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A Blockchain-Based Framework for Green Logistics in Supply Chains

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Abstract: The logistics industry around the world has proliferated over recent years as a large number of business organizations have come to recognize the importance of logistics. Cost control used to be emphasized to remain competitive, but recently green logistics has gained attention with the awareness of the integration of economy and society as a whole. Nowadays, green logistics is a useful concept to improve the sustainability of logistics operations, and its related policies and theoretical research have been investigated and explored. However, the practical applications of green logistics are impeded by real-time data sharing, which is common in the logistics industry. Blockchain technology is adopted to address this challenge and enable data sharing among related stakeholders. This paper presents a reference framework for green logistics based on blockchain to reach the sustainable operations of logistics, with the integration of the Internet of Things and big data. Finally, potential benefits and limitations are analyzed when implementing this framework.

Keywords: green logistics; blockchain; Internet of Things; supply chains

1. Introduction

Logistics refers to the strategic management process of the procurement, movement and storage of materials, parts and finished products, and the related information flows through the organization and its marketing channels [1]. The logistics industry around the world has proliferated over recent years as a large number of business organizations have come to recognize the importance of logistics to reap benefits in terms of competitiveness, cost and quality. The statistics show that the market size of the global logistics industry reached a value of $9.6 trillion in 2018, and its size is projected to be more than $12 trillion in 2023, which accounts for approximately 12% of the entire world's gross domestic product (GDP) [2]. The total expense of logistics in China accounted for 18.3% of China's GDP (3.8 trillion RMB) in 2006 and 14.9% of China's GDP (11.1 trillion RMB) in 2016 [3]. Therefore, logistics is a foundational industry for the development of the economy and society.

The logistics industry is a capital-intensive and labor-intensive industry. In order to survive in turbulent and fierce markets, many logistics companies have been concerned to control costs to maximize profit and remain competitive over the past decades. However, with resource depletion and an increasingly detrimental environmental burden, the logistics industry raises a concern about the sustainable development of supply chain logistics, termed green logistics [4]. Green logistics refers to planning, controlling and implementing the flow of logistics through incorporating modern logistics techniques with the aim of minimizing the environmental hazards [5]. The transition to green logistics means the logistics industry is gradually emphasizing the importance of integrating economic and environmental aspects into logistics. Although sustainability has been viewed as a cost to the logistics industry in the past, nowadays it is considered as a key driver of efficiency and profitability. In fact, the logistics industry has to manage logistics activities and processes effectively and efficiently, leading to cost reduction, in order to reduce the negative impact on the environment and society. This leads logistics companies to become willing to explore green logistics.

Logistics is a complex network in which many stakeholders are involved. Coordination and collaboration among different stakeholders are generally believed to decrease cost, increase efficiency as well as realize green logistics [6]. However, there are several challenges when different stakeholders cooperate with each other. First, the recording of logistics data is completed manually. For example, for many electrical appliance manufacturers, during the order fulfilling process, all the involved operations, manufacturing and logistics objects are manually matched to order through marking on paper forms and then input to systems manually [7]. Under that circumstance, real-time data cannot be collected and optimal solutions cannot then be calculated with sustainable considerations. Second, data sharing is a challenge among different stakeholders. Efficient logistics operations require collaboration among stakeholders, but without shared data stakeholders may fail to attain the seven "rights" (deliver the right product, in the right quantity and the right condition, to the right place at the right time for the right customer at the right price) [8]. Third, logistics data leakage poses a threat to customers. A large number of packages carry a large amount of customers' information that can be obtained easily using paper-based records. This issue may lead to mistrust among stakeholders and is a barrier to building cooperative relationships [9].

The applications of blockchain technology can have a great impact on logistics management [10]. Blockchain was conceived in 2008 and first applied to the financial application Bitcoin [11]. Recently, blockchain has been applied to other research fields, such as manufacturing [12] and "smart" city development [13,14]. In this context, the use of this technology for logistics is a topical research field as blockchain guarantees the reliability and immutability of data that are open to the public [15]. For example, in the telecommunications industry, blockchain enables the transparency and reliability of sharing network traffic, income or other forms of economic compensation, which can create economically sustainable internet access. Each participant can invest in resources to recover the economic costs of network equipment and maintenance [16]. In the aviation industry, the major implications of blockchain technology for operations management have been investigated and links between blockchain technology, operations management and sustainability issues within supply chain management have also been analyzed. However, there is a lack of a network or framework to ensure the best results in terms of effectiveness, efficiency and sustainability [17]. Most research focuses on exploring the policies, opportunities and barriers to blockchain in the logistics industry, overlooking how to apply blockchain to logistics.

