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Exploring Green Supply Chain Management: The Role of Green Technology in Business Development

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ABSTRACT

Across the world, the integration of green concepts within supply chains has become a critical focus for both developed and developing economies. Green Supply Chain Management (GSCM) has emerged as a vital strategy to enhance organizational performance through economic, environmental, and operational dimensions. This study explores the concept of green technology as an integral component of GSCM and examines its influence on business development and sustainability. Through an extensive review of literature, the paper analyzes various GSCM practices such as green purchasing, green manufacturing, green design, green marketing, green distribution, and reverse logistics. It further evaluates the impact of green technologies on economic growth, operational efficiency, environmental performance, and competitive advantage. The findings suggest that the adoption of green technologies not only improves resource efficiency and reduces emissions but also enhances organizational reputation and market competitiveness. Moreover, the study highlights challenges such as high implementation costs, lack of skilled manpower, and inadequate frameworks that hinder the effective adoption of green technologies. The paper concludes that aligning strategic decisions with sustainability goals and investing in green innovation can significantly contribute to long-term business development and ecological balance.

Keywords: Green Supply Chain Management (GSCM); Green Technology; Sustainability; Environmental Performance; Economic Growth; Operational Efficiency; Green Manufacturing; Reverse Logistics; Eco-innovation; Business Development.

INTRODUCTION

Across the globe, the emergence of green concepts and following them is the main point of concern for developed and developing economies. As per Asian Emerging Economies (AEE), green supply chain management (GSCM) practices have augmented the performance of the organizations in three aspects: economic, environmental, and operational (Geng, Mansouri, and Aktas 2017). Due to regulatory demands, drivers, and competitive and marketing pressures (Jafar Heydari, Kannan Govindan, and Zahra Basiri,2020). In marketing theory and practice, "eco-friendly" or "green" has become a buzzword and a trend in recent years. The people, profit, and attitudes are the business triple bottom line and benefit from going green. However, in corporate culture, going green necessitate a substantial shift. The strategic decisions should align with consumers' environmental beliefs and attitudes. Environmentally consciousness is augmenting, which is evident from the marketplace due to concerns related to the environment (G.D. Samarasinghe, F. J. Ahsan,2014). Practices related to Green Supply Chain Management (GSCM) are mainly known as strategies of management that present ecological aspects problems. (Ahmed A. Zaid, Abdul Talib Bon, Ayham A. M. Jaaron,2019). Another name of clean technology is green technology or environmental technology. It focuses on developing and implementing systems, products, and equipment, which leads to the protection and conservation of natural resources and environments. These systems, equipment, and products should fulfill the criteria such as

It should diminish the ruin of natural resources, and it should not be detrimental to the environmental section.

1) Use of renewable resources should be encouraged by it.
2) It must protect the use of natural energy and resource
3) For all life forms, it should encourage and enhance the healthy environment by low carbon gas emissions.

The main motive of green technology is to curb the negative impact of human participation on nature and remove the toxic generation from the environment by stabilizing their emission or changing the condition that leads to their production. Hence, it gives a platform for establishing balance in the biological and economic environment. Through comprehensive literature, a review study has been done to understand the impact of the application of Green Technologies by the various companies around the globe and how it is advantageous after implementation.

An attempt is made to examine its influences on the environment and how it helps in environmental sustainability. The main objective of this paper is to explain in detail the concept of Sustainable Supply Chain, Green technology, and its crucial role in enhancing performance, which augments the overall development of the organization in the current scenario. Thus, the principal aim of this research is to discover the notion of green technology. Furthermore, to find the association between green technology and its impact on the organization's efficiency.

LITERATURE REVIEW

A. GSCM and Related Practices

Green supply chain management (GSCM) is "green procurement, green manufacturing, green distribution, and reverse logistics." The objectives of this study are to know the present concept of green supply chain management, identify existing green practices, and analyze the impact of green practices on Industrial Performance.

