the circular economy, with the goal of minimizing waste and maximizing resource existence. Unlike winding into landfills, production and post-purchase waste is recycled, reused, or repurposed. As shown in figure 1 and figure 2, circular supply chains (CSCs), which provide better sustainability performance, are replacing conventional supply chains in light of the rise of the circular economy (CE). This research further illustrates how the circular economy minimizes the use of resources, redesigns goods, services, and materials to be less resource-intensive, and recycles "waste" into resources for the production of new goods and materials. Furthermore, the circular economy has the ability to advance an equitable society, strengthen economics, and safeguard the environment when it is planned carefully and inclusively. Social fairness is fundamental to sustainability. Therefore, one of the most recent sustainable economic models, according to the investigations, is the circular supply chain.

In this model, materials and products are designed to be recycled, refurbished, reused, or recovered (4-R), maintaining them in addition to the resources they are made useful for as long as possible. Enhancing business performance via the integration of supply chain management and circular economy techniques is crucial for the successful deployment of a circular supply chain. This research is an initial phase in investigating if and how big data might be used to improve the environmental, social, and economic viability of a company's circular economy supply chain.

Figure.2. **AH Evaluation on** Main Criteria Weighting Values

**Environmental Management Practice Roles on Supply Chain Resilience and Sustainability**

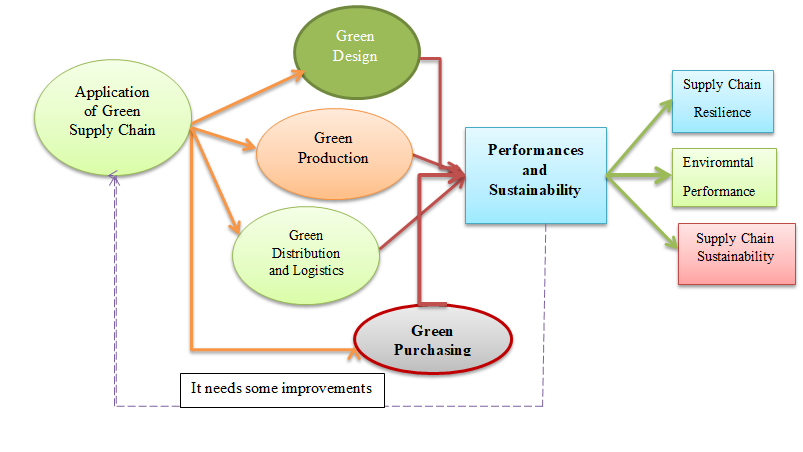
Performances on environmental and environmental supply chain management are a key part of a sustainable business strategy. The study revealed that GSCM practices significantly lead to supply chain resilience, supply chain performance, and environmental sustainability. Environmental sustainability is concerned with the intergenerational equity of receiving benefits from natural resources and environmental amenities. Environmental management concerns waste management and clean environmental practices. Regarding industrial waste (especially hazardous waste), illegal dumping and Trans boundary movement commonly attract more attention due to their potential threats to the environment and human health (Md. Maruf Sarker, 2019; Imam, 2010). When it comes to sustainability and environmental challenges, this waste has the most influence. Materials that are hazardous to humans and the environment and that are poisonous, reactive, explosive, combustible, organic, or bacterial in origin are classified as wastes (Dametew, 2015). Therefore, environmental management aids in the identification of degradation drivers and the application of mitigation solutions. This aids in anticipating the effects of environmental deterioration in the future and starting procedures to lessen the effect.

