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The Importance of Digitalization to Support and Improve Green Supply Chains

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Abstract: This study aims to shed light on the importance of technological and digital developments in improving supply chains with an environmental dimension, and the resulting opportunities through which the organization can sustain its competitive capabilities in international markets. This study dealt with a certain number of axes, in the forefront of which digitization and its importance in the activity of Algerian companies in general, and within the green sectors in particular. Modern digitization mechanisms were also discussed, especially with the emergence of the Corona pandemic

Keywords: Digitalization; Green Supply Chain; Supply Chain Digitalization.

1. Introduction

Nowadays, societies are witnessing transformations in various fields mainly built upon technological advancement and digitization. These changes have also reached the economic business environment. Today's institutions are racing to adopt mechanisms and technological means to make them more adaptable to their environment on one hand, and to ensure competitive advantages on the other hand.

Supply chain and procurement are among the functions within the institution that have been greatly impacted by digitization, considering that this function is one of the most cost-sensitive functions, and the efficiency of the supply chain represents a great opportunity for the enterprise to gain pricing flexibility in the markets in which it operates.

The performance of the institution's logistics system can also be improved through several new digital means such as artificial intelligence AI, blockchain, etc. These innovative technologies represent a significant addition for institutions seeking to improve the efficiency of their supply chain. The latter is considered a fertile field for digitization, especially with the emergence of concepts of environmental sustainability and the health conditions resulting from the COVID-19 pandemic.

On this basis, this research aims to explore the concepts of green supply chains built on digitization according to the following problem statement:

- What role does digitization have in supporting green supply chain activities?

To answer this question, the following sub-questions have been formulated:
- What is meant by green supply chains?
- What are the key green practices within supply chains?
- What are the main digitization mechanisms supporting green supply chains?

1.1. Hypotheses

- Digitization contributes to supporting the efforts of economic institutions to adopt concepts of green supply chains.
This includes the following Sub-hypotheses:
- Contemporary institutions support concepts of sustainable development, with green supply chains being a priority.
- Green practices within contemporary supply chains vary.
- Digitization is a source of enhancing green activities within the supply chain.

1.2. Significance and Aims of the Study

The importance of the study can be seen through attempting to address a modern topic in the field of marketing by highlighting the role of digitization in facilitating activities related to creating temporal and spatial benefits for goods and services, especially in light of current health conditions, which have accelerated the pace of adopting and enhancing digitization in all aspects of the enterprise. Based on this foundation, the study objectives can be summarized as follows:
- Highlighting the main mechanisms of digitization and its various applications in the economic institution.
- Clarifying the main green practices in modern supply chains;
- Stating the extent to which digitization contributes to supporting the environmental dimensions of logistics activities for institutions.

1.3. Study Methodology

The descriptive-analytical methodology has been adopted, which is suitable for describing phenomena through understanding and analyzing various activities, extracting results, and elucidating the different relationships that may appear among these phenomena.

2. **The Concept of Green Supply Chains**

1.2. The Concept of Supply Chains and Their Activities

1.2.1. The Concept of Supply Chains

Supply chains refer to the theoretical framework used by an institution to achieve integration between its various functions, starting from suppliers and ending with the final consumer, in order to achieve the flow of the institution's goods, services, and relevant information for the purpose of efficiently managing its internal operations and maximizing the value of its products and services from the perspective of its customers (Faza Awal & Zardana, 2021, p. 128).
Alternatively, it is a set of methods and techniques aimed at achieving integration between suppliers, manufacturing, warehouses, and stores to produce goods and distribute them in the required quantity at the right time and at the appropriate time in order to reduce costs within the desired level of service (Betaher Bakhta, 2019, p. 24).
From the foregoing, it can be said that supply chains are the methods and techniques used by the enterprise to increase the interconnection between various procurement and purchasing functions, starting from the purchasing process, storage, manufacturing, and distribution to the final consumer in the appropriate place and time.

1.2.2. Supply Chain Activities

Supply chain activities include core and supporting activities, which together constitute the supply chain (Betaher, 2019, p. 25-26).