B. Essential Concepts Of Green Supply Chain Management Emerging From The Literature

1) Green Purchasing: Green procuring events are encouraged by the international body known as International Green Purchasing Network (IGPN). This international body is committed to the growth of alertness about expanding environmental services and products. As per IGPN, Green Purchasing is defined as a set of activities by which "goods and services are selectively chosen according to environmental preference." Green Purchasing is an efficient practice of boosting services and goods that do not have a diminishing environmental effect. It also succors in cultivating the customer's ecological awareness. The National Association of State Procurement Officials (NASPO) based in Illinois defines Green Purchasing or Environmentally Preferable Purchasing (EFP) as a "process involved in purchasing a product that has an increased positive impact or lesser negative effect on the health of human the. Additionally, the environment contrasts with the same purpose products competing" (Nandini Gajendrum,2017).

2) Green Manufacturing: For the future expansion of the manufacturing industry, the idea of Green manufacturing has arisen as an integral theory. It encourages and leads towards the advancement of clean, low carbon, recycling, and proficient ecological evolution. Green producing is the mainstream of national enlargement strategy and growth policy, and it is a new inclination and foreseeable selection for the development of the manufacturing industry. Green manufacturing modernism is a basic mode to safeguard the reserves and environment and is a novel device to recognize the diving enlargement of the economy. The dynamics of green conversion in traditional manufacturing business mentions single factors, such as natural reserves, labor, capital, etc. The elements of green expansion of the recent manufacturing industry primarily signify to fundamental aspects:

3) Green Design: "approximately qualitatively distinct": a design practice in which environmental elements are considered design goals rather than a limitation. The central point is that green design integrates ecological goals with negligible loss to product execution, useful life, or functionality. "The key objective of green design is to avoid waste, which includes less material use whose application is for the same task. Moreover, there is less usage of pure material, less energy use for the same task achievement, and an increase in material and energy's useful life.

4) Green Marketing: Green Marketing signifies selling services and products based on environmental welfare. Such a service or product should be environmentally friendly in itself or manufactured in an eco-friendly way. In the current environmentally- conscious globe, the word "Green" has gained a lot of significance. Green produces are progressively familiar with the public producing green selling goods for public relations and sales. According to AMA, Green Marketing is "The study of marketing activities' advantageous and disadvantageous features on pollution, energy depletion, and non-energy resource depletion". Green marketing, also known as environmental marketing, includes a series of activities, including product modification changes in the production process, changes and modifications in packaging, and transforming advertising.

5) Green Distribution: Green distribution holds additional significance as a green component of SCM due to its huge impact on the natural atmosphere. It depends upon green transportation, which is described as; "transportation service which has a less or minimum negative effect on human health and the natural atmosphere compared with challenging transportation services that leads to the same objectives." Exploring prospective supplier’s environmental status, updating

and informing suppliers in ecological aspects, and referring to the ecological part on paper contract can be the illustration of practices that considers green components when transportation services are acquired (M. Ghobakhloo, S. H. Tang, N. Zulkifli, and M. K. A. Ariffin, 2013).

6) Reverse Logistics: Reverse logistics is a minor part of the entire logistics of a business. Reverse logistics deals with the management of the returned goods to the manufacturer by the consumer. It involves all the events that govern the outcome of these returned goods. Reverse logistics is relatively new, and logistics companies and researchers presently aim to core on its impacts on managerial decisions. As per Rogers and Tibben-Lembke reverse logistics is "the process of planning, implementing, and controlling the efficient, cost-effective flow of raw materials, in-process inventory, finished goods, and related information from the consumption point to origin point to recovery value or proper clearance."

7) Green Technology: Green technology (GT) is a broad term and a field of new innovative ways to make environmentally- friendly changes in daily life. The creation and usage of it are in a way that preserves the environment and natural resources. It is meant as an alternative source of technology that reduces fossil fuels and demonstrates minor damage to human, animal, and plant health and damage to the world. The use of green technology is supposed to reduce the amount of waste and pollution created during production and consumption. The relationship between the organization and stakeholders such as suppliers and investors also play a vital role in the actual application of GSCM, thus thereby enhancing the organization's operational efficiency and increasing competitive advantages (Ayham A.M. Jaaron, Ahmed A. Zaid, Abdul Talib Bon, 2018). Customer's cooperation: Customer's requirement for eco-friendly goods is rising. Many consumers choose progressive environmental records organizations, greener products, and are prepared to pay an elite for it (Lakshmi and Visalakshmi,2012). The human aspect holds a vital position in 'greening the supply chain. The role of the consumer in green supply chain management requires to be identified and recognized as an essential aspect for effective implementation of GSCM practices in the present scenario.

