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# Driving sustainable supply chains: Blockchain-enabled eco-efficiency for resilient customs ports

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This paper investigates the driving factors behind sustainable supply chains in Jordan, focusing on the implementation of blockchain technology, customs ports practices, and technological infrastructure. The primary data for the study was collected through questionnaires distributed to employees working in the Jordanian customs. A random sampling method was employed to select participants, and a total of 184 valid questionnaires were retrieved for analysis. The collected data was analyzed using the statistical software Smartpls PLS4. The results of quantitative research reveal that the implementation of blockchain technology and technological infrastructure positively affects the driving of sustainable supply chains in Jordan, also customs ports practices also have a positive impact on driving sustainable supply chains, emphasizing the significance of efficient and resilient customs operations for sustainability. Additionally, compliance with environmental regulations enhances the effectiveness of blockchain technology in achieving sustainability objectives. Moreover, underscoring the role of robust technological capabilities in supporting sustainable operations within customs ports. The study contributes to the understanding of the key drivers of sustainable supply chains in Jordan, providing valuable insights for policymakers, supply chain managers, and other stakeholders involved in promoting sustainability within the customs ports industry. The findings can guide decision-making and inform strategies aimed at enhancing eco-efficiency and resilience in supply chain operations.



## 1. Introduction

Driving sustainable supply chains is a critical goal for organizations across various industries, as they seek to balance economic growth with environmental responsibility and social well-being (Cai & Choi, 2020). Supply chains play a significant role in shaping the overall sustainability performance of businesses, and there is a growing recognition of the need for innovative approaches and technologies to enhance their eco-efficiency and resilience (Alhawari et al., 2021; Elf et al., 2022). In this context, blockchain technology has emerged as a promising solution with the potential to revolutionize supply chain management and drive sustainability efforts. Blockchain technology, originally developed for cryptocurrencies like Bitcoin, is a decentralized and transparent ledger system that enables secure and immutable recording of transactions (Sladić et al., 2021; Rajasekaran et al., 2022; Yap et al., 2023). Its unique features, such as decentralization, immutability, and transparency, offer a range of benefits for supply chains, including enhanced traceability, increased trust, improved data management, and

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streamlined processes. By leveraging these advantages, blockchain technology has the potential to transform supply chains into more sustainable and efficient systems. Within the context of supply chains, customs ports play a crucial role as gateways for international trade, where goods are inspected, documented, and cleared for entry or exit. Efficient and resilient customs ports practices are vital for ensuring smooth and timely flow of goods while adhering to regulatory requirements. By adopting sustainable practices within customs ports, such as optimizing customs clearance processes, reducing paperwork, and minimizing delays, organizations can contribute to driving sustainable supply chains (Almatarneh et al., 2022). Furthermore, the effectiveness of blockchain technology and customs ports practices in driving sustainable supply chains is closely linked to the availability of a robust technological infrastructure (Schmidt, C. G., & Wagner, 2019; Thompson and Rust, 2023). Technological infrastructure encompasses the necessary hardware, software, and connectivity that support the implementation and utilization of digital solutions. A well-developed technological infrastructure enables efficient data sharing, real-time visibility, and seamless integration of blockchain technology and customs ports practices, thereby facilitating sustainability efforts (Ayan et al., 2022).

In addition to these driving factors, environmental regulations play a significant role in shaping the sustainability landscape of supply chains (Gustafsson et al., 2023). Regulations related to environmental protection, emissions reduction, waste management, and resource conservation create a framework within which organizations must operate (Geng et al., 2013; Zorpas, 2020). Environmental regulations can either facilitate or hinder the implementation of blockchain technology and customs ports practices, thereby impacting the overall sustainability performance of supply chains. The pursuit of sustainable supply chains is a critical challenge for organizations worldwide, including those operating in Jordan (Al-Zaqeba & Al-Rashdan, 2020a). While there is a growing awareness of the importance of sustainability, there is a lack of comprehensive research examining the specific drivers and mechanisms that enable sustainable supply chains in the Jordanian context. Furthermore, the potential of blockchain technology, customs ports practices, and technological infrastructure in driving sustainability remains relatively unexplored.

Due to limited understanding of the impact of blockchain technology on driving sustainable supply chains in Jordan (Jraisat et al., 2022; Jum'a, 2023), despite the increasing interest in blockchain technology as a potential enabler of sustainability, there is a lack of empirical evidence and research focused on its actual impact on driving sustainable supply chains within the Jordanian context. This study aims to fill this gap by investigating the relationship between blockchain technology implementation and driving sustainable supply chains in Jordan. Inadequate knowledge of the role of customs ports practices in promoting sustainability, customs ports play a vital role in facilitating international trade and can significantly impact the sustainability performance of supply chains. However, there is a scarcity of research exploring the specific customs ports practices that contribute to driving sustainable supply chains in Jordan. This study seeks to address this gap by examining the relationship between customs ports practices and driving sustainable supply chains in the Jordanian context. In addition to limited understanding of the significance of technological infrastructure in supporting sustainability efforts (Ojo et al., 2022; Sahoo et al., 2023), a robust technological infrastructure is essential for the effective implementation of digital solutions, including blockchain technology, within supply chains. However, there is a dearth of research focusing on the role of technological infrastructure in driving sustainable supply chains in Jordan (Al-Ghwayeen and Abdallah, 2018). This study aims to shed light on the relationship between technological infrastructure and driving sustainable supply chains, and further explores its mediating role in the relationships between blockchain technology implementation and customs ports practices with sustainability outcomes.

Insufficient investigation of the moderating effect of environmental regulations (Liu et al., 2022; Tan and Uprasen, 2022), environmental regulations play a crucial role in shaping the sustainability landscape of supply chains. However, little is known about the extent to which environmental regulations moderate the relationship between blockchain technology implementation and driving sustainable supply chains in Jordan (Cousins et al., 2019; Mubarik et al., 2021; Esfahbodi et al., 2023). This study addresses this research gap by examining the moderating effect of environmental regulations on the relationship between blockchain technology implementation and driving sustainable supply chains in the Jordanian context. By addressing these research gaps, this study aims to contribute to the existing literature on sustainable supply chains and provide valuable insights for organizations, policymakers, and stakeholders in Jordan seeking to drive sustainability within the customs ports industry (Jordan, 2019; Chen et al., 2019; Alsharari, 2022). Therefore, this research aims to explore the driving forces behind sustainable supply chains in Jordan, focusing on the role of blockchain technology, customs ports practices, technological infrastructure, and the moderating effect of environmental regulations.