A- Core Activities

The core supply activities include:

- Customer Service: It includes a set of activities through which the institution interacts with the consumer personally or through indirect communication, where these activities are designed to satisfy the customer and provide the service efficiently.
- Information System: The supply information system is one branch of the management information system, and its importance lies in collecting supply information and providing it to users.
- Storage: It is defined as the retention of goods until there is demand for them, creating temporal benefits.
- Transportation: It involves moving materials and supplies from suppliers to the project, handling materials, and then from the project to customers.
- Physical Distribution: It is the function that makes goods and services available to the user, by transferring them from the producer to the consumer at the appropriate time and place, taking into account the tastes and needs of the consumer.

Sure! Here is the translation of the article from Arabic to English, with careful attention to technical expressions and quality:

B- Supporting Activities

They include:

- Purchasing: This function involves providing the institution with the necessary materials, equipment, machinery, and services, ensuring their flow to the warehouses and production sites in the required quantity, specifications, and at the lowest cost.
- Demand Forecasting: This involves predicting future events related to logistical requirements.
- Handling: This function involves preparing, loading, and unloading materials, as well as lifting and placing them to facilitate the movement and storage of goods.
- Packing and Packaging: To increase the efficiency of handling, products are placed in packages of different shapes and sizes. The packaging helps protect the goods from damage and facilitates their movement.

1.2.3. Transition from Traditional Supply Chains to Green Supply Chains

Supply chains represent the processes and procedures undertaken by institutions to transform raw materials into finished products and subsequently deliver them to the supplier. Various studies have shown that these chains have evolved from simple, one-directional processes to complex networks involving different parties. This evolution has often been driven by relevant technological advancements and environmental conditions.

The aim of the supply chain has been to maximize consumer satisfaction and increase the profitability of the institution. However, in recent years, with the emergence of environmental issues and the contribution of supply chains to several environmental problems such as emissions, waste, and resource consumption, there has been a significant negative impact on the environment. With the increasing awareness among stakeholders within institutions about environmental and social responsibility dimensions, the concept of green supply chains has emerged to embody this concern in reality (Charisios, Dionysis D, Dimitrios, & Dimitris, 2018, p. 8).

2.2. Definition of Green Supply Chain Management (GrSCM)

Green Supply Chain Management (GrSCM) is gaining increasing attention among researchers and practitioners of operations and supply chain management. This is mainly due to the rising indicators of environmental degradation, such as the depletion of raw material resources, increased waste, and high levels of environmental pollution. Institutions' interest in the environmental aspect is not only due to environmental degradation but also because environmental sustainability is currently a value driver within institutions, being one of the requirements of the modern customer (Srivastava, 2007, pp. 54-53).

It can be defined as the consideration of environmental factors in product design, material sourcing, green production, and delivering the final product to the customer while providing after-sales services through reverse supply (Moumeni & Tarbash, 2018, p. 118). This involves integrating environmental concerns into the supply chain, including activities related to reduction, reuse, reworking, renewal, restoration, recycling, remanufacturing, reverse logistics, etc. (Srivastava, 2007, p. 54).

It is also defined as the process of integrating environmental concerns into supply chain management practices, including reverse logistics. In other words, it involves incorporating environmental thinking into supply chain management, including product design, material sourcing and selection, manufacturing processes, final product delivery to consumers, and managing products after their end-of-life (Al-Saadi & Menasria, 2017, p. 866).

2.3. The Importance of Green Supply Chain Management

Institutions should reconsider their product designs and production techniques by producing recyclable and reusable products after their end-of-life. This depends on the ability to manage and coordinate relationships with suppliers to obtain green inputs and create green markets.

Green supply chain management has several advantages, which can be summarized as follows (Al-Saadi & Menasria, 2017, p. 866):

- Contributing to increasing the volume of environmentally friendly products.
- Improving the institution's competitive position by enhancing their market status.
- Encouraging countries to create new markets for environmentally friendly products.
- Designing and producing green products minimizes resource usage.
- Enhancing the international competitiveness of governments that support green supply chains and produce environmentally friendly products.