C. Effect of Green Technology on Organizational Performance

1) Economic Development: Is diligently connected with energy development. Majorly the world's commercial energy supplies are provided by fossil fuels, with the associated emissions causing global environmental problems. It is an issue of concern that these levels of energy production and use from current energy resources are tough to attain and unmanageable. Therefore, energy use efficiency needs to be augmented to adequately expand energy while the impact from clean energy resources added to diminish the negative environmental effect of energy usage. Environmental policies, financial subsidies, and tax policies are environmental, economic ways in green technology innovation.

2)

3) These processes can inspire society to dynamically improve clean production technology, pollution control technology, waste utilization technology, and other environmentally sound technology and meet people's rising awareness of green consumption. The government can take the policy discount and price subsidies to environmental type enterprises and products and reduce the import tariffs to environmentally friendly equipment. Give priority to developing the environmental industry, recycling industry, environmental protection industry, and green food industry to incent and guarantee green technology innovation behavior (Xian Zhiyong,2020)

4) Social Development: When environmental toxic waste and natural source exhaustion grow into a severe hindrance, technology is considered the main reason for ecological damage and pollution. Merely by diligently integrating technological innovation and environmental protection, the application of green technological innovation is the elementary approach to attain sustainable development of the social economy. Hence it leads to social action (Xian Zhiyong,2017)

5) Environmental Performance: As the term indicates, green technology has a "green" purpose. As the name implies, green technology is the unique one that has a "green" as the principle. Green technologies incorporate different technology features that help us diminish the human influence on the environment and make ways of sustainable expansion. Sustainability, Social suitability, and economic feasibility are the significant factors for green technologies. Our present actions are dragging the planet towards an environmental landslip that would make damage simply unavoidable if it transpired. Green technology uses renewable natural resources that are never depleting. The practices of green technology have novel and innovative power production techniques. It can effectively alter waste patterns and output, which can alleviate the harm to the planet, and we can follow green activities. (Ghanshyam Das Soni,2015)

D. Operational Performance: following the GSCM practices, the firms can enhance operational effectiveness. That enables companies to reduce several items, such as delivery time, scrap rate, and inventory levels, improving operational performance. The individual dimensions of GSCM practices such as green purchasing, cooperation with customers, eco-design, and investment recovery are significantly and positively linked with all sizes of operational performance (flexibility, delivery, quality, and cost) and customer satisfaction, (H. K. Dilhani Mallikarathna and C. W. Chathurani,2019).

E. Green Technology in the Contemporary Era

The concept of green investing has received considerable attention and has led to different forms of green investment avenues/portfolios, mutual funds, indexes, etc. The most popular green theme is climate change, and institutional investors have begun to coordinate efforts with prominent action groups on various environmental issues. The findings have important implications for investment decisions as investors may start investing in green firms (preferably non-blue-chip companies) to reap higher returns at lower risk. We expect more socially responsible mutual funds or green mutual funds will be launched in India shortly for green investment promotion. (Vanita Tripathia1, Varun Bhandarib,2012)

F. Branches of Green Technology

1) A-Solar Photovoltaic: This technology transforms sunlight into electricity using semiconductor modules. Primarily used for meeting lighting supplies, they can also be used for refrigeration, charging batteries, pumping water, and communication. Solar photovoltaic applied as a source of green agricultural energy for pest management, pumping water, street lighting in villages, lighting in rural houses.

2) Green Chemistry: Sustainable chemistry is another name of Green chemistry, an idea of chemical research and engineering that boosts the design of processes and products that diminish the use and generation of hazardous substances. In the United States, the Pollution Prevention Act in 1990 got approved. This act helped create a protocol for production with pollution fundamentally and innovatively, as its objective is to prevent problems before their occurrence. As a chemical belief, green chemistry applies to inorganic chemistry, organic chemistry, physical chemistry, biochemistry, and even analytical chemistry.

