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ỨNG DỤNG CÔNG NGHỆ BLOCKCHAIN TRONG QUẢN LÝ CHUỖI CUNG ỨNG NHẰM NÂNG CAO TÍNH BỀN VỮNG VÀ ĐỀ XUẤT CHO DOANH NGHIỆP VIỆT NAM

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Tóm tắt

Việc theo đuổi tính bền vững trong chuỗi cung ứng đang ngày càng trở nên vô cùng quan trọng đối với các tổ chức để cân bằng sự phát triển kinh tế với trách nhiệm xã hội và mối quan tâm môi trường trong bối cảnh kinh tế toàn cầu hiện nay. Công nghệ Blockchain xuất hiện như một giải pháp cung cấp hệ thống ghi chép phi tập trung và bất dịch, cho phép chia sẻ dữ liệu một cách an toàn và minh bạch dọc trong một chuỗi cung ứng. Việc ứng dụng công nghệ Blockchain đã giúp cải thiện tính minh bạch, mức độ tin cậy, khả năng truy vết và nâng cao tính hiệu quả trong quản lý chuỗi cung ứng. Bằng phương pháp nghiên cứu định tính, bao gồm việc thu thập dữ liệu thứ cấp từ các nghiên cứu trước đó về việc ứng dụng của công nghệ Blockchain trong quản lý chuỗi cung ứng và phân tích các trường hợp thực tiễn, nhóm tác giả đã xem xét tiềm năng của việc ứng dụng công nghệ Blockchain trong việc đảm bảo tính bền vững của chuỗi cung ứng. Nhóm tác giả tập trung vào ba trường hợp thực tiễn cụ thể về tính bền vững để làm rõ hoạt động cung ứng của các

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công ty khi ứng dụng Công nghệ Blockchain, từ đó đưa ra một số đề xuất những giải pháp để cải thiện hiệu suất bền vững của chuỗi cung ứng trong các doanh nghiệp Việt Nam.

Từ khóa: Công nghệ Blockchain, quản lý chuỗi cung ứng, tính bền vững

BLOCKCHAIN TECHNOLOGY APPLICATIONS IN SUPPLY CHAIN MANAGEMENT TO ACHIEVE SUSTAINABILITY PERFORMANCES AND IMPLICATIONS FOR VIETNAMESE BUSINESSES

Abstract

The pursuit of supply chain sustainability has grown to be of utmost importance for organizations striving to balance economic development with social responsibility and environmental concern in the contemporary global business environment. Blockchain has emerged as a disruptive solution that offers decentralized and immutable record-keeping, enabling secure and transparent data sharing along the supply chain. The application of Blockchain technology enhances transparency, reliability, traceability, and efficiency to the supply chain management. By using qualitative research design, including a narrative literature review and case study approach, the paper analyzes the exploration of Blockchain technology's transformative potential in supply chain sustainability. Our research would also focus on three specific sustainability cases to clarify the activities of companies, then provide some potential recommendations to improve supply chain sustainability performance in Vietnamese enterprises.

Keywords: Blockchain technology, supply chain management, sustainability

1. Introduction

In recent decades, the concept of sustainability has transcended being a mere buzzword and has evolved into a fundamental principle guiding the strategies and operations of businesses worldwide. With concerns about climate change, resource depletion, and social inequalities gaining prominence, organizations are under increasing pressure to align their practices with sustainable principles. This urgency is underscored by the United Nations' Sustainable Development Goals (SDGs), which provide a comprehensive framework for addressing global challenges and fostering equitable development by 2030. Within this context, supply chain has been seen as a critical focal point for sustainability efforts. However, the intricacies of supply chains, involving numerous stakeholders, geographical complexities, and varying regulatory environments, pose challenges to ensuring sustainability standards are met. Traditional supply chain management systems often struggle to provide the necessary transparency, traceability, and accountability to meet the demands of modern sustainability goals.

In light of these dynamics, Blockchain technology has become a potential game-changer to revolutionize supply chain management. Blockchain, initially designed as a secure and transparent ledger for cryptocurrencies through its decentralized nature, coupled with cryptographic security.

This makes it an ideal solution for addressing the challenges of transparency, traceability, and accountability that have long plagued traditional supply chain systems. Despite the difficulties in deploying innovative Blockchain technology in the area, many companies have already successfully implemented Blockchain by leveraging its inherent characteristics, such as immutability and decentralized record-keeping.

However, application of Blockchain technology in supply chain management to enhance sustainability is still seen as a complex issue for business. To find out what Vietnamese enterprises should do to overcome potential challenges and unlock the full potential of Blockchain-based technology, it is best to understand three cases of how some companies utilize Blockchain technology to sustainability performance in supply chain.

This paper explores the effects of Blockchain technology on sustainability performance in supply chain management. The purpose of this study is to document the association of Blockchain technology and the three pillars of sustainability, then based on literature reviews, examine three supply chain sustainability cases and suggest directions on tackling sustainability challenges in Vietnamese enterprises..

2. Theoretical framework

2.1. Blockchain

Blockchain is a reliable technology that allows information to be stored and transacted securely, unchangeable, and updated only through peer-consensus (Bashir, 2020).