2.4. Barriers to Adopting Green Supply Chains

2.4.1. Internal Factors

A- *Lack of Expertise in the Institution***:** Several factors hinder the adoption of green supply chains, including a lack of technical knowledge about various clean supply chain technologies. The lack of expertise can generate a false belief that investing in these technologies will negatively impact costs and increase risks, especially in small and medium-sized enterprises with limited financial capabilities.

B- *Misconceptions about Environmental Issues:* Lack of expertise is often accompanied by incorrect concepts about clean technologies. Institutions may implement such concepts as a precautionary strategy to avoid state-imposed penalties. If these technologies are optional and costly, companies might reject them, considering them a short-term nuisance to operational activities.

C- Poor Estimation of Returns and Costs in Environmental Financial Accounting: Supply chain activities are linked to financial results, a crucial factor for decision-makers within the company, whether public or private. Financial accounting seems to overlook the inclusion of environmental dimensions in decision-making processes due to difficulties in quantitatively determining impacts and risks. As a result, green supply chain dimensions and their long-term effects are often absent in institutional budgets, which tend to favor liquidity over long-term returns.

D- Impact of Short-Term Profit on Adopting Cleaner Technologies: The short-term profit mentality greatly influences all decisions made within a company and is often the reason for abandoning efforts to improve the institution's environmental performance. Managers must balance current performance and investment attractiveness for the institution. Hence, they might favor short-term profit distribution over environmental performance. Managers find themselves choosing between investments that ensure profitability and competitive advantage, or long-term investments that consider environmental aspects.

E- Lack of Coordination Between the Institution's Interests: The growth of a company and the diversification of its interests can increase the gap between the goals and concerns of

these interests, affecting the adoption of green concepts within the institution. Managers must encourage all parties to exert more effort to successfully adopt clean technologies within the institution.

F- Challenges of Transitioning to Green Technologies: The decision to switch to clean technologies requires the use of new equipment, technology, or products, as well as specialized personnel and expertise. These structural changes will affect current machinery and equipment and have implications for personnel, requiring special challenges to be addressed. Ensuring a competitive position by acquiring the latest technology against competitors while determining the right mix of effective and new technologies to achieve high and efficient performance levels requires significant financial and organizational efforts from the institution (Charisios, Dionysis D, Dimitrios, & Dimitris, 2018, pp. 15-22).

2.4.2. External Factors

A- Legal Gaps in Regulating Green Supply Chains: Implementing strict laws that specify the types of technology or nature of the techniques used in green supply chains with little room for initiative and innovation can generate a negative reaction towards environmental issues from managers, as there is no profit incentive. Given that the supply chain is a complex network of intertwined activities using various products, and considering the diversity in the size and forms of companies, adapting to specific laws regulating the type of technology imposed within sustainable logistics activities is challenging, where the institution does not have the freedom to choose the right technology mix for it. Institutions see these laws as cost barriers and hindrances to replacing their traditional supply chains. Additionally, procedural factors accompanying the adoption of cleaner technology are viewed as additional costs.

B- Risks of Adopting Cleaner Technology: Investing in any field involves certain risks, and with high costs, green investment becomes less attractive. These risks increase with the company's size, especially for small and medium-sized enterprises that find it difficult to access green technology. Investing in this technology, besides the risks faced by other investments, means the institution will encounter new, complex technology requiring long transition periods and lower productivity. The key risks of investing in green technology are:

- Green technologies are modern and their success is uncertain.
- Suppliers may fail to provide complete and sound technological systems.
- High technological development costs make institutions lean towards less expensive economic solutions instead of focusing on technology quality.

C- Limited External Funding: Institutions, especially small and medium-sized ones, face difficulties in accessing financial solutions to support green investments due to the absence of specialized financial plans to support such projects.

D- Lack of Markets for Recycled Goods: For an institution to engage in recycling activities and reusing products, there must be a market for these goods to facilitate their distribution and use. There should also be guarantees that the reuse of goods within green supply chains is feasible in the long term (Charisios, Dionysis D, Dimitrios, & Dimitris, 2018, pp. 22-26).