3) Green Nanotechnology: Nanotechnology encompasses handling materials at the nanometer scale, one billionth of a meter. According to some researchers, the supremacy of this discipline is forthcoming that will change the way everything in the world is produced. "Green nanotechnology" is the application of green chemistry and green engineering standard to this sphere.

4) Wind Energy: The costs of a home wind generator vary greatly. Some have constructed their wind generators with off-the-shelf parts from their local hardware stores. The energy production ability of a home wind generator is different about as much as the preliminary expense. Many kit-based generators will produce only enough power to offset 10-15% of your home energy costs, (Ghanshyam Das Soni, 2015).

G. Benchmarks to be Considered for Selection of Green Technology

The decision to choose appropriate technology various implements and methodology should be considered, which helps companies ascertain the uncertain future. In other words, the right technology searches for those technologies that have beneficial effects on revenue distribution, human enhancement, ecological quality, and the dissemination of political power.

1) Structure Self-Reliance: This includes the advanced technological tool that is self-sufficient enough to perform the required task. Hence the assessment-related future need for utilization of energy or capital needs to be considered to check the self- sufficiency of the technological tool.

2) Form of Modernity: This aspect is related to the social image. Adopting the advanced modern technological tool leads people to recognize them as current over the usage of advanced devices.

3) Sole Technology Versus Collaborative Technology: This standard considers the social or cultural selection in which the advanced tool works. Furthermore, it is a careful analysis of collective technology used by the group and is more structure- dependent. For example, collaborative technology is adopted by the group to alleviate the transaction cost. On the other hand, individual technology is a structure that is adapted to be more structure-independent technology.

4) The Price of Technology: The developing economies in today's era broadly consider the aspect of affordability. The budget for adopting an advanced technology is decided in keeping the cost as a significant factor as a base.

5) Risk Component: This aspect looks after how the technology system works efficiently and in local construction. In addition, it measures the degree of independence and dependence of technological structure. Thus, there is an external and internal risk analysis before applying technology to minimize its effect of chance.

6) Transformative Dimension of Technology: The success and competitiveness of technological tools can be evaluated based on their capacity to adapt to the variability of changing circumstances. If the device is stable, its application and usage will be futile for significant problems.

7) Multipurpose Advanced Technology: This advancement is essential in the modern era as it is related to structure design that can perform multitasking. (Mohd. Wira Mohd Shafiei and Hooman Abadi,2017)

H. Goals of Green technology

1) Safeguard of Natural Resources: The main motive of green technology is to curb the shortage and safeguard the depletion and damage to natural resources. It holds the responsibility for the well-being of society as a whole without conceding the aspect of natural resources for the current requirement.

2) Design of Recyclable Products: Green technology should give attention to designing products that can be recycled and reused or reclaimed fully again after use.

3) Alleviation of Pollution: The most vital objective of green technology is to focus on reducing pollution and discharge waste by alteration in the design of production and consumption.

4) Revolution in Technology: Green technology should mainly concentrate on using improved technology, which causes the minimum effect on natural resources or the environment. Thus, implementing such technology can be advantageous and protective for the earth. In addition to the above, some important goals of green technology are introducing sustainability, living, developing renewable energy, decreasing the production of waste, and conserving the utilization of natural resources. Furthermore, creating products that are refillable and recyclable and developing substitutes to the exercises that negatively impact human beings and nature.

The significance of Green Technology as an environmentally friendly approach is an advanced technology that majorly aims at conserving natural resources and the environment to a large extent, thereby protecting the ecological balance. Thus, clean technology upholds greater importance which can't be overlooked by green technology has a policy which has principle four pillars which are as follows ·

a) Energy: Explore to achieve energy independence and aid efficient implementation; ·
b) Environment: Preserve and diminish the effect on the environment;
c) Economic: Expansion of the national economic development through technology ·
d) Social: Advance the excellence of life for all. (Gangadhar B and Ramakrishna Naidu G,2017).

I. Challenges for Green Technology

1) Expensive: High implementation cost is the key hindrance to adopting green technology, and the related expansion and training cost is even costlier than other conventional technologies.