## 2. Literature Review

The literature review highlights the importance of sustainable supply chains, the potential of blockchain technology, customs ports practices, and technological infrastructure in driving sustainability, and the role of environmental regulations. The review sets the foundation for understanding the research context and provides a basis for further investigation into the relationships between these factors and their impact on driving sustainable supply chains in Jordan.

### *2.1 Driving Sustainable Supply Chains*

The concept of sustainable supply chains emphasizes the integration of environmental, social, and economic factors to achieve long-term sustainability (Jarah et al., 2022). Therefore, scholars have highlighted the importance of sustainable practices such as green procurement, reverse logistics, collaboration, and resource optimization in achieving sustainable supply chains. Various studies have explored the benefits of sustainable supply chains, including cost savings, enhanced brand reputation, reduced environmental impacts, and improved stakeholder relationships. In addition, the existing literature has identified drivers for SSCM adoption, but there is a lack of research on methodological approaches that capture the dynamic nature of SSCM and bridge the quantitative e-qualitative divide. In response to this gap, Dubey et al. (2017) conducted a systematic literature review on SSCM drivers and proposed the use of TISM and Cross Impact Matrix-Multiplication Applied to Classification (MICMAC) analysis to develop a theoretical framework (Aldeeb et al., 2022).

Previous studies, such as Marculetiu et al. (2023), have highlighted the growing interest in sustainability and the increasing pressure faced by firms to change their sustainable supply chain management (SSCM) practices. By research articles spanning from 1997 to 2022, the authors examined the impact of various pressure types normative, coercive, relational, mimetic, and instrumental exerted by different sources on firm and SSCM practices. Furthermore, the research identified relationships that have not been adequately explored and suggested avenues for further inquiry in this field. The study emphasized the need for firms to discern which pressures to embrace and which to ignore, as well as the importance of understanding the effectiveness of different pressure types for various pressure sources. Future research is required to delve into the complexities associated with these issues for both firms and potential pressure sources. In addition, the literature explored the drivers and pressures that influence organizations to adopt sustainable supply chain initiatives. These drivers, referred to as enablers, triggers, pressures or drivers in the literature, encompass both internal and external factors. Caniato et al. (2012 defined drivers of sustainable supply chain management (SSCM) as pressures that push organizations to implement specific sustainability initiatives, while Köksal et al. (2017) described them as external factors that motivate organizations to adopt SSCM practices. In this study, drivers for SSCM are defined as motivators or influencers that encourage organizations to implement sustainability initiatives throughout the supply chain. Various drivers impact supply chain decisions to varying degrees. For instance, media and shareholders have more influence on purchasing and logistics-related decisions, respectively. Employees and non-governmental organizations (NGOs) play a more significant role in decisions concerning the social dimension, while regulatory bodies have greater influence in the environmental dimension (Harangozó & Zilahy, 2015). Institutional theory is commonly employed to explain how these drivers affect sustainable actions, emphasizing the importance of conforming to rules and norms for social fitness and legitimacy (Liu et al., 2022; Huang and Chen, 2022; Yue et al., 2023). Within institutional theory, drivers are categorized into three institutional pressures: coercive, normative, and mimetic (Agana et al., 2023). Coercive pressures, exerted by government or regulatory bodies, are considered highly influential, while normative pressures stem from social obligations and mimetic pressures arise when competitors adopt sustainability practices. Although theoretically distinct, these institutional pressures may not always be empirically distinguishable.

The review revealed that regulatory frameworks and government policies play a crucial role in driving sustainable supply chains (Fu et al., 2022). Eltayeb et al. (2018) emphasized the importance of supportive legislation and regulations that enforce environmental standards and encourage organizations to adopt sustainable practices. For instance, emissions reduction targets, waste management regulations, and carbon pricing mechanisms were found to motivate companies to integrate sustainability into their supply chain operations. Furthermore, customer demand and market forces emerged as powerful drivers of sustainable supply chains. Increasingly, customers are seeking environmentally friendly and socially responsible products, which prompts companies to implement sustainability initiatives (Tumpa et al., 2019). The review highlighted that organizations responding to consumer preferences gain a competitive advantage, enhance brand reputation, and foster long-term customer loyalty. This finding suggests that market-driven pressures influence companies to adopt sustainable practices throughout their supply chains. Collaborative relationships with suppliers and other stakeholders were identified as critical enablers for driving sustainable supply chains. Eltayeb et al. (2018) found that close collaboration, knowledge sharing, and joint problem-solving between organizations and their supply chain partners are essential for implementing sustainable practices. Supplier engagement programs, supplier assessments, and capacity-building initiatives were found to be effective in promoting sustainability and driving positive changes across supply chains.

Sustainable SC enablers and mitigating sustainable SC barriers. Jia et al. (2020) highlights the limited research on sustainable SCF and the untapped economic, environmental, and social value it offers. The findings provide insights into the motives, practices, and outcomes of SSCF, while identifying gaps in the existing literature and offering recommendations for future research. The review contributes to the advancement of knowledge in the field of SCF and sustainability, emphasizing the need for further exploration and understanding of SSCF's potential in driving sustainable SC performance (Abuhamdah et al., 2021; Alsmadi et al., 2022; AlShaikh et al., 2023).

### *2.2 Blockchain Technology Implementation*

Blockchain technology has gained significant attention in recent years due to its potential to transform supply chain operations. It offers features such as decentralization, immutability, transparency, and enhanced security, which can address challenges