2.5. Factors Facilitating the Adoption of Green Supply Chains

2.5.1. Internal Factors

A- Continuous Improvement of Environmental Management Systems: Environmental management systems have several standards for environmental assessment, the most well-known being those provided by the International Organization for Standardization (ISO), specifically ISO 1400. These systems form the basic standard and motivation for an institution to adopt clean practices to improve its environmental performance. Institutions working with such standards benefit from continuous improvement in supply operations, especially with the emergence of total quality concepts that support this.

B- Voluntary Initiatives: Some green practices result from voluntary actions by companies rather than legal frameworks. These individual solutions effectively address environmentally friendly activity problems, bringing financial benefits, publicity, and a sense of progress. For instance, the Greek market company “Neon Energy” replaced and updated its lighting

system to an LED system without investing at the beneficiary's expense. To finance investment costs and generate profits, the savings from energy consumption are directed towards depreciations for "Neon Energy." In this context, the payback period is much shorter than the expected lifespan of the system. Although beneficiaries receive only non-financial benefits from the investment during the initial years, they can enjoy financial savings shortly by benefiting from stable cash flows during the investment period. Government initiatives also play an important role.

Another driver for voluntary initiatives to adopt green supply chains is the desire to emulate competitor institutions that have achieved positive results in adopting clean technologies within their supply chains.

C- Environmental Leadership: Environmental leadership refers to strategic decisions leading to environmental excellence. This major change in environmental issues has become part of performance indicators, similar to market share. Institutions have transferred this increasing importance of environmental performance to all their internal interests, encouraging the workforce to participate in achieving environmental goals. This concern reflects on the institution, portraying it as a socially and environmentally responsible company, attracting financial interest for shareholders, improving living conditions for the workforce, and benefiting all parties.

D- Environmental Reports: Institutions with environmental activities within their plans inform various stakeholders internally. This action is part of the broader value included in the company's green programs. However, collecting data and preparing reports on these activities is a complex process that requires examining the company's activities over a considerable period. Managers often resort to standardized and quantitative criteria to set measurable goals, monitor efficiency, and outline work plans and performance. Based on these criteria, environmental reports of the company or competing companies can be evaluated.

E- Environmental Accounting: Adopting environmentally focused systems in institutions requires environmental accounting systems that translate performance into financial data. While adopting these systems poses a challenge, it also presents an opportunity to strengthen green practices, allowing institutions to reap financial benefits, increase profits, and support sustainability. Environmental accounting will thus help institutions gain a competitive advantage primarily based on the environmental factor.

F- Enhancing Efficiency: In some cases, increasing the efficiency of the supply chain is fundamentally linked to the greening process through the improvements brought by the green supply chain. Although environmental costs remain high and their outcomes are associated with long payback periods, green management sometimes provides short-term profitability and returns, such as improving various daily habits like using timers within the supply chain (Charisios, Dionysis D, Dimitrios, & Dimitris, 2018, pp. 26-30).

2.5.2. External Factors

A- Regulations Promoting Innovation in Pollution Prevention: Some governments have sought to encourage institutions that have developed specific solutions to environmental issues and supported joint dealings to encourage environmental initiatives by setting standards and defining pollutants. This facilitates strategic planning and preventive work, reduces costs, and enhances initiatives for developing shared technology among institutions.

B- Economic Incentives: When adopting a green supply chain, an institution may benefit from various financial advantages, including tax breaks and governmental support for environmental investments. Conversely, a company with poor environmental performance may be penalized in the form of environmental fees. Thus, economic incentives can be seen as a guiding tool for sustainable environmental policy.

C- Education and Training: To ensure change and improvement, institutions resort to training and educating individuals and employees and transferring knowledge within the supply chain. In this context, improvement becomes a fundamental element of the company's mentality, along with attempting to transfer green behavior to consumers by positively

engaging with individuals interested in expanding green behaviors and educating them on how to act responsibly towards the environment at every step.