Figure.3. AHP result and alternatives ranking on environmental performance, sustainability and SC resilience

According to the AHP analysis result in figure 3, environmental performance (36.20%), sustainability (32.22%), and supply chain resilience (31.58%) are positively related to green supply chain practices, from the highest to the lowest, respectively. Excessive waste creation in the industrial sector is a sign of low product durability, inefficient production techniques, and unsustainable consumption habits. While the amount of trash produced may be seen as a measure of how well society uses raw materials, businesses should address the causes and consequences of waste as well as regulate the kind of waste produced through waste minimization, prevention, or reduction. Companies can use this terminology interchangeably, depending on the type of company and the production process. Furthermore, the study demonstrates how environmental management facilitates the creation and evaluation of programs for recycling, waste management, renewable energy, pollution prevention, and reduction. Waste prevention, also called source reduction, seeks to prevent waste from being generated. Waste prevention strategies include using less packaging, designing products to last longer, and reusing products and materials. Particularly, waste prevention helps reduce handling, treatment, and disposal costs and ultimately reduces the generation of methane. Since proper waste prevention improves the productivity and performance of textile manufacturing industries. Besides, waste minimization is about preventing and reducing waste at source through the efficient use of raw materials, energy, and water. This is at the highest level of the waste hierarchy and is based on the principles of prevention and reduction to eliminate or reduce waste at source (Dametew, 2015). Waste minimization is considered to be the highest level to reach in the waste management hierarchy, as it achieves both environmental and economic benefits by reducing waste and costs at the same time. In the meantime, waste minimization is considered one of the best approaches for improving sustainability performance in industry, including the food and drink industry, as it achieves environmental, economic, and social benefits by reducing waste at source, achieving cost savings, and creating new employment opportunities. In manufacturing firms, waste minimization can provide a competitive advantage to businesses in four ways, including cost savings, compliance, reduction of risk, and market positioning (Young, 2001). Waste is a very important issue that ought to be treated in such a simple way that the advantages achieved will be in both environmental and social aspects. Manufacturing industry waste management provides greater opportunities for waste recovery, diversion from landfills, and services suitable for businesses. Though Imam (2010) shows that waste management favours reuse and recycling before landfilling, with the idea of an environmentally sustainable society. Waste minimization and environmental sustainability provide direct relations withthe practice of green design, green production, and green distribution in the supply chain process. This provides a means to stop pollution and save energy through the invention and development of the latest knowledge that reduces and/or eliminates the utilization or generation of hazardous substances within the design, manufacture, and application of chemical products or processes. The study also shows that every supply chain process needs to develop a green design that attempts to improve and enhance more environmentally conscious products and processes. The application of green design involves developing a scientific framework for considering environmental issues and also the application of relevant analysis and synthesis methods. Besides, the challenge of green design is to change conventional design and manufacturing procedures to include environmental considerations systematically and effectively. This requires changes in existing procedures. Changes to any existing process are difficult. Environmental concerns must be introduced in practical and meaningful ways into these complicated design processes. For the longer term, the goal is to encourage consumers and designers to think proactively and concurrently about the environment. For this analysis we found that,environmental management practice has positive impact on supply chain resilience and sustainability through effective and efficient waste minimization and waste controls. Form this, hypothesis (H6):Consideration and application of environmental management in the supply chain process have positive impact on environmental performance and sustainability has been supported. Also, according to Bavarian correlation analysis within the significant\*\* at the 0.01 levels and 0.005 significance value all the hypothesis have been supported and confirmed a shown in table.7 and figure4.

Table.7. Hypnotise testing and Confirmations

|  |  |  |
| --- | --- | --- |
| List of dependent and independent variables | Correlations Analysis Results |  |
| Enviromntal performance | 1 | *H1 is supported* |
| Supply chain resilience | .727\*\* | *H1 is supported* |
| Responsibility of Supply Chain Segments | .805\*\* | *H2 have been supported* |
| Supply chin circularity | .793\*\* | *H4 is supported* |
| Consideration and Impacts of Environmental Management in the Supply Chain Process | .539\*\* | *H5 is supported* |
| Application of green supply chain practices have positive impacts on performance and sustainability | .709\*\* | *H1 is supported* |
| Adoption of Continuous Improvement Strategies on Sustainability and Performances | .587\*\* | *H3 have been supported* |
| Clear Waste Management Strategy and Mechanisms for Environmental Performances | .247 | *H7 is supported* |
| Digitalization and digital management practice on environmental performance and sustainability | .442\*\* | *H8 is supported* |