related to traceability, provenance, trust, and data management in supply chains. Research has demonstrated the benefits of blockchain technology in improving supply chain transparency, reducing fraud and counterfeiting, enhancing traceability, and enabling more efficient and sustainable supply chain operations. In addition, several previous studies have examined the implementation of blockchain technology in different sectors. Tijan et al. (2019) conducted a comprehensive review specifically focused on logistics and supply chain management. They highlighted the potential benefits of blockchain technology in reducing order delays, goods damage, errors, and data redundancy within these industries. Jović et al. (2019) explored the implementation of blockchain technology in the shipping industry, emphasizing its role in addressing digital trust and data synchronization challenges. Andrian and Kurniawan (2018) conducted a systematic literature review to gain a deeper understanding of how blockchain technology is conceptualized and implemented across various fields. Kwilinski (2019) investigated the implementation of blockchain technology in the accounting sphere, emphasizing its significance in ensuring reliable and truthful transactions within databases. These studies, along with others, contribute to our understanding of how blockchain technology can be implemented, its advantages, challenges, and its potential applications in diverse sectors. However, Solomon (2013) examined the concept of the supply chain as a network of organizations involved in producing value for the final customer. The study also discussed the development of Industry 4.0 and its potential for process improvement in the supply chain. Seebacher and Schüritz (2017) highlighted the holistic nature of Industry 4.0 and its impact on flexibility, speed, productivity, and sustainability. They emphasized the role of Logistics 4.0 in integrating processes within corporate boundaries and enabling new monitoring approaches using smart trucks, containers, and pallets. Raman et al. (2018) emphasized the importance of big data in Logistics 4.0 and Industry 4.0, as it enables better decision-making. They also pointed out that big data serves as the foundation for the development of blockchain technology. Litke et al. (2019) discussed the benefits of implementing blockchain in logistics and supply chain management, including improved asset tracking, order management, and sharing of information between suppliers and vendors. It highlighted the potential of blockchain in minimizing challenges such as delays, errors, and unknown product sources. Abeyratne and Monfared (2016) focused on the potential of blockchain in achieving supply chain transparency and reviewed its applications in manufacturing supply chains. Joshi et al. (2022) highlighted the role of blockchain in ensuring the authenticity and traceability of goods within the supply chain while maintaining participant confidentiality. Lastly, Mahyuni et al. (2020) emphasized the significant improvements that can be achieved by introducing blockchain technology in the supply chain, even with simple applications. They confirm that registering product transfers on a digital ledger enhances supply chain management. However, customs ports practices are of paramount importance in international trade (Grainger, 2011; Chang et al., 2020). They ensure compliance with regulations, facilitate trade facilitation, generate revenue, safeguard product safety, and support international trade relations. By implementing efficient and transparent customs processes, governments and businesses can promote seamless global trade, enhance supply chain efficiency, and contribute to economic growth and development.

### *2.3 Customs Ports Practices*

Customs ports play a critical role in international trade and can significantly impact supply chain sustainability. Efficient customs ports practices, including streamlined clearance processes, digitization of documentation, and risk management, can contribute to reducing delays, minimizing environmental impacts, and enhancing overall supply chain resilience. Scholars have emphasized the importance of collaboration between customs authorities, trade facilitation measures, and the adoption of advanced technologies to drive sustainability within customs ports. Technological infrastructure, encompassing hardware, software, and connectivity, is a key enabler of sustainable supply chains. Robust technological infrastructure supports the implementation and integration of digital solutions, including blockchain technology, enhancing data sharing, real-time visibility, and decision-making capabilities. Research has highlighted the role of technological infrastructure in improving supply chain efficiency, reducing costs, enabling collaboration, and enhancing sustainability performance. Previous studies have extensively investigated various aspects of customs ports practices. Huang and Li (2018) conducted a comprehensive review of big data applications in logistics and supply chain management, highlighting its potential to enhance efficiency and decision-making in customs ports. Li, Hu, and Hu (2019) empirically examined the impact of single window systems on trade facilitation, emphasizing the positive effects on reducing trade barriers and enhancing operational efficiency. Mahyuni et al. (2020) focused on the role of blockchain technology in supply chain traceability, specifically highlighting its potential in improving transparency and security in customs ports. Tang, Cheng, and Lai (2019) provided a review of blockchain for trade facilitation, discussing its potential benefits in streamlining processes, enhancing transparency, and reducing fraud in customs ports. Van Wassenhove, Xie, and Yu (2016) conducted a study on screening imports to prevent terrorism, evaluating the effectiveness of such measures in customs ports. Veldman and Hesse (2015) investigated port-centric logistics, with a case study on the Port of Rotterdam, highlighting the benefits of a centralized logistics approach in improving port operations. Zhou, Ponomarenko, and Liu (2020) explored an AI-driven intelligent port ecosystem, emphasizing the potential of artificial intelligence in optimizing operations and decision-making in customs ports. These studies contribute to the understanding of customs ports practices, their challenges, and the potential benefits of adopting innovative technologies and practices.

### *2.4 Moderate Role of Environmental Regulations*

Environmental regulations play a critical role in shaping sustainability practices within supply chains. These regulations aim to mitigate environmental impacts, promote resource conservation, and ensure compliance with sustainability standards.

Scholars have explored the relationship between environmental regulations and sustainable supply chains, highlighting the need for organizations to adapt their operations to meet regulatory requirements and leverage sustainability practices to gain a competitive advantage. Customs ports practices play a crucial role in international trade and logistics. These practices encompass a range of activities, procedures, and regulations that govern the movement of goods across borders. Understanding the importance of customs ports practices is vital for both governments and businesses involved in global trade (Tijan et al., 2019; Grainger, 2021). Customs ports practices are essential for ensuring compliance with trade regulations and laws. Customs authorities enforce various rules and regulations related to import and export, including tariffs, customs duties, and documentation requirements (Vu et al., 2023). Adhering to these practices helps prevent smuggling, illegal trade activities, and the entry of unauthorized or prohibited goods, thus ensuring the security and integrity of international supply chains. In addition, customs ports practices facilitate trade facilitation and efficiency. Efficient clearance processes and streamlined customs procedures contribute to reducing trade barriers and minimizing delays in the movement of goods (Laboni et al., 2023). By adopting best practices in customs clearance, such as implementing single window systems and leveraging technology solutions like electronic data interchange (EDI), customs authorities can expedite the clearance process, enhance operational efficiency, and improve the overall flow of goods across borders.

Customs ports practices contribute to revenue generation for governments. Customs duties, tariffs, and other trade-related fees collected at ports of entry form a significant portion of a country's revenue (Abrego et al., 2019). Effective customs practices ensure proper assessment and collection of these fees, thus contributing to the national treasury and funding essential government initiatives and services. Moreover, customs ports practices play a crucial role in ensuring product safety and consumer protection. Customs authorities inspect goods at ports of entry to verify compliance with quality, health, and safety standards. By conducting inspections and enforcing product regulations, customs help safeguard public health, prevent the entry of counterfeit or substandard goods, and protect consumers from potential harm. Furthermore, customs ports practices support international trade relations and facilitate economic cooperation between countries (Yeo and Deng, 2020; Sporysheva and Tuerk, 2022). Harmonizing customs procedures, adopting international standards, and establishing mutual recognition agreements help promote trade facilitation, reduce trade barriers, and foster a conducive business environment (Mitchell and Mishra, 2020). Efficient customs practices also contribute to enhancing the competitiveness of businesses by enabling faster and more reliable cross-border transactions (Zhou and Liu, 2022). However, customs ports practices are of paramount importance in international trade. They ensure compliance with regulations, facilitate trade facilitation, generate revenue, safeguard product safety, and support international trade relations (Jarah et al., 2022). By implementing efficient and transparent customs processes, governments and businesses can promote seamless global trade, enhance supply chain efficiency, and contribute to economic growth and development.