D- Supply Chain Pressures: Large institutions within the supply chain often hold significant importance and status, giving them the ability to lead and direct other parties. This enables them to exert pressure on other channel members to ensure better environmental practices, sometimes making these requirements a condition for entering long-term partnerships. Suppliers might also use these requirements as part of their routine evaluation of their environmental management systems.

E- Financial Institutions: Financial institutions can act as catalysts for environmental performance for institutions and supply chains by imposing conditions such as full compliance with environmental standards for establishing financial relationships with them.

F- Stakeholder Pressure: Society and its concerns are central to all levels of institutional planning. Institutions must consider concerns about the negative impacts of the supply chain and mitigate them to gain a special position in the community in which they operate and raise awareness about environmental issues.

G- Green Consumers: Since the beginning of this century, awareness of environmental issues has increased, leading to the formation of consumer groups and organizations exerting pressure on service providers to comply with sustainability standards in the operations and activities of institutions.

*H-International Trade:*Institutions operating within globalization and the internationalization of activities necessitates adhering to a set of international standards in exchange, such as quality and environmental standards known as ISO 1400. The supply chain plays an important role in the success of international trade. Hence, it is beneficial for an institution to have a supply chain consistent with various global trade trends (Charisios, Dionysis D, Dimitrios, & Dimitris, 2018, pp. 30-37).

3. Dimensions and Practices of the Green Supply Chain

The green supply chain management dimensions and practices are multidimensional and will be addressed in the following:

3.1. Green Information Technology

Also known as green computing, it encompasses all policies and regulations related to the green use of information technology equipment and devices in organizations. It includes initiatives and strategies that support the environmental footprint of technology, resulting in energy reductions in devices, electricity, fuel, and paper. Many IT companies have begun developing and offering products compatible with green information technology, which helps organizations and stakeholders, including clients, suppliers, and consumers, make informed decisions (Haroun Joumaa, 2014, p. 5).

3.2. Eco-design

Eco-design refers to the design of a product or process with a focus on minimizing and preventing environmental impacts before production, distribution, and use. It involves analyzing the product at the end of its life cycle, revealing costs, and the environmental impact of reusing and recycling the product. Eco-design helps identify the optimal tool for pollution prevention, as 80% of product characteristics and 70-80% of lifecycle costs are determined at this stage. Product design is linked to its lifecycle, which is the basis for offering environmentally friendly products. Features of an eco-friendly product, such as disassembly, reuse, and renewal, are all related to its lifespan. Cisco is a leader in eco-design, with its sustainability programs encompassing all parties it deals with, including suppliers, clients, governments, and industrial companies. Cisco is a leader in the field of eco-design, where its sustainability programs encompass all the stakeholders it interacts with, including suppliers, customers, governments, and industrial companies. Cisco's

management has defined the eco-design and environmental requirements for its products, including: (Sarkis & Dou, 2018, p. 23).

- Efficient energy use;
- Design for recycling;
- Long product life;
- Reducing packaging material volume;
- Environmental oversight at all product stages

In recent years, the company has integrated 96% of its new products into the principles of eco-design, focusing its design efforts on critical environmental issues such as gas emissions, global warming, water, soil, and air pollution. One significant effort by the company has been the reduction of hazardous materials in the physical aspects of its digital products, particularly the materials used to reduce flammability in materials and physical products (Brominated Flame Retardants, BFRs). Studies have shown that these are harmful to neurological health, are endocrine disruptors, and are toxic to both the environment and humans (Sarkis & Dou, 2018, p. 24).

3.3. Green Procurement

Green procurement is a process involving collaboration with suppliers to develop environmentally friendly products. This process aims to reduce waste sources, encourage material recycling and reuse without compromising financial performance requirements (Moumeni & Tarbash, 2018, p. 119).

Typically, the goal of green procurement is to minimize environmental damage and impacts throughout the product's lifecycle and all associated activities, including manufacturing, transportation, use, reuse, and remanufacturing. Previously, procurement managers focused on economic dimensions such as quality and price. However, with the emergence of environmental concerns and increased consumer awareness, environmental dimensions have been integrated alongside commercial and organizational aspects.