In a Blockchain, information is stored in blocks, and each block contains a certain number of transactions and information and is encoded using a cryptographic hash. Once validated, a block is connected with previous blocks, making a Blockchain. Since each block contains the hash of the previous blocks, any modification will change the hash of the block and lose the integrity of the Blockchain, making Blockchain immutable (Treiblmaier, 2018). The fact that Blockchain is not stored in a central server, but is recorded in multiple computers in a peer-to-peer network enables people to share all information based on distributed consensus.

The emergence of Blockchain technology is considered to change several industries including finance, real estate, and retail (Kfoury A A Emart, 2021). According to Meijer and Carlo (2016), the use of Blockchain can cut down costs in the financial sector and reduce the time to settle payments. In the challenging environment of retailing, its implementation is believed to add up advantages, including lean operations and the connection among suppliers, retailers, and end-users without the intervention of middlemen (Kfoury A A Emart, 2021).

2.2. Supply chain management

Supply chain management is defined as the process of adding value, maximizing profitability through efficiency, and achieving customer satisfaction by controlling a network of interactions within a company and between interdependent organizations and business units (Stock and Boyer, 2009). The supply chain process consists of different sub-processes, which can be divided into four key elements: planning, management, control and execution, and procurement (Samaranayake, 2005). The variety of components makes it a challenge to manage and ensure effective and efficient operation. Supply chains must become optimized to overcome existing obstacles and adapt to new changes (Samaranayake, 2005).

2.3. Sustainability performances

In the modern context, businesses have to broaden their scope from profit optimization to sustainable development (Brandenburg, Gruchmann and Oelze, 2019). In 1987, the term "sustainability" was defined by the United Nations Brundtland Commission as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". It was also stated that this development can only be achieved when the three pillars social, environmental, and economic coexist with no dominant area (World Commission on Environment and Development (WCED), 1987)

Sustainability performance refers to the ability of an organization to achieve its objectives in the three pillars while ensuring the long-term viability of its operations. Research has shown that sustainability performance is influenced by a variety of factors, including organizational culture, leadership, stakeholder engagement, and innovation (Schaltegger and Wagner, 2011).

3. Literature review

This paper explores the literature of the Blockchain-based supply chain with the sustainability concept by using literature analysis methods two steps: assembling articles by doing a search for a set of precise keywords: "Blockchain", "supply chain management", "Blockchain-based supply chain", "supply chain sustainability", followed by analyzing research gaps in these articles.

Using the above literature review analysis method, three types of sustainability - environmental, economic, and social - were examined in earlier research on the sustainable features relating to the influence of Blockchain in supply chains. Environmental sustainability focuses on protecting and enhancing natural resources. Due to its capacity to assist businesses in lowering their carbon emissions, Blockchain contributes to environmental sustainability (Wang et al., 2019). Because everyone involved is fully aware of the financial rewards of having a good reputation as an organization, it generates a reputation-based system that motivates participants to discover the long-term solution to emissions (Esmaeilian et al., 2020).

Economic sustainability is the capacity of an economy to expand continuously while effectively managing its resources. Such efficiency like efficient supply chain processing,

transaction handling and delivery can be achieved in supply chain management with the help of Blockchain. In a study on supply chain efficiency and collaboration explored by Wang et al. (2019), they highlighted how Blockchain can streamline complex supply chain processes, such as customs documentation and cross-border trade, reducing delays and promoting energy supply operations. Another paper on the utilization of Blockchain-based smart contracts in automating transactions and agreements by (Seera et al., 2021) highlighted how these self-executing contracts can streamline payment processes, reduce administrative overhead, and foster trust among supply chain participants.

Social sustainability is about the ability of keeping the well-being of a society. A society's well-being depends on factors like justice, ethics, respect for human rights, and tolerance of variety. In the research of transparency and traceability within supply chains, a research by Behnke and Janssen (2019) discussed how Blockchain can offer real-time visibility into the movement of food products, enabling consumers to verify the authenticity and origin of items. This transparency reduces information asymmetry, promotes ethical sourcing, and discourages fraudulent practices. The supply chain's responsiveness and product traceability will boost consumers' loyalty in the company. (Thakur and Breslin, 2020). All of these characteristics of Blockchain will be useful for monitoring and controlling the overall process of the humanitarian supply chain and firms involved in the supply chain will become socially more responsible

While the literature on the application of Blockchain in supply chain sustainability has grown significantly, there are still identified research gaps that underscore the need for more comprehensive and targeted studies. The existing literature often lacks comprehensive frameworks that guide organizations in the step-by-step implementation of Blockchain technology for supply chain sustainability. Besides that, the literature also requires more in-depth and detailed cases that outline challenges, successes, and lessons learned. We also found that there is limited literature available which covers how Blockchain will impact the supply chain in terms of its sustainability in Vietnam.

Therefore, in this study, we seek to extend to how to measure sustainability indicators through leading articles collected and categorized on the basis of three basic characteristics of Blockchain-based supply chain, frameworks, and case studies. Moreover, successful implementation of Blockchain in the field of supply chain in these cases will provide a recommendation for Vietnamese supply chain situations.