This paper aims to develop a blockchain-based framework with the integration of the Internet of Things (IoT) and big data for logistics management. IoT is used first to convert traditional objects into smart objects so that real-time data can be collected and captured. Then, blockchain is used to achieve real-time data sharing and protect data. Based on big data, a set of applications are designed to develop green logistics for various stakeholders.

The remainder of this paper is organized as follows. Section 2 reviews two streams of literature, green logistics and supply chain management and blockchain technology. Section 3 describes logistics management in supply chains and analyzes the possible problems. Section 4 depicts a blockchain-based framework for green logistics and presents key services to facilitate the development of green logistics. Section 5 discusses the benefits and limitations of the proposed framework. Section 6 concludes the work and the contribution, and proposes possible avenues for future research.

2. Literature Review

In this section, two main streams of literature are briefly reviewed, including green logistics and supply chain management (SCM) and blockchain technology.

2.1. Green Logistics and Supply Chain Management

In recent years, green logistics and SCM have gained increasing attention in academia and industry, which has entailed a growth in the number of academic publications in this field.

Many studies have reviewed relevant literature with the purpose of identifying green SCM research issues. Through categorizing the literature on global SCM, Sarkis et al. [18] introduced the research situation of green logistics and green supply chain in detail, pointed out research directions and provided future opportunities for other researchers. Ahi and Searcy [19] first identified and analyzed the 22 definitions of green SCM and 12 definitions of sustainable SCM based on papers published before 2013, then concluded that there was not a completely recognized definition and proposed a new sustainable SCM definition. Based on the analysis of more than 1000 published studies, Fahimnia et al. [20] proposed a bibliometric and network analysis that can objectively identify influential works, authors and emerging research clusters. In particular, they proposed a systematic map that can be used to illustrate the evolution of publications in the field and to find potential research directions. According to a literature review of the sustainability of logistics systems and logistics activities, and analysis of the sustainability reports published by logistics companies in Brazil, an overview of companies in Brazil was derived. In this overview, it introduced the practical application of sustainable practices in logistics operations [21]. In addition to summarizing the literature of green logistics and green SCM theoretically, a review summarized green SCM based on modeling approaches. The research status of mathematical modeling technology for sustainable SCM was reviewed, and this review contributes to the further substantiation of the field [22].

In terms of other types of literature, how to design and evaluate the performance of sustainable logistics networks has been taken into account in numerous relevant studies. There are some researchers concentrating on utilizing optimization methods and mathematical programming models to study green SCM. For example, Frota Neto et al. [23] developed a framework for the design and evaluation of sustainable logistic networks as environmental influences play an increasingly important role in logistics network design, and utilized the European pulp and paper sector as a background to examine the methodologies. Similarly, a conceptual model for a cost-effective and efficient reverse logistics network was proposed, and useful insights for various stakeholders and recommendations for further research were introduced based on detailed network configuration [24]. Pishvaee et al. [25] proposed a fuzzy mathematical programming model for the strategic configuration design of green logistics networks under uncertain conditions. The main advantage of these networks is they can achieve a balance between minimizing environmental impact and the total cost of network construction. In general, numerous studies have shown that effective and efficient green logistics could make outstanding contributions to economic, environmental, operational and social performance [26].