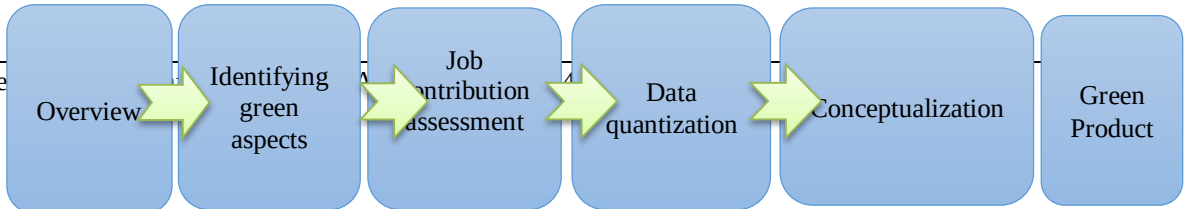
It is essential to note that balancing economic and traditional performance with the environmental performance of purchased materials is crucial in green procurement. There is a common belief among managers that recyclable materials are usually more expensive and of lower quality than non-environmentally friendly materials. Additionally, issues related to delivery and lack of experience in handling these materials by suppliers should not be overlooked (Sarkis & Dou, 2018, pp. 47-48).

3.4. Green Manufacturing

Green manufacturing is the shift towards environmental protection and sustainable development by innovating manufacturing methods, developing techniques, and making appropriate adjustments to the product lifecycle. This includes planning manufacturing, reducing energy consumption, utilizing resources efficiently, and minimizing waste during the manufacturing process (Moumeni & Tarbash, 2018, p. 119).

Globally, institutions are committed to various regulations that govern environmental issues such as water, air, and soil pollution, as well as global warming. Here, we will outline the six essential stages that institutions must adhere to in the green manufacturing process, as illustrated in the following diagram:

Fig1. Stages of Green Product Design





Source : (Charisios , Dionysis D, Dimitrios , & Dimitris , 2018, p. 67)

Source : (Charisios , Dionysis D, Dimitrios , & Dimitris , 2018, pp. 67-73)

3.5. Green Distribution

Green distribution involves the application of practices and technologies aimed at mitigating the negative environmental impacts of transportation and distribution. This includes the development of eco-friendly transportation methods, designing efficient distribution networks, and selecting distribution centers or central warehouses near points of sale with the highest demand. This approach achieves optimal and faster service for customers, shortens distribution routes, and consequently reduces emissions and pollutant gases.

3.6. Reverse Supply Chain

The need for reverse supply chains has emerged due to several main factors that have put significant pressure on the environment today, such as solid waste, leading to increased manufacturing rates. Reverse logistics involves the planning, implementation, and control of the efficient flow of raw materials, inventory, goods, and related information from the point of consumption back to the point of origin for the purpose of recapturing value or proper disposal (Moumeni & Tarbash, 2018, p. 119).

4. Digitalization, Green Supply Chains, and Their Mechanisms

Advanced digital technologies play a significant role in leveraging green supply chains, which inherently involve environmentally harmful activities, whether in primary sourcing activities, production management, or final supply activities like demand management and recycling activities.

Digital technology supports significant advantages such as better information tracking and availability, and enhanced communication and collaboration across the entire supply chain. However, it also has drawbacks, including high costs, technological immaturity, and large energy requirements. Here, we will explain the key modern digital technologies that help reinforce green activities within supply chains.

4.1. Internet of Things (IoT)

The Internet of Things (IoT) is defined as the interconnection between physical devices, as well as virtual entities, operating through a smart infrastructure that relies on the internet (Sarkis, Kouhizadeh, & Serena Zhu, 2018, p. 7).

IoT refers to the connection of any device to the internet via a set of specific protocols, forming a network of physical objects, whether computers, mobile devices, toys, or connected cameras. These devices can communicate with each other using artificial intelligence technologies without human intervention (Moussi & Dasi, 2020, p. 524).

Real-time data collection, information sharing, and communications can enhance supply chain performance. Despite recent rapid IoT research, its application within supply chains remains underdeveloped and requires further study.