4. Analysis of Blockchain-based supply chain's characteristics and case studies

4.1. Reliability: Case study of Maersk and IBM and Bext360

Blockchain technology plays a crucial role in enhancing data reliability. A private Blockchain offers several advantages in operations and supply chain management, particularly in terms of security, timeliness, and transparency. Unlike traditional centralized systems, a private Blockchain provides a distributed and decentralized network where no single entity has control. This resolves issues of disclosure and accountability, especially when the interests of the parties involved are not aligned. Real-time updates allow important data to be shared and accessed by all parties involved, eliminating the need for laborious and error-prone reconciliation processes. This increased visibility enables each member of the network to have better and timely insights into the activities occurring. Additionally, the encryption and coding of data in a Blockchain contribute to improved transparency, efficiency, and trust in information sharing. By maintaining and accessing real-time data, global complex supply chains can benefit from increased transparency and agility in their operations. This aspect has garnered significant attention from scholars in operations and supply chain management, as it allows for the utilization of big data for enhancing organizational and supply chain performance. In conclusion, by providing a decentralized and immutable ledger, Blockchain gives a check on any adulteration of information, thus increasing information validity compared to the centralized database which is more susceptible to hacking, corruption, or crashing.

To deeper understand the reliability of applying Blockchain, these are to case studies which represent the successful implementation of Blockchain in supply chain management.

a. Maersk and IBM

Maersk and IBM collaborated to create a Blockchain solution named "TradeLens" with the goal of digitizing global trade processes. The international shipment processes for goods by sea are highly complex and involve numerous organizations and individuals, including shippers, freight forwarders, ocean carriers, ports, and customs authorities. To streamline these processes, the TradeLens platform developed by Maersk and IBM utilizes Blockchain technology.

Shipping Information Line

TradeLens provides end-to-end supply chain visibility of all actors involved in global shipping in order to change ship events in real time in a safe and seamless way.

Paperless Trade

TradeLens digitizes and automates document filing for the import and export of goods by ensuring end-users secure, documented and stamped documents across national and organizational boundaries. This enhances the safety of sending and signing contracts.

The platform also incorporates Blockchain-based smart contracts, which play a crucial role in managing approvals and processing information faster than the current system. This innovative approach significantly reduces errors, ensuring a more efficient and reliable process for all stakeholders involved.

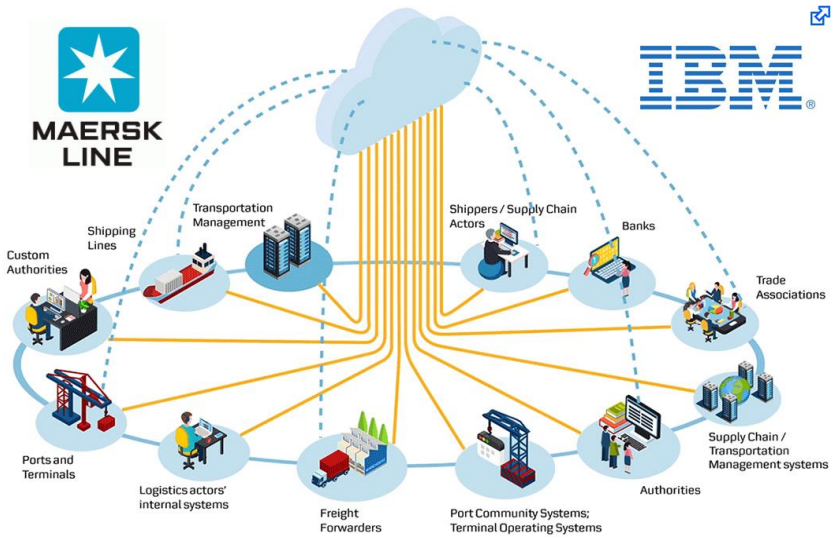

Figure 1: Digital joint venture platform between Maersk and IBM

Source: *Staff, 2018*

In 2016, IBM and Maersk conducted a pilot run, tracking a container of flowers from Mombasa, Kenya to Rotterdam in the Netherlands. This pilot run, along with several follow-ups, convinced Maersk of the potential of Blockchain in the shipping industry. Building on the success of the pilot project, Maersk and IBM joined forces with Schneider Electricals, a company in Lyon, France. They tracked a container filled with goods from the plant location to Rotterdam, then shipped the containers to the Port of Newark in the U.S., and finally delivered them to the Schneider Electric facility. The involvement of multiple countries in the shipment highlighted the time, paperwork, and potential costs involved. By replacing traditional paperwork with secure and immutable digital records, Blockchain technology helps streamline processes and reduce the risk of spoilage or delays in perishable goods due to lost or delayed documentation. This digitalization benefits all partners in the global supply chain network by enabling them to track freight and eliminate the need for cumbersome paperwork.