**Figure.4.** The Effects of Green Supply Chain Practices Supply Chain Resilience, Performance and Sustainability

**Roles Green supply Chain on (Economic, Social, and Environmental) Sustainability**

To overcome environmental challenges, the manufacturing industry should engage its business processes within green and clear supply chain practices. Meanwhile, green supply-chain integration provides a means to integrate a firm’s roots in both environmental and supply chain management issues (Gábriel, 2016). While green supply chain integration tries to improve and enhance environmental efficiency within supply chain systems in firms. According to the (Mochamad Agung Wibowo, 2018) study, green supply chain management is a new field that tries to address some of the traditional supply chain weaknesses, like environmental efficiency. As shown in the figure.4, using various GSC KPIs, supply chain resilience, performance, and sustainability have direct and positive relations with GSCM as shown in figure.5.

Figure.5**.** Green supply chain practice with Various Key performance indicator (KPI)

This investigation shows that supply chain segments, from suppliers and manufacturers to customers’ needs, need to adopt a green and sustainable supply chain process. This green supply chain practice includes green purchasing, design, production, and distribution, as well as the reverse supply chain and circular supply chain. Effective and efficient green practices have the highest and most positive impacts on economic, social, and environmental sustainability. Also, integrated green supply chain management provides resilience, performance, and environmental sustainability. Our empirical study also confirmed that green supply chain practices have positive and direct impacts on economic performance and sustainability across supply chain segments.

**Conclusion**

Green, integrated, agile supply chains and sustainable economic development will aggravate the shortage of resources and environmental pollution continuously, which also brings serious challenges to the development of enterprises. This study aims to investigate the effects of green supply chain practices on supply chain resilience, environmental performance, and sustainability in the textile and apparel industry. The green supply chain principle focuses on minimizing challenges or making the negative effects of sustainability, resilience, and environmental performance negligible. Based on its principles, this study has analysed the current situation of the green supply chain in the manufacturing industry and tried to show solutions for sustainability. The relationship between green supply chain management practices and environmental performance, supply chain resilience, and sustainability was studied and investigated in this study.The finding shows that GSCM practices have a positive impact and relationships on environmental performance, sustainability, and supply chain resilience in the business process. From this investigation, we conclude, green supply chain practices are important factors in achieving agile, sustainable, and improved supply chain and environmental performance in the textile and apparel industry. Also, green supply chain process practices hold great potential for reducing environmental effects, pollution, and challenges related to supply chain resilience and environmental performance. Supply chain circularity, digitalization and digital management practices, adoption of continuous improvement strategies, responsibility of supply chain segments, and clear and clean waste management strategies were considered as performance indicators for the investigations. Each dimension and indicator has positive impacts on the performance and sustainability of manufacturing industries with respect to environmental, resilience, and sustainability issues along the supply chains. However, the effectiveness and impact levels of these KPIs vary from one to the next during green and sustainable supply chain management practices. Likewise, supply chain resilience, environmental performance, and sustainability issues are considered the dependent variables of this investigation. Most developing nations, including Ethiopia, have manufacturing industries that work with non-integrated and traditional supply chain processes rather than green practices. For this reason, the performance in supply chain resilience, sustainability, and clean production processes has been poor and insufficient.

Based on our findings, we recommended that all developed and developing manufacturing industries should work to adopt sustainable and green supply chain-based practices and establish strategic collaboration with suppliers and customers. The adoption and implementation of green and innovative supply chain strategies are provided to ensure supply chain flexibility, agility, and performance throughout the supply chain segments. These results improve sustainability, environmental performance, and resilience in the supply chain process. As well, from this investigation, we recommended that it is advisable for the manufacturing industry and industry leaders to pay attention to the adoption and implementation of green supply chain management practices as a way to improve supply chain resilience, sustainability, and environmental performance.

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