Lai and Wong [4] validated the attributes of green logistics management and global performance management with environmental and operational performance in developing countries. They provided ideas for Chinese green logistics management. Furthermore, according to evidence from developed and developing countries, Wang et al. [27] systematically studied the impact of green logistics on international trade, which could help facilitate the understanding of the relationship between green logistics and international trade, and formulate improved policies targeted at achieving sustainable development. Geng et al. [28] reviewed 50 papers published between 1996 and 2015, and summarized that the practice of green SCM in Asia had achieved better performance in four aspects: economy, environment, operational and social performance. Croce et al. [29] provided a framework and quantitatively evaluated transport services with electrical vehicles to make a contribution to sustainable mobility. They also presented a procedure for the solution of the vehicle routing problem based on reliable link travel times [30]. Sbihi and Eglese [31] introduced the kinds of operations research models that play a key role in addressing green logistics issues and highlighted that combinatorial optimization should be central when designing a reasonable solution. Additionally, Sheu et al. [32] optimized the operation of logistics distribution, and proposed an integrated logistics operation model in a given green-supply chain, which can increase the total net profit based on government policies. Tan et al. [33] combined auction theory and market design theory congestion reduction to realize sustainable traffic levels. Holman et al. [34] stated that the basic principle of sustainable logistics management in the 21st century is wholeness in systems thinking, and confirmed its basic role in the interaction of the performance of the logistics system components and the external environment.

Meanwhile, the significance of synergies for sustainable logistics enterprises was proposed since logistics costs will be reduced. The higher the degree of coordination of logistics enterprises, the higher is the efficiency that was verified [35].

2.2. Blockchain Technology

Blockchain technology has been regarded as a disruptive technology that has a profound impact on many fields, such as supply chains, business, healthcare, manufacturing and data management [36]. Smart contracts in blockchain are an important function that is designed to automatically facilitate, verify and enforce the negotiation and implementation of digital contracts without central authorities [37]. Many applications are designed based on this function. For example, in order to develop e-business in the IoT, an IoT electronic business model was developed using blockchain technology to realize peer-to-peer (P2P) trade efficiently and flexibly at a low cost [38]. Using smart contracts, blockchain was explored to trade real-world assets automatically, such as cars, and used to mitigate adverse selection effects in lemon markets through tracing and tracking a reliable and transparent record of transaction history [39]. In addition to physical assets, data are also regarded as a valuable asset to make management smarter. For example, Yue et al. [40] applied blockchain to the healthcare industry to share healthcare data among different data management systems and improve the quality of healthcare service while protecting data privacy.

To support the implementation of the IoT, blockchain is adopted. Although the IoT can connect smart devices to collect data for real-time decision-making, IoT technology is being impeded by some issues, such as data privacy and security issues [41]. Hence, Zhao et al. [42] integrated blockchain with the industrial IoT to build trust between the components of the IoT and business models and then used smart contracts to process and store data securely. Liu et al. [43] combined Ethereum blockchain and deep reinforcement learning to design a blockchain-based efficient data collection and secure sharing scheme in order to create a reliable and safe environment. Based on the integration of the IoT and blockchain, many industrial applications have been developed. For example, in the chemical industry, blockchain was explored and employed to facilitate machine-to-machine (M2M) interactions and establish an M2M electricity market, and a scenario was used to investigate the electricity trading [44]. Lee, Azamfar and Singh [12] used blockchain in cyber-physical production systems to integrate and synchronize the virtual world and physical world based on a unified three-level blockchain architecture.

In logistics and supply chain management, blockchain significantly improves operational efficiency. Cole et al. [45] investigated blockchain from an operations and supply chain management perspective to identify potential research directions and provide an agenda for future research on six key themes. Queiroz et al. [46] synthesized the existing literature on the integration of blockchain and SCM between 2008 and 2018 to analyze current blockchain applications and provide several important implications for practitioners. Pournader et al. [47] introduced the current status of blockchain application in supply chain, logistics and transportation management and discussed the future research of blockchain technology and its application in industry and services. Wang et al. [48] proposed that blockchain technology is still in its infancy but its application in the supply chain is gaining more and more attention, and studied the ways in which blockchain technology may affect future supply chain practices and policies. Kshetri [49] proposed that the arrival of blockchain will change supply chain activities. They also studied how blockchain may affect key supply chain management goals, such as cost, quality, speed, reliability, risk reduction, sustainability and flexibility. Thus, Queiroz and Wamba used modeling methods to prove that blockchain is a cutting-edge technology, and it has been changing and reshaping the relationship between all logistics and supply chain system members [50]. Zhang et al. [51] applied blockchain to life cycle assessment to assess the environmental impacts of a product or service. Venkatesh et al. [52] used blockchain to protect labor rights and provide safe workplaces from a perspective of social sustainability in the global supply chain. Tijan et al. [53] presented a systematic review of blockchain in logistics to analyze major challenges. Fu and Zhu [54] proposed an intelligent logistics system using blockchain to solve security threats and privacy leak risks in logistics and designed operation mechanisms for consensus authentication, and data storage and access.