b. Bext 360

On the Denver platform, the startup application Bext360, in collaboration with cloud-based software Stellar, enables customers to automatically purchase high-quality coffee beans from farms at fair and agreed-upon prices. This platform provides transparency and visibility to buyers, allowing them to monitor the supply chain and transportation process of coffee beans, ensuring that they know the actual quality of the coffee they are purchasing. Furthermore, farmers benefit from this system as they can be assured of a market for their quality food products and can quickly gain profits. By implementing an automated verification process, the end-user cafes can also have better transparency about the origin of the coffee they serve. Bext360 has developed a machine

that uses intelligent image recognition technology to assess the quality of coffee beans, identify the seller, and assign appropriate pricing. Transactions are recorded through a smartphone application. This technology has been tested at coffee plantations in Mexico, with plans for a significant trial in California. Additionally, Bext360 has utilized Blockchain technology to ensure traceability for Token, a new coffee brand created through a partnership between Moyee Coffee and the FairChain Foundation. Token aims to become the first end-to-end coffee brand in the world, connecting Western coffee drinkers directly to the community involved in growing and roasting the coffee beans and eliminating intermediaries (Nguyen, Thi and Doan, 2019).

4.2. Traceability and Visibility: Case study of DHL

Blockchain technology is also applied with the goal of improving traceability and visibility of products. The Blockchain system stores a wide range of data regarding production method, origin and preservation method of goods. Such data is stored permanently and possibly shared among related parties, thus improving the tracking ability. Businesses can use this information to provide proof of legitimacy (such as pharmaceuticals) or proof of authenticity (such as luxury fashion items) for the products they sell. These solutions will also benefit final consumers, who are able to learn more about the products' provenance or storage procedures.

As mentioned above, Blockchain has the potential to become a "weapon" in the future operations of counterfeit pharmaceutical products testing. WHO estimates that 10% of the global pharmaceutical trade is related to counterfeit drugs, of which nearly 48.7% reported to be in Western Pacific developing countries. To enable pharmaceutical trade visibility and traceability, DHL and Accenture have been collaborating on a digitization project using Blockchain technology.

In the supply chain, product encryption is no longer a novel idea. In the case of the pharmaceutical industry, pharmaceutical serialization is the process of assigning a unique identifier (such as a serial number) to each product unit. This identifier is then linked with necessary information such as origin, batch number and expiry date. Efficient serialization allows users to electronically trace pharmaceuticals at all times. As a result, it is possible to know exactly where they are at any stage in the product life cycle. However, maintaining transparency throughout the shipping process is a major challenge, especially those with manual intervention - warehousing stage for instance.

Facing such a problem, DHL and Accenture have been applying Blockchain technology with the goal is for interested parties to be able to verify if the product is supplied by a legitimate manufacturer or transported and stored following the correct procedure. Above all, this solution can help consumers verify the legality, truthfulness of pharmaceutical products, and especially, compliance with shipping standards. This not only ensures that at the time of purchase, the

consumer buys the correct, genuine drug in good condition, but also ensures the expected medicinal value as labeled on the package.

In order to do this, a global supply network across six continents has been used to test encryption technologies from DHL, Accenture and other related partners. From production to the store and even to the ultimate client, the system meticulously documents and stores every stage of the process. This experiment demonstrates that Blockchain technology can handle over 1,500 transactions and over 7 billion pharmaceutical units per second.

This Blockchain-hybrid project proved the feasibility of Blockchain technology in tracking pharmaceuticals - “from A to Z” - and ensuring security, transparency, and readily availability. "The success of this study demonstrates Blockchain's potential in the fight against counterfeit drugs. Together with our partners, we are working to upgrade the solution, as well as collaborate with other top-tiers in the industry to bring this idea to reality soon” – Keith Turner, CIO – Head of Development at DHL Supply Chain.

4.3. Synchronized transaction process: Case study of Smart Contract of ShipChain and America Merill Lynch Bank

Recent evaluations within the logistics field suggest that a notable proportion, roughly 10%, of freight invoices are discovered to contain incorrect details. This inaccuracy not only gives rise to conflicts but also initiates diverse operational inefficiencies throughout the sector. Significantly, this issue extends its impact to the oil and energy domain. According to professionals at Accenture, by enhancing invoice accuracy and reducing instances of overpayments, annual freight expenses can be cut down by at least 5% (Heutger and Kückelhaus, 2018).

Blockchain has the potential to greatly improve transportation efficiency with the ability to support transaction/payment processes and resolve disputes between parties. Digital documents and real-time data are embedded in the Blockchain system, and this information allows for the establishment of smart contracts.

As Rozario and Vasarhelyi (2018) point out, the concept of a smart contract was initially introduced by Szabo (1994). Szabo characterized a smart contract as "a computerized transaction protocol intended to fulfill the terms of a contract." In a more metaphorical sense, "Smart contracts can be thought of as 'packages' containing data codes that encapsulate the conditions of real-world contracts, and these are executed within the digital realm" (Taherdoost, 2023).

However, in the context of Blockchain technology, the definition of smart contracts can be summarized as follows: "Smart contracts are contracts written in computer code and operate on the foundation of Blockchain technology or distributed ledger" (Gates, 2017).

Smart contracts have a clear purpose: they facilitate the verification of shipments between buyers and sellers using Blockchain technology. This verification process empowers buyers to

initiate automatic payments to sellers directly, eliminating the necessity of intermediaries. Consequently, this reduction in intermediaries not only streamlines the transaction process but also leads to cost savings and quicker transaction completions.