2) Lack of Proficient Personnel: Clean technology requires special functional skills for operation and management. Thus, a lack of skilled personnel or human resources poses a barrier to implementing green technology.

3) Lack of an Appropriate Framework: There is no suitable and proper framework for establishing Green technology, which hampers the adoption and implementation of green technology. In addition to the above obstacles, various other barriers hinder the adoption and circulation of green technology, such as lack of data and information, no or lack of alternative chemical or raw material inputs, uncertainty regarding performance impacts. Thus, support infrastructure, technology readiness, and geographic elements are some factors that need attention to be put on for the application of green technology.

I. **Sustainability via Green Technology**

In their report, the World Commission on the Environment and Development, known as the Brundtland Commission, "Our Common Future," presented and outlined the word sustainable development. According to report practice, the utilization of natural sources, the provision of financing, and the procedure of technological enlargement and organizational revolution are in coherence with each other for both present and upcoming generations. Grounded on this context, "sustainability" is measured as a track advancing that permits humankind to encounter current economic, human health, and societal needs without negotiating the growth and achievement of future generations. The hazard allied with "dirty" technologies, for instance, petroleum products, is augmenting at an alarming rate. The "clean" technologies as an outcome are foreseen to postulate alleviated outcomes of substitutes.

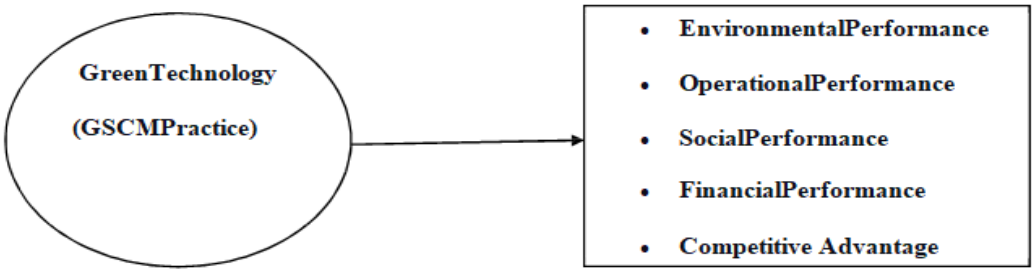
Maximum of the administering bodies in developing and developed countries are advancing the massive sum of capital into clean power market and following industries' acceleration renewable energy technologies that are power proficient. Green Technology (GT) covers a comprehensive unit of resources for producing power to poisonous cleaning produce. The primary motive is that this area has been notably significant since most of the public believes in vivid innovation and

modifications in their living. Green technology encounters the requirement of the social order in modes that can persist forever into the upcoming without harming or reducing natural sources. In terms of the technology that can generate products that can be completely recovered or recycled, such framework to the critical cycle of production has effectively diminished pollution and hazardous waste by changing production and consumption patterns. Technological innovations have aroused in developing alternative fuels as a new means of generating energy and energy efficiency. Besides, Green Technology is the development of green engineering and green chemistry, one of the highest motivating arenas of technology, that is understood to change the methods that the whole thing in the world is manufactured (Gangadhar B and Ramakrishna Naidu G,2017). As per the OECD detail report "In the direction of Green Growth," policymakers should emulate the notion of green growth. An economy must be dynamic, flexible, and productive while using reserve and enforcing a mutual impact on nature for its preservation. Investment and innovation are perceived as drivers that lead to green technology development. Technology, increasing productivity, and innovation are the main factors considered in the common scenarios used for the development of forecast that furthermore gives rise to ecological advantages extensively. (Minjian Guo, Joanna Nowakowska- Grunt, Vladimir Gorbanyov and Maria Egorova, 2020).

RESEARCH METHODOLOGY

A descriptive approach has been followed, and a comprehensive summarization of literature related to green technology and its impact or critical role in augmenting its performance has been presented. This paper analyzes, summarizes, and gives a detailed theory of green technology and related aspects.

CONCEPTUAL FRAMEWORK



The above conceptual model presents that green technology impacts the various levels of performance of the organization. Thus, this investigation offers green technology as a green practice that influences the organization's production.