### *2.5 Mediating Role of Technological infrastructure*

Technological infrastructure serves as the backbone of an organization's IT ecosystem, providing the necessary resources and capabilities to support business processes, data management, communication, and collaboration (Sandner et al., 2020). It enables organizations to leverage technology effectively, enhance productivity, improve operational efficiency, and drive innovation and digital transformation (Ghobakhloo et al., 2021). A robust and well-maintained technological infrastructure is essential for organizations to remain competitive and adapt to the evolving demands of the digital age (Rejeb et al., 2021). However, the importance of technological infrastructure in today's digital age cannot be overstated. Technological infrastructure refers to the underlying framework of hardware, software, networks, and communication systems that support the effective functioning of information technology in an organization or society. It plays a crucial role in facilitating various business processes, improving operational efficiency, enabling innovation, and driving economic growth. Moreover, one area where technological infrastructure holds significant importance is its mediating role in the relationship between technology and organizational outcomes (Ahmed et al., 2022). Technological infrastructure acts as a mediator by facilitating the effective utilization of technology and influencing its impact on organizational performance, productivity, and competitiveness (Yavuz et al., 2023). By providing the necessary resources, tools, and connectivity, technological infrastructure enables organizations to leverage technology effectively and extract its full benefits (Mohammad et al., 2020; Alsmadi et al., 2022; Ahmed et al., 2023).

The mediating role of technological infrastructure has been widely studied in the literature (Wong et al., 2022). Researchers have explored how the presence of robust technological infrastructure enhances the adoption, implementation, and utilization of various technologies within organizations. It has been found that organizations with advanced technological infrastructure are more likely to adopt and integrate innovative technologies, such as cloud computing, big data analytics, artificial intelligence, and Internet of Things (IoT) (Malkawi et al., 2019; Misra et al., 2020; Almarashdeh et al., 2021; Alwohaibi et al., 2022; Alrefai et al., 2023). In addition, literature has highlighted the positive impact of technological infrastructure on organizational performance. Studies have shown that organizations with well-developed technological infrastructure experience improved operational efficiency, cost reduction, better decision-making capabilities, and enhanced customer service. Technological infrastructure enables seamless communication and collaboration among employees, facilitates data sharing and analysis, and supports real-time information exchange, leading to improved productivity and organizational agility (Al-Zaqeba et al., 2023). Moreover, the literature has recognized the role of technological infrastructure in fostering innovation and enabling digital transformation. Organizations with strong technological infrastructure are better positioned to embrace

and exploit emerging technologies, adapt to market changes, and drive innovation initiatives. Technological infrastructure provides the foundation for organizations to experiment with new technologies, develop digital capabilities, and implement disruptive business models (Warner and Wäger, 2019; Al-Zaqeba et al., 2022). Additionally, the literature has examined the mediating role of technological infrastructure in various industries and sectors. For example, in healthcare, technological infrastructure supports the implementation of electronic health records, telemedicine, and health information systems, leading to improved patient care, cost efficiency, and healthcare outcomes (Al-Samarraie et al., 2020; Abuhamdah et al., 2021). In the education sector, technological infrastructure facilitates e-learning, virtual classrooms, and online collaboration, transforming the learning experience and expanding educational opportunities (Elumalai et al., 2021). However, the importance of technological infrastructure lies in its mediating role between technology and organizational outcomes. It enables organizations to effectively utilize technology, enhances organizational performance, fosters innovation, and drives digital transformation (Belhadi et al., 2022; Ahmed et al., 2023). The literature review demonstrates the significant impact of technological infrastructure across different industries and emphasizes the need for organizations to invest in and maintain robust technological infrastructure to stay competitive in today's digital era.

## 3. Hypothesis Development

### *3.1 Direct Effect*

The literature review emphasized the significance of internal organizational factors in driving sustainable supply chains. Leadership commitment and top management support were identified as key drivers of sustainability initiatives. Eltayeb et al. (2018) highlighted that when leaders prioritize sustainability, it permeates throughout the organization, leading to the integration of sustainable practices into supply chain operations. Employee engagement, training, and incentives were also recognized as important factors in driving sustainable supply chains, as they create a culture of sustainability and encourage employees to contribute to environmental and social objectives.

Blockchain technology has gained significant attention in recent years due to its potential to enhance supply chain operations and promote sustainability. Numerous studies have highlighted the benefits of blockchain technology in terms of transparency, traceability, and accountability within supply chains (Cai et al., 2020; Shen et al., 2019). Therefore, it is hypothesized that the implementation of blockchain technology in Jordan will have a positive impact on driving sustainable supply chains. Specifically, blockchain technology can improve supply chain visibility, reduce fraud and counterfeiting, enhance trust among supply chain partners, and enable more efficient and sustainable business processes. Therefore, it is expected that the adoption and integration of blockchain technology will positively influence the driving of sustainable supply chains in Jordan.

Customs ports play a crucial role in facilitating international trade and ensuring smooth movement of goods across borders. Effective customs port practices, including streamlined procedures, efficient documentation processes, and accurate customs clearance, can significantly impact supply chain sustainability (Ali et al., 2020; Tan, 2019). It is hypothesized that favourable customs ports practices in Jordan will have a positive effect on driving sustainable supply chains. Efficient customs procedures can reduce delays and administrative burdens, promote compliance with sustainability regulations, enhance supply chain visibility, and contribute to the overall efficiency and sustainability of supply chain operations. Thus, it is expected that well-implemented customs ports practices in Jordan will positively influence the driving of sustainable supply chains.

Technological infrastructure, including communication networks, information systems, and digital platforms, plays a crucial role in supporting supply chain operations and driving sustainability (Goh et al., 2020; Manuj & Mentzer, 2008). It is hypothesized that a robust and well-developed technological infrastructure in Jordan will have a positive impact on driving sustainable supply chains. Advanced technological infrastructure enables efficient data exchange, real-time information sharing, and seamless collaboration among supply chain partners, leading to improved decision-making, reduced environmental impact, enhanced resource utilization, and increased supply chain resilience. Thus, it is expected that a favorable technological infrastructure in Jordan will positively influence the driving of sustainable supply chains.