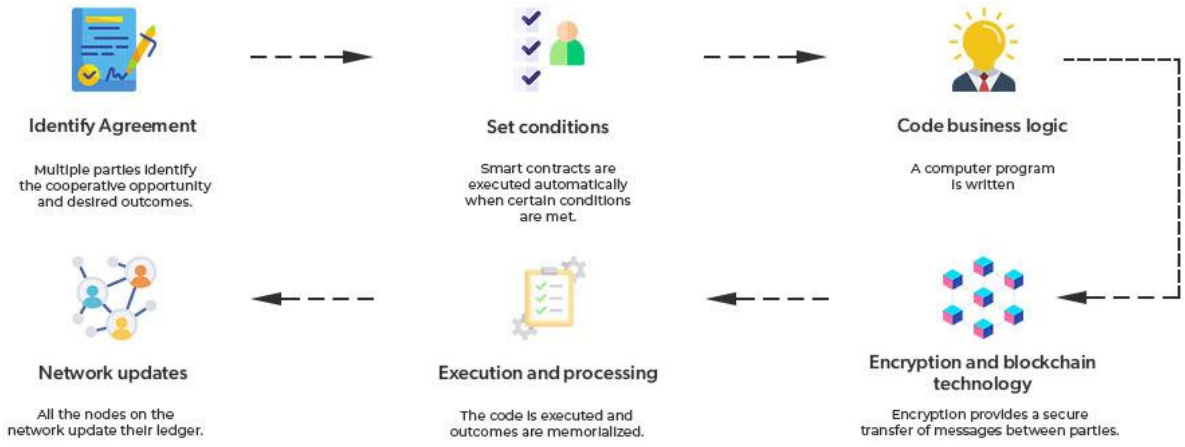

Figure 2: The process of how Smart Contract works

Source: *GeeksforGeeks, 2019*

ShipChain emerged as one of the pioneering startups to venture into the realm of smart contract applications within the logistics sector. Presently, ShipChain is in the process of implementing a solution for tracking and tracing products through Blockchain technology. This innovative system is designed for adaptability across various transportation modes. Furthermore, the startup envisions creating a system featuring an open API structure, facilitating seamless integration with existing transportation management software.

Vital information within the supply chain is securely stored in an unchangeable database on the Blockchain platform. This repository of data enables the activation of smart contracts once predetermined conditions are met. An example of this is the triggering of a smart contract when a driver successfully completes delivery confirmations.

The cornerstone of automating the payment and transaction procedures lies in the utilization of "SHIP tokens" – the proprietary cryptocurrency of ShipChain. Participants engaging with ShipChain's platform are required to procure "SHIP tokens" to cover freight expenses and conduct transactions within the system.

When IoT converges with Blockchain, the prominence of smart contracts takes center stage. Smart contracts in the context of Blockchain and IoT refer to self-executing agreements triggered by predefined conditions recorded on the Blockchain. These conditions can be automatically met

through data collected by IoT devices, such as sensors, actuators, and RFID tags. This synergy empowers devices to communicate with each other and autonomously execute actions when specific events occur. For instance, a temperature sensor in a supply chain can trigger a smart contract to initiate a quality check if the temperature crosses a certain threshold during transit.

Another prominent example of smart contracts is the digitization of Letters of Credit (L/Cs). Traditionally, L/Cs have been pivotal in international trade, but the process often involves delays and complexities. With smart contracts, L/Cs become automated, efficient, and secure.

Smart contracts encode the terms of trade agreements, such as quality standards, delivery, and payment conditions. As these conditions are met, the smart contract triggers automatic execution of the L/C, ensuring prompt payment to the seller. This process accelerates transactions, offers transparency, and bolsters security. Through Blockchain's tamper-proof nature, transaction data's integrity is preserved. Additionally, the transparency diminishes disputes and minimizes reliance on intermediaries, reducing costs and potential bottlenecks.

A collaborative effort between Bank of America Merrill Lynch (BofAML), HSBC, and the Infocomm Development Authority of Singapore (IDA) has yielded a novel electronic Letter of Credit (L/C) solution built on Blockchain technology. This advanced platform ensures the secure sharing of information among exporters, importers, and banks. The execution of commercial transactions is then automatically managed through a series of smart contracts. During the trial period, all stakeholders can conveniently access real-time data through their mobile devices, providing insight into ongoing activities. Furthermore, the system is designed to accommodate information related to forthcoming transactions.

4.4. General Assessment

In this section, we evaluate the effectiveness of applying Blockchain technology to sustainability performance in the case studies. The evaluation is based on three aspects: Environmental, Economic, and Social.