In summary, little attention has been paid to applying blockchain to green logistics. Although blockchain has been used in logistics, most research studies focus on literature reviews and provide insights for practitioners and academia. Therefore, this paper aims to narrow the gap by designing a blockchain-based framework for green logistics.

3. Logistics in Supply Chains

Logistics in supply chains is the management of the flow of goods between the point of origin and the point of consumption in order to meet requirements [55]. As shown in Figure 1, a typical supply chain consists of suppliers, manufacturers, distributors and customers. An upstream stakeholder can be regarded as a seller of its downstream stakeholders. Therefore, in the business process, upstream stakeholders can be abstracted as sellers and downstream stakeholders can be abstracted as buyers. For example, manufacturers are sellers of distributors. When buyers purchase goods from sellers, there are at least two procedures, including procurement and distribution. After placing an order successfully, sellers will arrange a third-party logistics (3PL) provider to transport goods. In most cases, multimodal transport is used. Transportation contains long-haul transport, warehousing and short-haul transport. Finally, goods are delivered to buyers and the transaction is completed. In the logistics process, stakeholders need to collaborate and coordinate together to complete transportation tasks. To realize collaboration and coordination, stakeholders need to use real-time data and information so that optimal solutions and decisions can be made to realize green logistics.

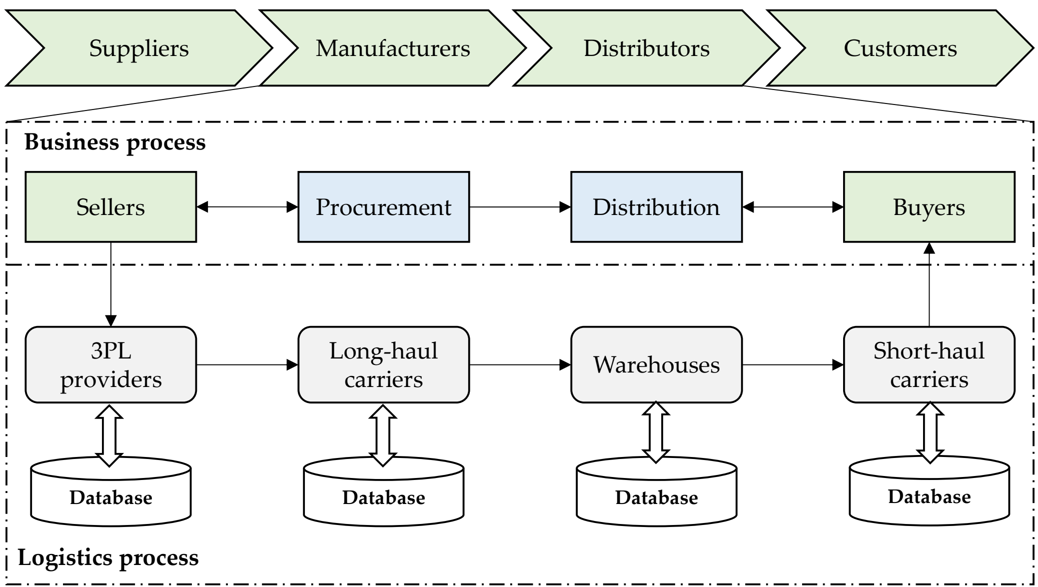

Figure 1. Logistics in supply chains.

However, stakeholders may have their own private databases, which hinders stakeholders from sharing data. Although some platforms are designed to facilitate data and information sharing, data or information updating may be delayed since data and information are collected manually or it takes longer to update data and information across the system. Due to lack of real-time data and information, logistics resources may be used inefficiently, which results in the waste of energy; and dynamic decisions cannot be made to meet requirements, such as receive dates and transport capacity information. Therefore, nowadays logistics has a hard task as strong connections among stakeholders are established. It is important to collect and share real-time data and information.