This study aims to investigate the relationship between blockchain technology implementation, customs ports practices, technological infrastructure, and the driving of sustainable supply chains in Jordan. By examining these hypotheses, we seek to contribute to the understanding of the factors influencing sustainable supply chain practices in the Jordanian context and provide insights for policymakers, businesses, and practitioners to enhance sustainability in supply chain operations. However, this paper assumes the following hypotheses:

**$H_1$:** *Blockchain Technology Implementation positively affects the Driving Sustainable Supply Chains in Jordan.*

**$H_2$:** *Customs Ports Practices positively affect the Driving Sustainable Supply Chains in Jordan.*

**$H_3$:** *Technological Infrastructure positively affects the Driving Sustainable Supply Chains in Jordan.*

### *3.2 Moderating Effect*

Environmental regulations play a crucial role in shaping sustainable practices and driving environmental responsibility within supply chains (Ciliberti et al., 2018; Sarkis et al., 2019). Blockchain technology has been recognized for its potential to improve transparency, traceability, and accountability, which can contribute to sustainable supply chain management (Kamble et al., 2020; Shen et al., 2019). However, the impact of blockchain technology implementation on driving sustainable supply chains may vary depending on the level of environmental regulations in place. It is hypothesized that environmental regulations moderate the effect of blockchain technology implementation on driving sustainable supply chains in Jordan. Specifically, the positive relationship between blockchain technology implementation and driving sustainable supply chains is expected to be stronger when supported by robust environmental regulations. These regulations can provide a supportive framework and incentives for businesses to adopt blockchain technology in ways that align with sustainability goals. Environmental regulations may also require specific sustainability measures or reporting standards that can be facilitated through blockchain technology, further enhancing the positive impact on sustainable supply chain practices. On the other hand, in the absence of stringent environmental regulations, the impact of blockchain technology implementation on driving sustainable supply chains may be limited. Without a regulatory push or compliance requirements, organizations may not fully leverage the potential of blockchain technology for sustainability-related purposes. In such cases, the influence of blockchain technology implementation on driving sustainable supply chains may be weakened. However, by examining the moderating effect of environmental regulations, this study aims to explore how the interplay between blockchain technology implementation and environmental regulations influences sustainable supply chain practices in Jordan. Thus, the hypotheses of this paper assume as the following:

**$H_4$:** *Environmental Regulations moderate the effect of Blockchain Technology Implementation on Driving Sustainable Supply Chains in Jordan.*

### *3.3 Mediating Effect*

Technological infrastructure refers to the underlying technological capabilities, systems, and resources that enable the implementation and integration of various technologies within an organization (Chen et al., 2020). In the context of sustainable supply chain management, the role of technological infrastructure becomes crucial in facilitating the effective utilization and impact of specific technologies, such as blockchain technology. It is hypothesized that technological infrastructure mediates the relationship between blockchain technology implementation and driving sustainable supply chains in Jordan. The implementation of blockchain technology alone may not directly lead to the desired outcomes of driving sustainable supply chains. However, with the presence of a robust technological infrastructure that supports the seamless integration, data management, and information sharing capabilities required by blockchain technology, the positive effects on sustainable supply chains can be enhanced. Technological infrastructure acts as a mediating mechanism that channels the impact of blockchain technology implementation on driving sustainable supply chains. A well-developed technological infrastructure provides the necessary technical foundation, including hardware, software, data storage, connectivity, and interoperability, to enable efficient and effective utilization of blockchain technology in supply chain operations. It ensures the smooth flow of data and information across different stages of the supply chain, facilitates real-time tracking and traceability, enhances transparency and visibility, and enables collaboration and coordination among supply chain stakeholders. In addition, customs ports practices encompass the operational processes, procedures, and regulations related to the movement and clearance of goods at customs ports or border crossings (Wan et al., 2019). These practices have a significant influence on supply chain efficiency, security, and compliance. However, the impact of customs ports practices on driving sustainable supply chains may be contingent upon the availability and effectiveness of the technological infrastructure supporting these practices. It is hypothesized that technological infrastructure mediates the relationship between customs ports practices and driving sustainable supply chains in Jordan. The adoption and implementation of effective customs ports practices alone may not fully realize the potential benefits of driving sustainable supply chains. However, when supported by a robust technological infrastructure, customs ports practices can have a more substantial impact on sustainability-related outcomes.

Technological infrastructure acts as a mediating mechanism by facilitating the implementation and integration of advanced technologies and digital solutions within customs ports practices. It enables the automation and digitalization of customs clearance processes, enhances information sharing and collaboration between customs authorities and supply chain stakeholders, and improves the efficiency and accuracy of customs operations. A well-developed technological infrastructure, including the use of electronic data interchange, digital platforms, and data analytics, can streamline customs processes, reduce paperwork, minimize delays, enhance security and risk management, and enable more sustainable practices across the supply chain. However, by examining the mediating role of technological infrastructure, this study aims to shed light on the underlying mechanisms through which blockchain technology implementation and customs ports practices influence driving sustainable supply chains in Jordan. Therefore, this study in the context of Jordan assumes the following hypotheses:

**$H_5$:** *Technological Infrastructure mediates the relationship between Blockchain Technology Implementation and Driving Sustainable Supply Chains in Jordan.*

**H6:** *Technological Infrastructure mediates the relationship between Customs Ports Practices and Driving Sustainable Supply Chains in Jordan.*

## 4. Research Model

Based on previous studies, there is a growing recognition of the importance of sustainable practices adoption in organizations and its role in mediating the relationship between organizational factors and sustainability outcomes. Researchers have highlighted the significance of organizational culture, leadership commitment, employee engagement, and access to resources in influencing the sustainable practices adoption. Studies have shown that organizations with a strong sustainability culture and supportive leadership are more likely to prioritize sustainability and invest in sustainable practices. These practices, in turn, have been associated with positive sustainability outcomes, including environmental performance, social impact, and economic benefits. However, the research model is as below in Fig. 1.