Although there is currently no direct evidence to substantiate the direct impact of Maersk's Blockchain technology on the improvement of sustainable supply chains, it is evident from various aspects that TradeLen holds significant potential. From the perspective of economics, the simplified transaction processes by the Blockchain-based system reduced Maersk’s total operating costs. In addition, the decrease in the shipping cost will promote economic growth as enterprises can reduce their cost in international trade. Moreover, the Blockchain-based system implemented by Maersk utilizes electronic paperwork, which plays a substantial role in environmental conservation by diminishing carbon emissions. The incorporation of sustainable supply chains within the logistics sector not only enhances overall supply chain performance but also leads to a reduction in emissions, thereby benefiting public health and the reputation of the country. In terms of social sustainability performance, by leveraging the Blockchain-based system, Maersk can

enhance human rights and a fair working environment. In the case of Bext 360, the application of Blockchain has solved the problem of farmers' low wages, delayed payments or even no payments at all for their beans from the view of social sustainability. With the complete chain of information, a robot automates the quality evaluation of coffee beans and assigns a fair price.

Additionally, DHL's application to counterfeit drug tracking, if successfully applied in practice, will probably become a revolution not only for the pharmaceutical industry but also for the retail industry in general. In terms of social aspect, the positive effects of Blockchain application are very clear, which is to help consumers minimize the risk of buying fake drugs, poor quality drugs, or even legitimate drugs that have been degraded in quality due to inappropriate shipping process – a case in which without the "traceability" feature of Blockchain technology, consumers would not be aware enough to protect their own own interests. Additionally, official manufacturers are protected from drug swapping (a situation in which authentic pharmaceutical products are swapped with fake ones) in transit by intermediate distributors.

Meanwhile, regarding the case of Smart Contracts, as mentioned above, the problem stems from orders with incorrect information, leading to disputes among related parties and increasing operating costs throughout the supply chain. Therefore, the application of Blockchain in this case has the most positive impact on the Economic aspect of Sustainability Performance. When information is accurately updated in real time, distributors are enabled to accelerate their supply operations and avoid inventory that causes increased storage costs and contract compensation cost due to damage of goods, especially types of goods requiring refrigeration such as agricultural products. As a result, the amount of industrial wastes is reduced and the workers involved in the transportation process are also relieved - these can be considered as positive effects on both Social and Economic aspects, respectively.

In general, from an economic standpoint, the simplified transaction processes and reduced operating costs contribute to overall economic growth. Additionally, the use of electronic paperwork helps to conserve the environment by reducing carbon emissions. Moreover, the incorporation of sustainable supply chains fosters improved supply chain performance, reduces emissions, and benefits public health and the country's reputation. Socially, the Blockchain-based system can enhance human rights and create a fair working environment. The application of Blockchain technology in industries such as pharmaceuticals and logistics also has far-reaching benefits, including protection against counterfeit drugs and increased operational efficiency. Overall, the adoption of Blockchain technology holds great promise in driving sustainability and advancement across various sectors.

5. Implications of Blockchain - based supply chain for Vietnamese enterprises

5.1. Overview of Vietnamese current sustainability performances in supply chain

5.1.1. Applications of sustainable practices in supply chain in Vietnam

Supply chain plays a vital role in the transportation and the flow of goods and services. However, supply chain applied means that harms can be triggered for the environment and the well-being of the residents when a large volume of exhausts are exuded into the atmosphere. That is when the Green Supply Chain steps in as the government and businesses are realizing the outstanding benefits of integrating innovative and environmentally-friendly methods into the supply chain.

In Vietnam, the trend towards sustainable performance in supply chain can be recognized in the undermentioned integrated methods, the most significant of which can be identified as Blockchain:

Blockchain

According to VnExpress (2023), Blockchain-based supply chain management can help optimize cost in international money transfers. Also the technology enhances transparency, traceability and reduces cumbersome international customs procedures, allowing faster international purchases, and automatically enforcing contract terms through smart contracts".

Therefore, businesses and firms in Vietnam are making an effort to integrate the technology into their companies' supply chain so that the system can be less dependent and also to increase the transparency and traceability of goods and services. There are notable functions of Blockchain that urge users to apply onto the companies' supply chain management:

Traceability: Within the Blockchain-based supply chain environment, real-time location tracking of goods becomes easy. For instance, container freight management and document processing regarding transactions can be stored and shared in the Blockchain. All transaction information can be confirmed by relevant participants along the movement path of cargo in real-time through Blockchain technology. Therefore, a Blockchain-based supply chain allows for enhancing transparency.

Transparency of data: All members of the supply chain can be given access to the "blocks" already coded to track the order's schedule shared data from a valuable data source only reliable without having to copy the dataset and save it to its own file. All data is copied automatically in the most accurate and reliable way.

Confidentiality: Blockchain ensures that transactions and private messages are encrypted, which will hedge the common risks such as: hack, modify and steal data. Thanks to Blockchain, data access parties create reliable data sources, increasing trust among members thanks to their innate security system.

Smart contracts: Allow two parties that have not yet met to transact with each other on the Internet without an intermediary. This contract can automatically enforce the rules and procedures

established by the agreed parties. After signing, the contract will be automatized, which is equivalent to a legal contract recorded in the computer language.

Cost Efficiency: Blockchain-based supply chains allow the efficient management of inventory and the reduction of costs. Supply chain entails exorbitant costs that may harm the budget of the company, such as inventory cost, maintenance cost, transportation cost. Therefore, the Blockchain-based supply chain enhances cost efficiency through traceability, security functions and also its ability to create smart contracts. Blockchain can track inventory levels and optimize inventory management processes, reducing inventory costs and improving supply chain efficiency.