To effectively counter the above challenges, blockchain technology has been exploited to facilitate this process [10]. This paper aims to further explore the application of blockchain in the logistics industry by integrating the IoT and big data.

4. Blockchain-Based Framework for Green Logistics

In order to achieve multi-party data sharing and real-time decision-making, the Internet of Things technology is required. However, data privacy and security issues often arise during the application of this technology. Blockchain technology is based on a method by which previously unknown parties can jointly generate and maintain almost any database on a completely distributed basis.

This section depicts a blockchain-based framework for green logistics based on blockchain to achieve the sustainable operations of logistics, with the integration of the Internet of Things and big data. The main purpose is to introduce how the IoT is deployed to convert traditional objects into smart objects and key applications related to logistics.

4.1. Overview of the Framework

Figure 2 shows the overview of the proposed framework that is composed of seven layers: physical layer, perception layer, network layer, blockchain layer, management layer, application layer and user layer.

The bottom layer is the physical layer. This layer consists of all types of logistics resources that are involved in the logistics process and are the basic resources to support the operation of logistics. These resources are categorized into three types. The first type is goods that need to be transported from sellers to buyers. The second type is logistics operators who are responsible for the movement of goods. The third type is logistics equipment, such as trucks, forklifts and warehouses.

The second layer is the perception layer. This layer provides the ability to monitor and perceive the status of logistics resources through a wide range of sensing devices, such as radio frequency identification (RFID) technology. RFID readers and tags, as well as scanners and barcodes, are used to identify goods uniquely. Webcams are used to monitor the workplace environment and protect the safety of goods. Trucks are equipped with global positioning systems (GPS) so that the real-time position of trucks can be captured. Wearable technology is applied to the logistics industry because this technology can effectively improve efficiency and reduce the workload of logistics operators. This is also regarded as sustainable development from a social perspective. Other smart sensors, such as smart electricity meters, smart water meters and smart gas meters, can be deployed to detect the depletion of resources.

The network layer provides communication channels. Data collected through the perception layer can be transmitted to the blockchain layer using these communication channels, such as 4G/5G networks, ZigBee, Bluetooth, Transmission Control Protocol/Internet Protocol (TCP/IP), ultra-wideband and etc. This layer is conducive to the fast transmission of real-time data securely.

The collected data is stored in a series of blocks that are chained one by one in chronological order to form a blockchain. A blockchain is composed of a header and a body. The former contains all the meta information, while the latter stores a Merkle tree of verified and hashed data [56]. A Merkle tree includes order information, shipment dates, receive dates, good information, operator information, etc. In order to form a blockchain, three key elements are required. The first is the consensus mechanism that refers to consensus algorithms to guarantee the data consistency and let all nodes of the blockchain network reach an agreement on data; the second is the incentive mechanism that is used to motivate all nodes to record data; and the third is the cryptography that aims at encrypting and protecting data.