IoT devices can effectively virtualize supply chain products and facilitate their tracking and source verification. They also provide real-time information that allows for the assessment of inventory status and factors related to purchasing by leveraging GPS and RFID technologies (Sarkis, Kouhizadeh, & Serena Zhu, 2018, p. 9). These technologies help track every activity in the supply chain from product design to distribution and final delivery. During this process, the company can obtain precise information that responds to market changes quickly and appropriately. IoT also enables immediate customer demand fulfillment, which traditionally would take 120 days. Furthermore, coordination between point-of-sale users and the company in this modern approach ensures the use of information that helps reduce material waste, save costs, and increase profit margins (Mishra, Gunasekaran, Childe, Papadopoulos, Dubey, & Wamba, 2016, p. 9).

Additionally, some studies emphasize the importance of IoT in designing a smart factory that supports green environmental initiatives by reducing gas emissions and redesigning processes in an eco-friendly manner (Sarkis, Kouhizadeh, & Serena Zhu, 2018, p. 8).

4.2.Blockchain Technology

Blockchain technology, or "blockchain," is the latest revolution in the world of finance and business. While there is no unified concept for it, all definitions generally agree that it is the new generation technology for conducting transactions or deals, founded on trust, responsibility, and transparency thanks to the mechanism of consensus associated with the use of the large public ledger. (Trobrija, 2020, p. 32)

Blockchain enables users to retain and transfer data through the distributed ledger, which eliminates barriers to effective information management in traditional supply chains. Additionally, blockchain technology provides a secure and unified platform for sharing data management of different supply chain operations and other business processes. It also offers numerous opportunities to address green and sustainable supply chain issues.

Blockchain technology allows suppliers to share their resources without the need for trust with the parties they deal with, as it is designed to eliminate intermediaries and their trust in transactions.

The blockchain-based platform can create a market for users who share resources, leading to resource reduction and waste reduction, as everyone operates within the framework of the sharing economy, especially regarding greening energy supply chains. (Sarkis, Kouhizadeh, & Serena Zhu, 2018, p. 8)

Decentralized energy management is another form of benefiting from blockchain, where renewable energy is distributed peer-to-peer, facilitating distribution and monitoring through that chain. In addition to this, this technology can also be used in the organizational field for large-sized companies with scattered and complex interests and facilities, where routine control of those interests is done using the distributed ledger for monitoring resources, energy, and waste. This digital process is the basis for evaluating green performance and correcting the performance of interests that do not commit to environmental aspects in their performance.

Institutions can also benefit from this technology in collaboration and joint work between several institutions in the field of shared storage and warehouse management. Where it increases storage efficiency and reduces waste by tracking goods and informing waste-generating manufacturers to ensure proper disposal of these materials.

Walmart's Experience in Applying Blockchain Technology in Food Supply Chains

Blockchain technology is one of the most important technological additions that have appeared recently, as this technology can be used in storing and trading data without centralized authority. Although the application of this technology in the food supply chains remains in its early stages, Walmart has succeeded to some extent in benefiting from the advantages provided by this technology. The effects of applying blockchain technology to Walmart's supply chains can be clarified or classified into four categories: (Tan, Jiaqi, Liu, & Chen, 2018, pp. 171-173)