Besides Blockchain, Vietnamese businesses and firms also make relentless efforts to integrate other measurements so as to increase the sustainability of their supply chain management system, such as: using eco-friendly materials/input; reducing the exploitation of natural resources; applying green marketing; developing green policy within the company; etc.

5.1.2. Applications of sustainable practices in supply chain in Vietnam

Blockchain technology is applied in tracing the origin of Cat Chu mango. When Blockchain is applied in the supply chain management of My Huong Cooperative, the parties involved in the chain are divided into 4 links: the first link is the Cooperative, the second is the carrier, the third is the retailer and the last is the consumer link.

The cooperative has the role of creating a starting number record for the shipment, containing information identifying the shipment (product name, product code, standard, production standards, harvest date, etc.). The shipping unit confirms the order has been shipped out of the place of production, records the ship date information and updates the shipping status for the shipment. The retailer will scan the trace code to confirm the shipment has arrived and update the status of the shipment. The end consumer will use the application on the phone or other electronic means to scan the access code, get the order information, from when they will know all relevant information about the origin, place of manufacture, who shipped, condition, usability of the product.

The application of Blockchain in supply chain management, specifically the traceability of Cat Chu mangoes, has helped My Xuong Cooperative achieve high efficiency. The supply chain is transparent and clear and the traceability is no longer difficult. The example of My Xuong Cooperative is one of the typical applications of Blockchain technology in supply chain management in Vietnam.

5.1.3. Evaluation of Vietnamese sustainability performances in supply chain

Vietnamese Blockchain-based technology has made significant advancements in the supply chain sector, offering various benefits such as transparency, traceability, and efficiency. Here are some notable achievements:

Traceability and Transparency: Blockchain technology has been employed in Vietnam to enhance the traceability and transparency of supply chains. By recording transactions and data in an immutable and decentralized manner, Blockchain enables stakeholders to track the movement of goods from their origin to the final destination. This transparency helps in preventing fraud, counterfeiting, and unauthorized changes to the supply chain data.

Logistics and Customs: Blockchain has been utilized to streamline logistics and customs processes in Vietnam. By digitizing documents, automating verification, and creating a shared and tamper-proof ledger, Blockchain reduces paperwork, minimizes delays, and enhances the efficiency of customs clearance procedures.

E-commerce and Payments: Blockchain-based platforms have emerged in Vietnam to facilitate secure and efficient e-commerce transactions. These platforms leverage smart contracts and decentralized payment systems to provide a trusted environment for buyers and sellers. Blockchain also enables faster cross-border transactions and reduces the need for intermediaries, thereby lowering transaction costs.

Intellectual Property Protection: Blockchain technology has been explored in Vietnam to protect intellectual property rights. By recording copyrights, patents, and trademarks on the Blockchain, creators and innovators can establish proof of ownership and timestamp their creations, thereby reducing disputes and ensuring proper attribution.

Government Initiatives: The Vietnamese government has recognized the potential of Blockchain technology and has taken steps to support its development. Initiatives such as research grants, regulatory sandboxes, and partnerships between the public and private sectors have fostered innovation and the adoption of Blockchain in various supply chain domains.

These achievements highlight the positive impact of Blockchain-based technology in enhancing transparency, efficiency, and trust within the Vietnamese supply chain ecosystem. As the technology continues to evolve, it is expected to play an increasingly significant role in transforming the supply chain landscape in Vietnam.

Limitations

While Vietnamese Blockchain-based technology has shown promise in the supply chain sector, there are also limitations that need to be considered. Here are some of the key limitations:

Adoption and Awareness: One of the primary challenges is the adoption and awareness of Blockchain technology within the Vietnamese supply chain industry. Many businesses, particularly small and medium-sized enterprises (SMEs), may lack the necessary understanding or resources to implement Blockchain solutions. Limited knowledge and awareness can hinder the widespread adoption of the technology.

Infrastructure and Connectivity: Blockchain technology relies on a robust digital infrastructure and connectivity for optimal performance. In certain regions of Vietnam, especially rural areas, there may be limitations in terms of internet connectivity and technological infrastructure. This can impede the seamless integration and real-time data synchronization required for effective Blockchain implementations.

Data Quality and Standardization: Blockchain technology relies on accurate and standardized data inputs to ensure the integrity and reliability of the information stored on the Blockchain. However, in supply chain ecosystems, data can be fragmented, inconsistent, or of varying quality. Achieving consistent data inputs across different stakeholders can be a challenge, potentially impacting the effectiveness of Blockchain-based solutions.

Regulatory Environment: Blockchain technology operates within a regulatory framework, and any legal or regulatory uncertainties can hinder its adoption. In Vietnam, as in many other countries, the legal and regulatory landscape concerning Blockchain technology is still evolving. Businesses may face challenges in navigating regulatory requirements and ensuring compliance, particularly in sectors where specific regulations govern supply chain processes.