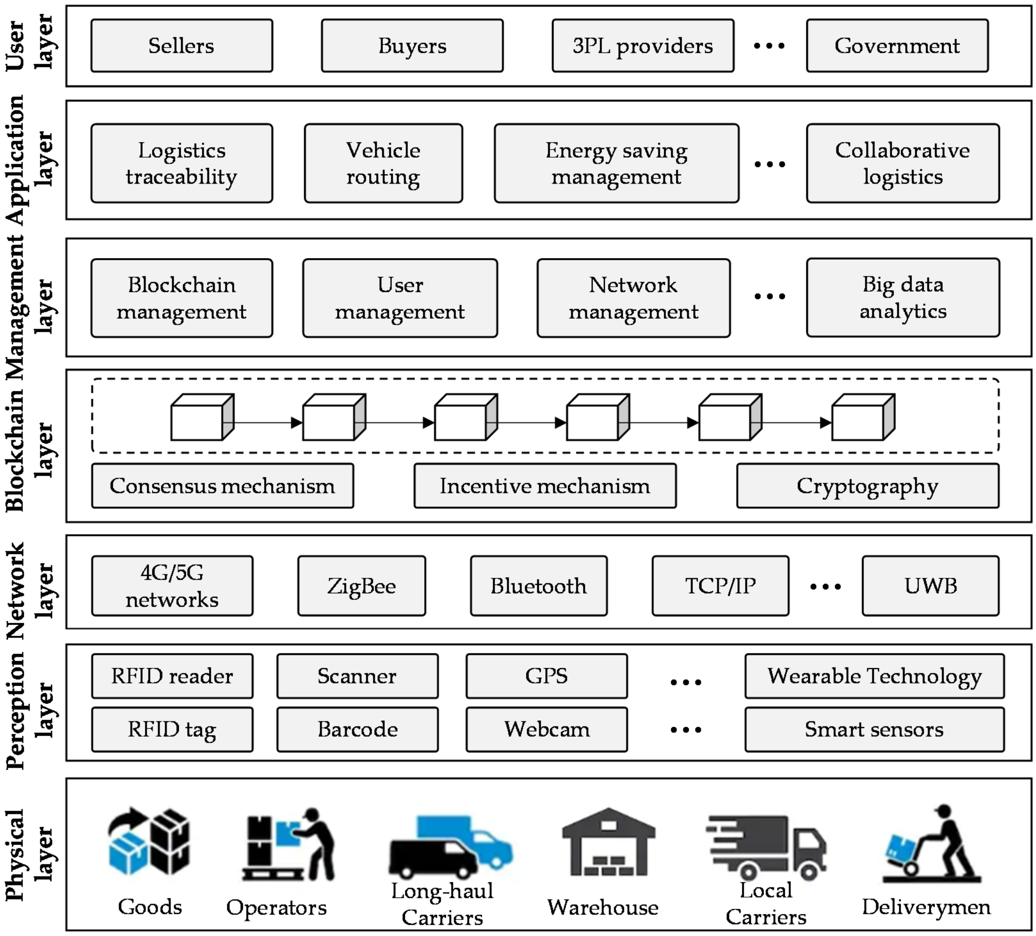

Figure 2. Blockchain-based framework for green logistics.

The management layer is several management tools that support the operation of this framework. These tools include blockchain management, user management, network management, big data analytics, etc. Blockchain management aims to manage and update the blockchain layer. User management is responsible for managing analysis of the logistics process in supply chains, and identifying problems users and generating public and private keys. Network management is used to control communication channels. Big data analytics is used to process data stored in blockchain for applications.

The application layer provides diversified applications, such as logistics traceability, emission analysis, smart transactions and collaborative logistics for users in the user layer. Users refer to stakeholders related to logistics in supply chains.

4.2. Key Applications

Logistics traceability. This application is a fundamental but important application. It provides related stakeholders with the ability to trace and track goods with the adoption of the blockchain network, as shown in Figure 3. This application has a great impact on the efficiency of logistics and supply chains, goods' safety and just-in-time delivery performance. Through logistics traceability enabled by blockchain technology, stakeholders can easily obtain consistent and reliable data and information on the logistics process of goods. Based on consistent and reliable data and information, stakeholders can save resources and materials to bring considerable economic profits to enterprises. This provides the potential for the realization of reverse green logistics, which is the coordination of the complete, effective and efficient utilization of products and materials throughout the product life cycle [57]. The government also can use this application to regulate the logistics industry readily.

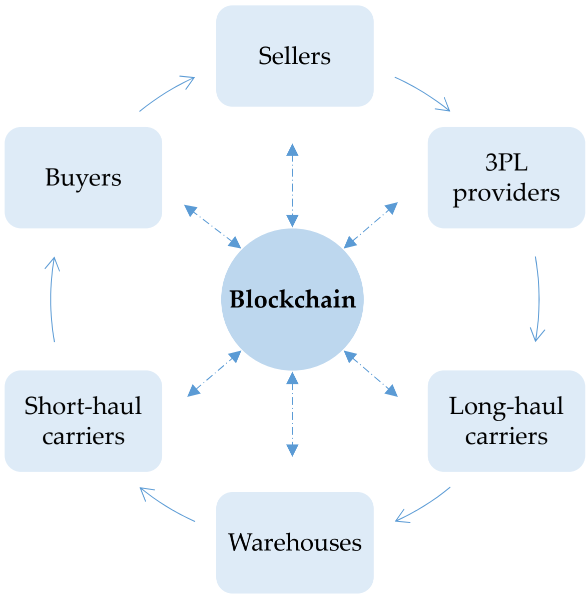

Figure 3. Logistics traceability.