FINDINGS

Based on analysis of various literature, researchers concluded that green technology plays an essential role in augmenting the overall performance and efficiency of the organization. Consumer welfare can be improved if the efficiency of green technology adoption and the coefficient of greenness level on market demand is sufficiently high. Thus, this outcome signifies that if the government is consumer-centric, the manufacturer should be motivated to build up the cost reduction potential concerning green technology. Consumers should be educated about sustainability consciousness knowledge. (Bin Shen, Chen Zhu, Qingying Li, Xiaofeng Wang,2020). In one of the literatures, results show that green technology plays a crucial role in reducing carbon emissions. Apart from FDI and trade, green technology is a vital factor in reducing carbon emissions. (Sudharshan Reddy Paramati, Di Mo, and Ruixian Huang,2021). A new and innovative technological model comprising biotechnologies, renewable energies, investment targeting, and more ecologically and technically efficient products and processes should be considered significant. Eco-innovation has an integral feature of eradicating the detrimental impact of the innovation, which somehow leads to environmental degradation that represents the dark side. Sustainable global development is one of the inevitable and highly prioritized aspects which should be implemented in all productive activities as it is an efficient tool in reducing the negative effect of the Industrial revolution that has caused pollution and environmental change, which has become dangerous and threatening to our planet. (Fernanda Q. Sperotto and Iván G. P. Tartaruga,2020).

SUGGESTIONS

A. To begin with, the government should expand R&D investment in Green Technology to uphold its endurance and strengthen the expansion of Green technology. A rise in the total sum of R&D investment in Green Technology will direct to the qualitative enhancement of Green Technology and progress at the national level of Green technology.

B. Secondly, the organized and stable analysis of global drift in renewable climate technologies, firms should be directed to monitor the development of the high quality of Green Technology beyond its existing emphasis on a limited technology such as fuel cells, LEDs, and solar cells. This enhancement will assist in encountering the global market's drift and increase trades and functions of national Green Technology.

C. Thirdly, to encourage the domestic interest and investment in Green technology, it must be emulated by the up-gradation of the practical use of Green technology in national and sphere markets. Therefore, the government must reinforce the industry- university-institute alliance and encourage the commercialization of the expansion of Green technology.

D. Fourth, to endure the expansion of domestic green technology and R&D in the extensive span, the destructive impact of Green Technology must be measured by companies throughout the R&D process. Hence, officials must offer the R&D ability to forecast the adverse effects of Green Technology and to set up a standard for outlining and monitoring them. (Jae Yun Jeong , Inje Kang , Ki Seok Choi and Byeong-Hee Lee,2018)

E. Fifth, using data on GREENEX is beneficial from the analysis of a previous study that portfolio of green stocks outperformed during a financial crisis than other portfolios; hence attempts should be made to increase the awareness among the firms for green investing.

CONCLUSION

The study establishes that Green Supply Chain Management (GSCM) and Green Technology (GT) are not merely environmental imperatives but essential strategic tools for achieving sustainable business growth and competitive advantage. The adoption of green practices—ranging from green purchasing and manufacturing to green distribution and reverse logistics—enables organizations to balance economic efficiency with environmental responsibility. Integrating green technology within supply chain operations contributes significantly to enhancing operational performance, reducing carbon emissions, improving resource efficiency, and ensuring long-term sustainability. The research underscores that the role of green technology extends beyond ecological preservation; it directly influences economic and social development by fostering innovation, creating new market opportunities, and improving corporate image.

However, challenges such as high implementation costs, inadequate policy frameworks, and a shortage of skilled professionals continue to impede the widespread adoption of these technologies. Overcoming these barriers requires a collaborative approach involving government support through incentives and policy reforms, industry commitment to innovation and R&D, and consumer awareness toward eco-friendly products. Ultimately, the transition toward a green supply chain supported by sustainable technologies represents a paradigm shift in modern business practices.

Organizations that integrate green initiatives into their core strategies are better positioned to meet global environmental regulations, satisfy consumer expectations, and secure a competitive edge in the evolving marketplace. Therefore, green technology adoption within supply chain management not only mitigates environmental degradation but also establishes a pathway toward holistic and sustainable business development—balancing economic growth, social welfare, and environmental stewardship for future generations.

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