- *Reducing Health and Food Risks:* Reducing the risk of contamination in food items is the primary benefit Walmart gains from applying blockchain technology within its food supply chain. For example, China is the world market with the highest population density targeted by the company to enter, but it can be affected by issues of spoiled food that accompany the distribution process from time to time, where a study by the World Health Organization confirmed that spoiled food contains bacteria, viruses, and harmful chemicals, where 1 in 10 people get sick from eating spoiled food. Blockchain technology is expected to positively impact food tracking within the supply chain by the ability to monitor food at all stages of the supply chain, from source to store, through digital means that depict the journey of the commodity with complete transparency, where the sources of disease and food contamination can be easily monitored, reduce the time to identify the cause of contamination, and avoid contaminating more food, knowing that contaminated food helps to withdraw it instead of withdrawing all the food from the shelves and therefore making an economic return from it.
- *Improving Cooperation and Enhancing Strategic Alliances:* Walmart operates in many countries and has thousands of suppliers across various continents, and it is expected that this technology will deal with the complex relationships in the supply chain through the joint distributed ledger, given the characteristics of food and that concern all sectors of society. IBM is trying to solve the food safety issue through cooperation rather than competition by establishing blockchain-based partnership experiments, which was suggested to Walmart and sees it as the ideal way to gain a strategic alliance that contributes to deepening cooperation in the food industry.
- *Reducing the Impact of Pollution or the Ecological Footprint:* As mentioned earlier, food waste is a waste of resources and an additional cause of global warming that increases with increasing waste, and with the increase in the annual contribution to food waste in generating carbon dioxide according to the Food and Agriculture Organization, it is likely that Walmart will achieve its sustainable goal of reducing carbon dioxide in its global supply chain by adopting blockchain technology as mentioned in the Global Responsibility Report for 2018.
- *Enhancing Efficiency and Effectiveness in Supply Chains:* This technology enables to increase the efficiency of the flow within the supply chain, whether the flow of food, information, or financial flows, as this technology ensures decision-making in real-time. For example, when the expiration of any food or mistreatment is finished, Walmart can identify it before reaching consumers, either on the level of logistics services or actually on the shelf level, and walmart mentioned in the Global Responsibility Report that their goal is to reduce food waste and eliminate it in their operations, and to plan for achieving zero waste in Canada, Japan, USA, and Britain, by 2025, as Walmart uses blockchain technology to reduce the problem of food spoilage in the institution through planning the best way to deliver and reduce the time of delivery of perishable foods and thus reduce the cost and food wasting.

This technology can also benefit supply chains through:

- Selecting permanent dealers;
- More benefit for farmers;
- Taking advantage of direct sales to customers.

4.3. Quantum Computing

Quantum computing is a new technology based on the physical properties of quantum mechanics to solve complex problems quickly and with high accuracy. Although digital supply chains provide many advantages, they can cause a problem of data inflation that is difficult to manage. However, quantum computing has the ability to use this data to support smart operations and green manufacturing that contribute to greening institutions, by improving energy use in the supply chain. Among the most promising applications of quantum computing, dynamic routing and programming are considered important tasks where determining the optimal route of logistics and delivery services is a time-consuming task when using a traditional computer, but quantum computers can provide multiple guidance alternatives simultaneously and form simulations of the movement of goods and obtain the best method for that, which saves cost and effort, while taking into account environmental aspects when determining the best method.
Regarding the opposite supply chain, quantum computer technology helps in the field of product recovery and improvement. Depending on the nature of the products, the optimal scenarios can be determined, which increases the usability and reuse of products. (Sarkis, Kouhizadeh, & Serena Zhu, 2018, p. 9)

5.Conclusion

In this research paper, we addressed the relationship between modern digitization technologies and supply chains within economic institutions, and the efforts made by these institutions to activate this relationship. Despite the novelty of green supply chain concepts, they have gained widespread adoption, aided primarily by digitization. This field is fertile ground for increasing the efficiency and effectiveness of supply chains, especially given the current global health conditions. However, digitization still requires efforts to ensure proper control of its technologies and to guarantee the rationality of their usage costs.
From the findings of this study, several points emerge:

- Green supply chains are a strategic direction for most institutions seeking integration into the global economy.
- Digitization is one of the modern mechanisms that encourages increased environmental activities in supply chains.
- The use of digitization remains a double-edged sword, as this technology is modern and still requires effort, time, and cost.
- Internet of Things (IoT), Blockchain technology, and Quantum Computing are among the most important technologies used to enhance the efficiency and effectiveness of supply chains.
- Walmart is a leader in adopting Blockchain technology within its food supply chain, successfully offering healthier products with lower environmental impact at reduced costs.
- Assessing the effectiveness and efficiency of digitization technologies within supply chains is still in its early stages, despite promising prospects for these technologies in supporting environmental activities.

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