Vehicle routing. The vehicle routing application aims at finding optimal routes for multiple vehicles to visit a set of buyers. This application plays a crucial role in the logistics and supply chain design. With real-time data, vehicle routes can be optimized in real time to avoid traffic jams and reduce carbon emissions. Thus, energy consumption can be reduced significantly and protect the environment. All requirements and shipment specifications are recorded in the blockchain network, and users can retrieve them from blockchain and set optimization targets to calculate optimal results. Vehicle routing can give rise to better green logistics and supply chain design decisions for improving the sustainability performance.

Energy saving management. Energy saving management is a useful tool to monitor, control and manage the usage of energy. Conventionally, energy cannot be managed and controlled properly because there is a lack of reliable data on energy consumption. Logistics companies cannot overall evaluate environmental performance. With physical objects equipped with smart sensors, real-time data on energy consumption can be collected and then recorded in the blockchain. Logistics companies can use data to conduct energy analysis without manual data manipulation and use the analysis results to seek energy saving solutions. Big data analytics can provide an overall solution to save energy [58]. For example, logistics companies can properly select different types of vehicles (green vehicles and diesel vehicles) under different scenarios through this application. Energy saving management can reduce environmental pollution and solve the problems that perplex enterprise managers. It is also one of the most important ways to establish a green supply chain.

Collaborative logistics. This application enables logistics companies to collaborate with each other to serve a set of customers while reducing freight logistics costs and maximizing capacity utilizations of facilities [59]. This collaboration among logistics companies can reduce energy consumption and carbon emissions, and increase profitability. Generally, there is a collaborative logistics market with multiple agents who want to trade their logistics resources or logistics tasks. Due to dynamic demand and supply, traditional collaborative logistics markets find it difficult to allocate logistics resources and tasks. By adopting blockchain technology, a P2P collaborative logistics market can be established, which allows them to trade freely, as shown in Figure 4. This application not only maximizes the allocation of resources, but also reduces the consumption of raw materials, thus improving the environment, promoting sustainable development and the formation of green supply chains. In blockchain-enabled P2P markets, smart contracts can be used to facilitate the trading process. Agents use smart contracts to set trading protocols, and auction methods such as English auctions, Dutch auctions and combinatorial auctions can be used to build collaborative relationships. Once conditions are satisfied, trading can be completed successfully.

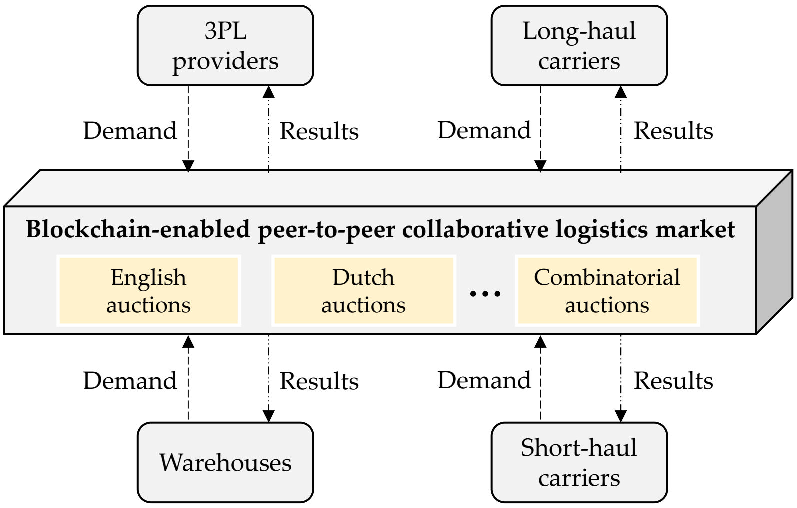

Figure 4. Collaborative logistics market.

5. Discussions

5.1. Benefits

There are several benefits when blockchain is applied to the logistics industry, including transparency, establishing trust, and enhancing collaboration and cooperation.

Improving transparency. This blockchain-based framework can disclose reliable, consistent and immutable data to related stakeholders. Unlike traditional approaches for data sharing, stakeholders can retrieve data from the blockchain network in real time. Thus, data on the logistics process is readily available to end users.