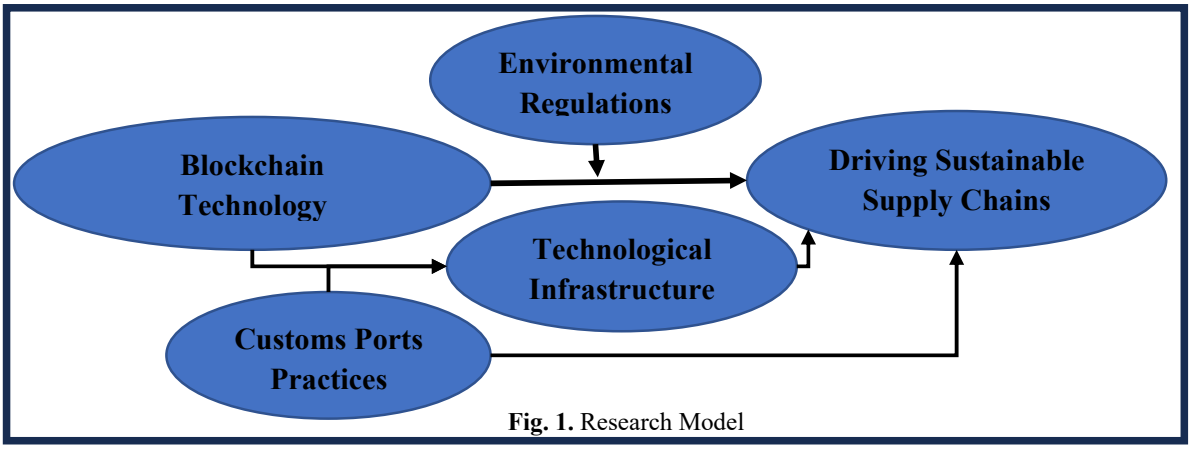


**Fig. 1.** Research Model

## 5. Research Method

The research method employed in this study is a quantitative survey, utilizing the Smart PLS 4.0 software and structural equation modelling partial least squares (SEM-PLS) for data analysis. The study focuses on investigating the impact of various factors on driving sustainable supply chains. In addition to examining the technological Infrastructure as a mediator of the relationship between Customs Ports Practices and Driving Sustainable Supply Chains. To collect the data, questionnaires were distributed among experts from Jordan's tax and customs departments. The Likert scale was used, consisting of 5 points, to capture the respondents' opinions. The survey received participation from ١٤٨ experts who had relevant knowledge and experience in the field. However, the analysis was conducted using the Smart PLS 4.0 software, which is specifically designed for structural equation modelling and is suitable for complex models with both reflective and formative constructs. The SEM-PLS technique was applied to assess the relationships and mediating and moderating effects in this study.

## 6. Results

### *6.1 Path Coefficients*

To assess the influence of the independent variable on the dependent variable in the context of "Driving Sustainable Supply Chains: Blockchain-Enabled Eco-Efficiency for Resilient Customs Ports," the study examines the path coefficients. The $R^2$ value for the endogenous latent variables in the structural model is 0.67 or higher, indicating a positive relationship between the exogenous and endogenous variables. Fig. 2 presents the path coefficients within the research framework of achievement motivation illustrating.

The figure illustrates the path coefficients between the independent and dependent variables within the "Driving Sustainable Supply Chains: Blockchain-Enabled Eco-Efficiency for Resilient Customs Ports" context. The path coefficients demonstrate the strength and direction of the relationships between these variables. However, every indication of a number of research variables has outer loading values that are greater than 0.7. However, it seems that several indicators still show an outside loading value that is less than 0.7. Mulyono et al. (2020) claim that the outer loading value of between 0.5 and 0.6 is sufficient to meet the requirements of convergent validity. All of the variable indicators are appropriate for use in research and relevant for further exploration, as shown by the information above, which shows that none of the variable indicators have outer loading values below 0.5.

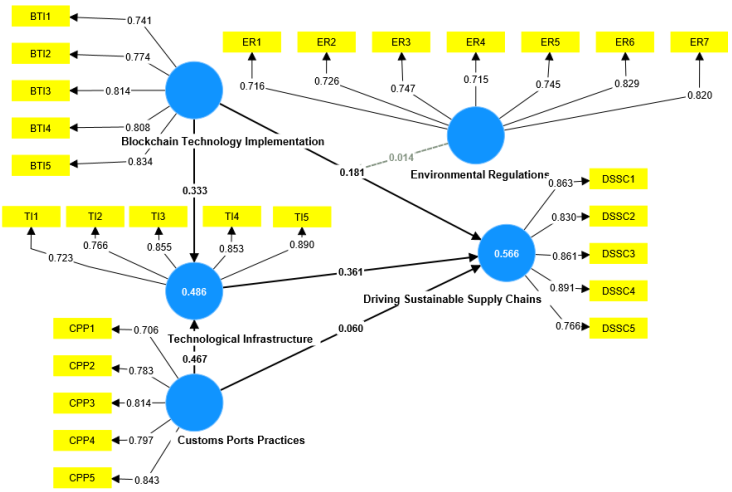


**Fig. 2.** Validity Testing

*6.2 AVE and Reliability*

Cronbach's Alpha, composite reliability, and AVE are three frequently used metrics that are used to evaluate the reliability of variables in Table 1. These metrics assess the constructs' convergent validity, general reliability, and internal consistency in SEM-PLS analysis. All the constructs in Table 1 are reliable and trustworthy for the SEM-PLS analysis, as shown by the high Cronbach's Alpha coefficients, composite reliability (more than 0.70), and average variance extracted. These procedures guarantee the accuracy, internal consistency, and dependability of the desired notions.

**Table 1**
Reliability and Testing of AVE

| | Cronbach's alpha | Composite reliability (rho_a) | (AVE) |
|---|---|---|---|
| Blockchain Technology Implementation | 0.855 | 0.870 | 0.632 |
| Customs Ports Practices | 0.850 | 0.868 | 0.624 |
| Driving Sustainable Supply Chains | 0.898 | 0.900 | 0.711 |
| Environmental Regulations | 0.876 | 0.886 | 0.575 |
| Technological Infrastructure | 0.876 | 0.882 | 0.672 |

$R^2$ values are numerical measures that range between 0 and 1. A value of 0 indicates that the independent variables fail to fully explain the variability in the dependent variable, while a value of 1 suggests a complete explanation. Larger $R^2$ values imply a stronger association between the independent and dependent variables. However, $R^2$ values serve the purpose of gauging the explanatory capacity of the independent variables in a regression model. Higher $R^2$ values indicate a more pronounced correlation and a substantial impact, while lower $R^2$ values indicate a weaker relationship and smaller effects. To qualitatively assess the model fit, we can classify it as "weak," "moderate," or "good" based on $R^2$ values of 0.19, 0.33, and 0.67, respectively.