Security and Privacy Concerns: While Blockchain technology provides inherent security features, such as immutability and cryptographic mechanisms, it is not immune to all security risks. Vulnerabilities in smart contracts, private key management, and the potential for 51% attacks are some of the security concerns that need to be addressed. Additionally, the transparency of Blockchain raises privacy concerns, as sensitive business information may be accessible to all participants in the network.

Addressing these limitations requires concerted efforts from various stakeholders, including government bodies, industry associations, and technology providers. Continued investment in infrastructure, awareness programs, and regulatory clarity can help overcome these challenges and unlock the full potential of Blockchain-based technology in Vietnam's supply chain industry.

5.2. Implications for Vietnamese enterprises

The adoption of Blockchain technology in the supply chain holds several promising implications for Vietnamese enterprises seeking to enhance their sustainability performances:

Enhanced transparency and traceability: Blockchain's transparency and immutability help with traceability and accountability. By recording each supply chain step on an unchangeable ledger, Vietnamese firms can provide stakeholders and consumers with clear visibility into product origins. This transparency builds consumer trust and encourages sustainable practices, as any ethical deviations become easily noticeable.

Verification of sustainable practices: Through Blockchain, sustainable practices like responsible sourcing, carbon footprint reduction, and fair labor conditions can be securely and

immutably documented. For Vietnamese enterprises, Blockchain serves as a tool to validate and verify these practices across the supply chain, presenting reliable evidence to both consumers and stakeholders. This process of verification introduces an extra layer of authenticity to claims of sustainability, fostering a culture of accountability and integrity.

Collaborative initiatives: Using Blockchain in supply chains encourages cooperation among stakeholders. Businesses operating in Vietnam can partner with suppliers, makers, and distributors to work together toward sustainability. Smart contracts and shared records make instant communication and efficient teamwork possible, ensuring everyone is on the same page with sustainability goals. This teamwork might even establish industry-wide guidelines for responsible practices.

Market access and differentiation: As global markets increasingly value sustainability, adopting Blockchain-based supply chains can position Vietnamese enterprises as leaders in responsible business practices. By leveraging Blockchain to provide transparent and verifiable information about sustainability, enterprises can attract environmentally and socially conscious consumers. This access to new markets and consumer segments can provide a competitive advantage while driving a positive impact on sustainability performances.

Increase awareness and adoption: Businesses and firms should instill knowledge about sustainable actions in supply chain by ways such as: promote the development of industry standards and interoperability protocols for Blockchain-based supply chain solutions; launch targeted awareness campaigns through various channels, including industry events, conferences, social media, and traditional media outlets. By such way, companies and firms can take initial steps in integrating block-chain into their supply chain management.

Invest in infrastructure: Parties can make investment in infrastructure such as internet connectivity and technological infrastructure so that the flow of goods and services through the implementation of Blockchain can be delivered timely without interruption. Therefore, the integration and real-time data synchronization required for effective Blockchain implementations can be fostered.

6. Conclusion

In the rapidly evolving landscape of global commerce, achieving supply chain sustainability is no longer a choice but an imperative. This paper has explored the potential of Blockchain technology as a transformative force in advancing supply chain sustainability and considered its applications in the Vietnam supply chain context.

The discussed applications of Blockchain in diverse industries, from food supply, pharmaceuticals to logistics industry and beyond, have illuminated its capacity to enhance supply

chain sustainability performance. The case studies of Maersk and IBM, and Bext360 showed that Blockchain technology reduces paperwork, streamlines processes, and increases supply chain transparency, efficiency, and reliability, across borders. Additional case study of DHL and Accenture applied Blockchain technology to verify product legitimacy and compliance demonstrated Blockchain's ability to handle numerous transactions and units per second, showcasing its potential for tracking pharmaceuticals securely and transparently. We also provide another case of ShipChain and America Merill Lynch Bank to conclude that Blockchain technology can offer significant potential in enhancing efficiency and accuracy within logistics and supply chain operations.

The paper also concerns Blockchain-based supply chain management and its sustainability performance in Vietnam. Vietnamese supply chains are embracing sustainable practices, and Blockchain technology presents a promising solution. Blockchain enhances transparency, traceability, and verification of eco-friendly actions. The case study of My Huong Cooperative's use of Blockchain for tracing Cat Chu mangoes demonstrates its efficiency. While achievements have been made, challenges include adoption, infrastructure, data quality, regulations, and security concerns. Embracing Blockchain technology within the supply chain not only improves business operations but also strengthens sustainability efforts, positioning Vietnamese enterprises as responsible players in the global market.

However, the study has limitations such as the scope of the present study is very limited as it not only covers the triple pillars of sustainability. Besides that, not only Vietnamese enterprises but also many African and Asian ones have become leading companies in Blockchain adoption. In developing countries, Blockchain adoption and green practices in procurement and the supply chain are at a very early stage, and there is a need to develop regulatory authorities at the government level to implement these practices. One direction for future investigation could be considering the government’s role in the adoption of Blockchain. Overall, given that an increasing number of businesses have adopted Blockchain technology, a study subject for future investigation with theory development may be an empirical analysis measuring the effects of Blockchain technology on sustainability performance in other fields.

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