Establishing trust. Generally, it is difficult for stakeholders to establish trust. With the implementation of blockchain, the performance of logistics companies can be evaluated based on their historical performance, such as on-time deliveries and pickups. Additionally, logistics companies also can monitor the performance of customers, such as the fulfillment of contracts. In addition, smart contracts can be issued to facilitate the payment and pricing process. Once all conditions are satisfied, payment processes can proceed automatically.

Enhancing collaboration and cooperation. With the establishment of trust among stakeholders, they will become willing to collaborate and cooperate with each other. Thus, in the logistics process, stakeholders can seek globally optimal solutions to reduce overall costs and improve profitability. In addition, due to real-time data sharing, stakeholders can adjust their planning and scheduling based on actual situations. Even if stakeholders are competitors, they can also reap benefits through collaboration. For example, in the application layer, competitors can use collaborative logistics to reduce costs and maximize capacity utilization.

5.2. Challenges

Several challenges hinder the logistics industry from adopting blockchain technology to develop green logistics, including incentive mechanisms, data storage and transmission as well as implementation cost.

Data storage and transmission. The world is full of data. Nowadays, the amount of data increases rapidly; Google needs to process more than 24 petabytes of data per day and Facebook can upload more than 10 million photos per hour [60]. Similarly, in the logistics industry, a large amount of data can be collected and stored every day. Thus, this poses a threat to the application of blockchain. First, as the amount of data is collected, each node in the blockchain network needs a large storage capacity because data is stored repeatedly in each node. This will result in the waste of storage. In addition, electricity is also consumed, which violates the original intention of green development. Second, when a large number of IoT devices are deployed, real-time collection will lead to network congestion that reduces the quality of services. As a result, the stability of blockchain cannot be guaranteed. Therefore, data transmission is a huge challenge for the logistics industry.

Implementation cost and risk. In order to implement a blockchain-based framework for green logistics, cost and risk are barriers for the logistics industry. High cost is a burden on logistics companies. There are several types of costs, including device costs, training costs, operation costs and maintenance costs. Although potential benefits have been elaborated, most of them have not been achieved. Rather than make a large investment, companies might prefer not to adopt blockchain. Besides, high risk is another burden. How blockchain can be used is still being explored. As a result, the operations of logistics companies are vulnerable to disrupt once there are technical problems.

Incentive mechanisms. In cryptocurrency systems, miners in a blockchain network are rewarded. However, the logistics industry obtains few rewards when logistics companies record data on the logistics process. Hence, they cannot be motivated to do so. Without the involvement and engagement of logistics companies, blockchain cannot be established, and applications and services cannot be further used to facilitate logistics operations. Therefore, incentive mechanisms are necessary.

6. Conclusions

Blockchain technology is a disruptive innovation with potential to transform current industries and businesses. This paper proposes a framework for green logistics based on blockchain by integrating the IoT and big data in the logistics industry. This research is a pioneer work which explores the application of blockchain in logistics operations. The contribution of this paper is threefold. First, this paper analyzes the logistics process in supply chains and identifies existing problems that hinder the logistics industry from realizing green logistics. Second, a seven-layer framework is proposed based on blockchain. This framework enables the logistics industry to transform from the traditional operation mode into a blockchain-based operation mode. Several important applications are presented to reduce the cost of operation and management and improve profitability. Third, benefits and challenges are explained in detail so that logistics practitioners can conduct a cost-benefit analysis.

Regarding future research directions, the following research questions will be answered. The first question is how to effectively connect the physical layer with the perception layer to collect logistics data. The second question is how to design incentive mechanisms that motivate logistics companies to participate in the construction of blockchain. The third question is how to address high costs and risks when adopting blockchain technology.

Author Contributions: B.Q.T. reviewed literature, designed this study and prepared the original manuscript; J.L. organized the study and made some suggestions for the first manuscript; F.W. supported this study and provided some suggestions for the first manuscript; K.K. designed figures and corrected writing errors in the final manuscript. F.C. corrected writing errors and provided some suggestions for the final manuscript. All authors have read and agreed to the published version of the manuscript.

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