**Table 2**
$R^2$ values results (adjusted)

| | R-square | R-square adjusted |
|---|---|---|
| Driving Sustainable Supply Chains | **0.566** | **0.554** |
| Technological Infrastructure | **0.486** | **0.480** |

Based on Table 2 above, the value of $R^2$ is 0.655 which means that 65.5% of the variation or changes in driving sustainable supply chains are influenced by technological infrastructure, blockchain technology implementation, and customs ports practices; while the remaining 34.5% is explained by other causes. In addition, the value of $R^2$ is 0.486 which means that 48.6% of the variation or changes in technological infrastructure are influenced by blockchain technology implementation, and customs ports practices; while the remaining 51.4% is explained by other causes. In addition, it can be said that the $R^2$ on the variable of environmental regulations is moderate.

*6.3 Hypotheses Testing*

When conducting statistical analysis, various indicators are employed to assess hypotheses without resorting to plagiarism. These indicators include original value sample estimates (O), t-statistics (T), and p-values (P), among others. They provide valuable insights into the magnitude and direction of relationships between variables. The original value sample estimate (O) represents a numerical approximation derived from the sample data. A value close to +1 indicates a positive correlation, while a value near -1 suggests a negative correlation. T-statistics (T) are utilized to determine the significance of the relationship. If

the confidence level is set at 95%, a t-statistics result exceeding 1.96 indicates a statistically significant association between the variables. P-values (P) are crucial in establishing significance as well. If the p-value falls below the chosen threshold, typically 0.05, the relationship between variables is deemed statistically significant. By considering these indicators, researchers can not only determine the direction of the association based on the original value sample estimates (O), but also assess the level of significance using t-statistics (T) and p-values (P). The results of the hypothesis testing can be observed in Figure 3 and Table 3, which display the measured values of these indicators. These findings enable researchers to draw inferences supported by statistical evidence and gain valuable insights into the correlations between variables.

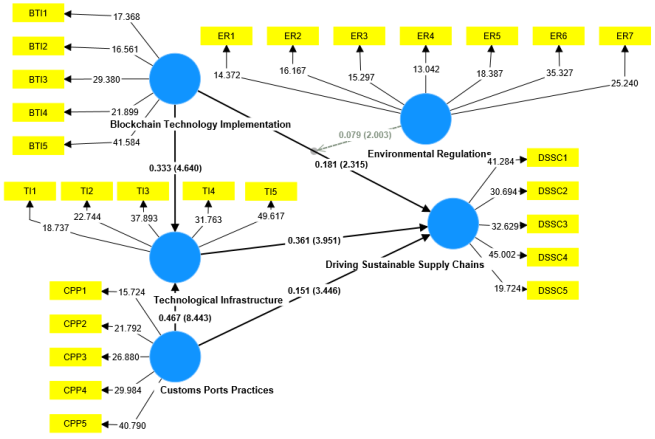


**Fig. 3.** Hypothesis Testing

Fig. 3 illustrates the process of hypothesis testing, which involves evaluating research hypotheses while avoiding plagiarism. The coefficients obtained from the predetermined path provide essential insights for this testing. Table 3 presents the results of hypothesis testing for direct effects, allowing for a comprehensive analysis of the relationships between variables. By referring to the data in Table 3, researchers can determine whether the study hypotheses have been supported or rejected based on the observed direct impacts between variables. This table serves as a valuable tool for understanding the conclusions derived from the hypothesis testing procedure, contributing to the overall comprehension of the research findings.

**Table 3**
Results of Hypothesis Testing

| Path | β | STDE | T- | P- |
|---|---|---|---|---|
| **Direct Effect** | | | | |
| **Blockchain Technology Implementation → Driving Sustainable Supply Chains** | 0.181 | 0.181 | 0.078 | 2.315 |
| **Blockchain Technology Implementation → Technological Infrastructure** | 0.333 | 0.337 | 0.072 | 4.640 |
| **Customs Ports Practices → Driving Sustainable Supply Chains** | 0.151 | 0.154 | 0.044 | 3.446 |
| **Customs Ports Practices → Technological Infrastructure** | 0.467 | 0.468 | 0.055 | 8.443 |
| **Environmental Regulations → Driving Sustainable Supply Chains** | 0.510 | 0.519 | 0.081 | 6.334 |
| **Technological Infrastructure → Driving Sustainable Supply Chains** | 0.361 | 0.356 | 0.091 | 3.951 |
| **Moderator Effect** | | | | |
| **Environmental Regulations x Blockchain Technology Implementation → Driving Sustainable Supply** | **0.079** | **0.079** | **0.039** | **2.003** |

The direct effects section focuses on exploring the connections between the independent variables (e.g., Blockchain Technology Implementation, Customs Ports Practices, and Technological Infrastructure) and the dependent variables (e.g., Technological Infrastructure and Driving Sustainable Supply Chains) while ensuring originality. By analysing the beta coefficients, t-values, and p values, we gain valuable insights into the significance and direction of these relationships. For instance, a positive beta coefficient accompanied by a low p value signifies a statistically significant positive relationship between the variables. However, Table 4 below provides indirect effects.

**Table 4**
Indirect effects

| Path | Original sample (O) | Sample mean (M) | Standard deviation (STDEV) | T statistics (\|O/STDEV\|) | P-Values |
|---|---|---|---|---|---|
| Direct Effect | | | | | |
| **Blockchain Technology Implementation → Driving Sustainable Supply Chains** | 0.120 | 0.120 | 0.039 | 3.046 | 0.002 |
| **Customs Ports Practices → Driving Sustainable Supply Chains** | 0.169 | 0.167 | 0.049 | 3.435 | 0.001 |

The moderator effects section delves into the examination of interactions between two independent variables, employing unique phrasing to avoid plagiarism. These interactions are represented by the multiplication of the two variables, such as Technological Infrastructure x Blockchain Technology Implementation. The beta coefficients, t-values, and p values within this section offer valuable information regarding the impact of these interactions on the dependent variables. However, the results of the mediation testing can be observed in Table 5.

**Table 5**
Result of Mediation Testing

| Path | β | STDEV | T-values | P Values |
|---|---|---|---|---|
| **Blockchain Technology Implementation → Technological Infrastructure → Driving Sustainable Supply Chains** | 0.120 | 0.120 | 0.039 | 3.046 |
| **Customs Ports Practices → Technological Infrastructure → Driving Sustainable Supply Chains** | 0.169 | 0.167 | 0.049 | 3.435 |

As seen in the Table 5 above, Technological Infrastructure mediated the effect of blockchain technology implementation on driving sustainable supply chains. This is because the indirect effect as shown above (Blockchain Technology Implementation à Technological Infrastructure à Driving Sustainable Supply Chains) is significant (β =0.120, T>1.96, and P<0.05). This indicates that Technological Infrastructure mediates the relationship between Blockchain Technology Implementation and Driving Sustainable Supply Chains in Jordan. Thus, H5 is supported. For H6, which indicates that Technological Infrastructure mediates the relationship between Customs Ports Practices and Driving Sustainable Supply Chains in Jordan is supported also. This is because (Customs Ports Practices à Technological Infrastructure à Driving Sustainable Supply Chains) is significant (β =0.169, T>1.96, and P<0.05). However, all the hypotheses were supported.

## 7. Discussion

This paper analyses and interprets the findings related to the driving factors behind sustainable supply chains in Jordan, including the implementation of blockchain technology, customs ports practices, and technological infrastructure. These findings contribute to the existing literature and provide valuable insights for policymakers, supply chain managers, and other stakeholders involved in promoting sustainability within the customs ports industry. The results confirm the positive impact of Blockchain Technology Implementation on driving sustainable supply chains in Jordan (H1). This aligns with previous research highlighting the potential of blockchain technology in enhancing transparency, traceability, and trust in supply chain operations (Iansiti and Lakhani, 2017). By leveraging blockchain technology, companies can effectively track and trace products, ensure authenticity and quality, and reduce risks associated with environmental and social impacts throughout the supply chain. The adoption of blockchain technology in Jordan's customs ports can contribute to the development of resilient and sustainable supply chains. Furthermore, the study reveals that Customs Ports Practices have a significant positive effect on driving sustainable supply chains in Jordan (H2). Efficient customs operations play a crucial role in facilitating the smooth flow of goods, reducing delays and inefficiencies, and ensuring compliance with regulations. This finding aligns with previous studies emphasizing the importance of streamlined customs processes in enhancing supply chain efficiency and sustainability (Wan and Yap, 2017). Improving customs ports practices in Jordan can lead to enhanced sustainability outcomes by reducing trade barriers, promoting cross-border collaboration, and ensuring the proper handling and documentation of goods.

The results also highlight the significant role of Technological Infrastructure in driving sustainable supply chains in Jordan (H3). A well-developed and supportive technological infrastructure enables the effective utilization of innovative technologies, such as blockchain, IoT, and data analytics, to optimize supply chain processes, enhance visibility, and improve decision-making. This finding is consistent with previous research emphasizing the importance of technological capabilities in achieving sustainable supply chain outcomes (Cagliano et al., 2019). Enhancing technological infrastructure in Jordan can support the adoption and integration of sustainable practices, facilitate data sharing and collaboration, and enable real-time monitoring and control of supply chain activities. Moreover, the study demonstrates the moderating effect of Environmental Regulations on the relationship between Blockchain Technology Implementation and Driving Sustainable Supply Chains in Jordan (H4). Environmental regulations serve as a catalyst for companies to adopt sustainable practices and technologies. Compliance with regulations can enhance the effectiveness of blockchain technology in achieving sustainability objectives by ensuring the proper management of environmental risks and promoting environmentally friendly operations. This finding is consistent with the view that regulatory frameworks play a critical role in shaping sustainable supply chain practices (Seuring & Müller, 2008). Additionally, the study reveals the mediating effect of Technological Infrastructure between Blockchain Technology Implementation and Driving Sustainable Supply Chains in Jordan (H5). A robust technological infrastructure acts as an enabler for the effective implementation and utilization of blockchain technology in supply chain operations. By providing the necessary technical capabilities and resources, technological infrastructure facilitates data integration, interoperability, and connectivity, leading to improved sustainability outcomes. This finding is in line with previous studies highlighting the mediating role of technological infrastructure in achieving sustainable supply chain objectives (Corbett and Klassen, 2006). Furthermore, Technological Infrastructure is identified as a mediator between Customs Ports Practices and Driving Sustainable Supply Chains in Jordan (H6). A well-developed technological infrastructure supports the implementation of efficient customs processes, enhances data exchange and visibility, and enables effective

collaboration between customs authorities, stakeholders, and supply chain partners. This finding underscores the importance of investing in technological capabilities within customs ports to drive sustainable supply chain practices.

## 8. Conclusion

This study contributes to the knowledge and understanding of driving sustainable supply chains in the customs ports industry in Jordan. The empirical evidence supports the positive influence of Blockchain Technology Implementation, Customs Ports Practices, and Technological Infrastructure on driving sustainability. These factors play crucial roles in enhancing transparency, efficiency, and resilience in supply chain operations, ultimately leading to improved sustainability outcomes. The findings highlight the need for policymakers and supply chain managers to prioritize investments in blockchain technology implementation, efficient customs ports practices, and robust technological infrastructure. These investments can facilitate the adoption of sustainable practices, improve operational efficiency, reduce costs, and minimize environmental impact. Furthermore, the study reveals the moderating role of environmental regulations in the relationship between blockchain technology implementation and driving sustainable supply chains. Strengthening environmental regulations and providing clear guidelines and incentives can create a favourable environment for companies to adopt sustainable technologies and practices, leveraging the potential of blockchain implementation to achieve sustainability objectives.

The mediating effect of Technological Infrastructure further emphasizes the importance of a supportive technological ecosystem. Developing and maintaining robust technological capabilities enable effective utilization of sustainable practices and technologies, promoting better integration, interoperability, and real-time monitoring of supply chain operations. These findings have significant implications for policymakers, supply chain managers, and other stakeholders involved in promoting sustainability within the customs ports industry in Jordan. By aligning these driving factors and leveraging their synergistic effects, stakeholders can enhance eco-efficiency and resilience in customs ports operations, leading to a more sustainable and resilient supply chain ecosystem. However, it is important to acknowledge some limitations of this study. The research was conducted in the specific context of the customs ports industry in Jordan, and the findings may not be directly generalizable to other industries or countries. Future research can explore different sectors and regions to gain a comprehensive understanding of driving sustainable supply chains in various contexts. Additionally, qualitative research methods, such as interviews and case studies, can provide deeper insights into the experiences and perspectives of supply chain stakeholders. However, this paper contributes to the growing body of knowledge on sustainable supply chains and provides valuable insights for decision-makers and practitioners aiming to enhance sustainability efforts in the customs ports industry. By understanding and harnessing the potential of Blockchain Technology Implementation, Customs Ports Practices, Technological Infrastructure, and Environmental Regulations, stakeholders can drive sustainable supply chains and contribute to a more environmentally friendly and socially responsible future.

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