Reverse Logistics Solution in e-Supply Chain Management by Blockchain Technology

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Abstract

The greatest problem for e-Supply Chain Management (e-SCM) is the cost of delivery. In the situation of returned products, transportation has to be paid twice. Reverse logistics is the process of transferring products from their typical final place to its origin for the purpose of capturing value or defect on the product. Additionally to this there are also costs of correction of invoices, inspection of products and refund. One method to solve this problem is demand forecasting which depends on its coordination and integration of the supply chain. However, this type of solution requires extra effort to forecast expected future demand. Recently, blockchain is emerged as a novel approach to building trust in a trustless environment and thereby guarantees data integrity, availability, traceability and security in data management and it presents a valuable solution to e-SCM. This research illustrates how to solve the problem of reverse logistics in e-SCM using blockchain technology to enhance transparency and trusting through the chain. This is achieved by introducing a new framework that integrates supplier relationship management (SRM) with customer relationship management (CRM) in application suite by blockchain technology. In the suggested framework the blockchain is utilized as a communication message to handle the reverse logistics. The benefit of the proposed framework appears in digital products in reverse logistics by saving all information in blockchain to make the operation of transferring them to supplier without any extra cost or difficulty.

Keywords: *e-Supply Chain Management, Blockchain, Reverse logistics, Supplier relationship management, Customer relationship management, Information systems.*

1. Introduction

Satoshi Nakamoto in 2008 invented blockchain as a cryptocurrency called “Bitcoin.” It is proposed as a public ledger in a peer-to-peer (P2P) distributed network [1]. The supply chains for commercial markets can exceed over hundreds of production stages and several geographical locations so that the source and history of a product is usually opaque to upstream actors. Shortage of clearness and trust in the supply chain lead to lack of information about the source and working conditions behind the product [2]. A blockchain saves transactions between parties on a distributed ledger [3]. Supply chains are gaining increasingly more crucially, more extended, and more international. An event on one side of the world can stop production or delivery of a service on the other side. The event may be a natural or man-made cause, and the event may be large or small, but if the supply of a critical component or service is broken down, the consequences can be severely dangerous to firms further along the supply chain, both financially and in terms of reputation [4]. e-SCM needs to

build a system for reverse logistics which comes into play when the client needs to return a product because it is damaged or they wish to exchange the product for its size, color and other reasons thereof. The e-SCM has to indicate a hassle free return and exchange policy because this will go a long way in building a bond of trust with the clients [2].

The merger of blockchain and SCM offers whole SCs the opportunity to create value for their customers through the design of agile, flexible systems built around dynamic, high performance networks of Web enabled customer and supplier partnerships and critical information flows called e-SCM [5]. For this reason, there is an urgent need to use blockchains in the e-SCM to cover the reverse logistic fault [6]. This paper aims to enhance e-SCM transparency by solving reverse logistic using permissioned blockchains within the framework of making a verified data of untrusted ones utilizing integrated information systems (IIS) which uses the communication message in the link between CRM and SRM.

The rest of this research is organized as follows. Section 2 demonstrates the blockchain. Section 3 presents SCM and the stages of SCM development. Section 4 shows e-SCM. Section 5 discusses the benefits of blockchain in e-SCM. Section 6 defines the concept of integrated information systems. Section 7 illustrates the proposed e-SCM framework depending on blockchain and IIS. Section 8 discusses the concluding and future works.

2. Blockchain Definition

Basically, a blockchain would be explained by a distributed ledger: a chronological chain of ‘blocks’ where every block includes a record of valid network activity since the ending block was increased to the chain [7]. Every block would be explained as an encrypted bit of information. Theoretically, everyone can add data to the chain of blocks by transacting in the network, everyone can read this data at any time, but no one can change it without sufficient authorization. As a result, a blockchain is a complete and unchangeable history of network activities, which are shared among all nodes of a distributed network. Blockchain technology for the first time, simplifies two or more entities that may or may not know or trust each other to securely transfer value over the internet without including a third party. Instead, the needing for validation of transactions is achieved through a process known as ‘mining’ that verifies the security and validity of the information added to the chain. Blockchain technology can be explained as the technology that powers the Internet of Transactions [8].

One main reason to why blockchain technology is so important is that it found the solution of the duplication spending problem. If anyone emails a file to another one, he will still have a copy of the file after he sent it. Unlike a file, value such as an apartment or a cryptocurrency such as bitcoin should only exist one replica of at all the times. If this is not the case, the apartment can be sold twice and the money can be spent twice, thus the term double spending. On a blockchain the double spending problem is handled by publicly announcing the transaction to all miners in the blockchain such that all miners verify all transactions [9-11].

Due to such interest from most companies and the great amount of money being circulated in cryptocurrencies, innovative and creative organizations and entrepreneurs have been attracted to this new branch of information technology [12]. This fast growth in the field has changed the perspective of many governments to see the potential of this technology over its initial affiliation with illegal activities [13]. Some existing applications and use cases of blockchain are shown in figure 1.

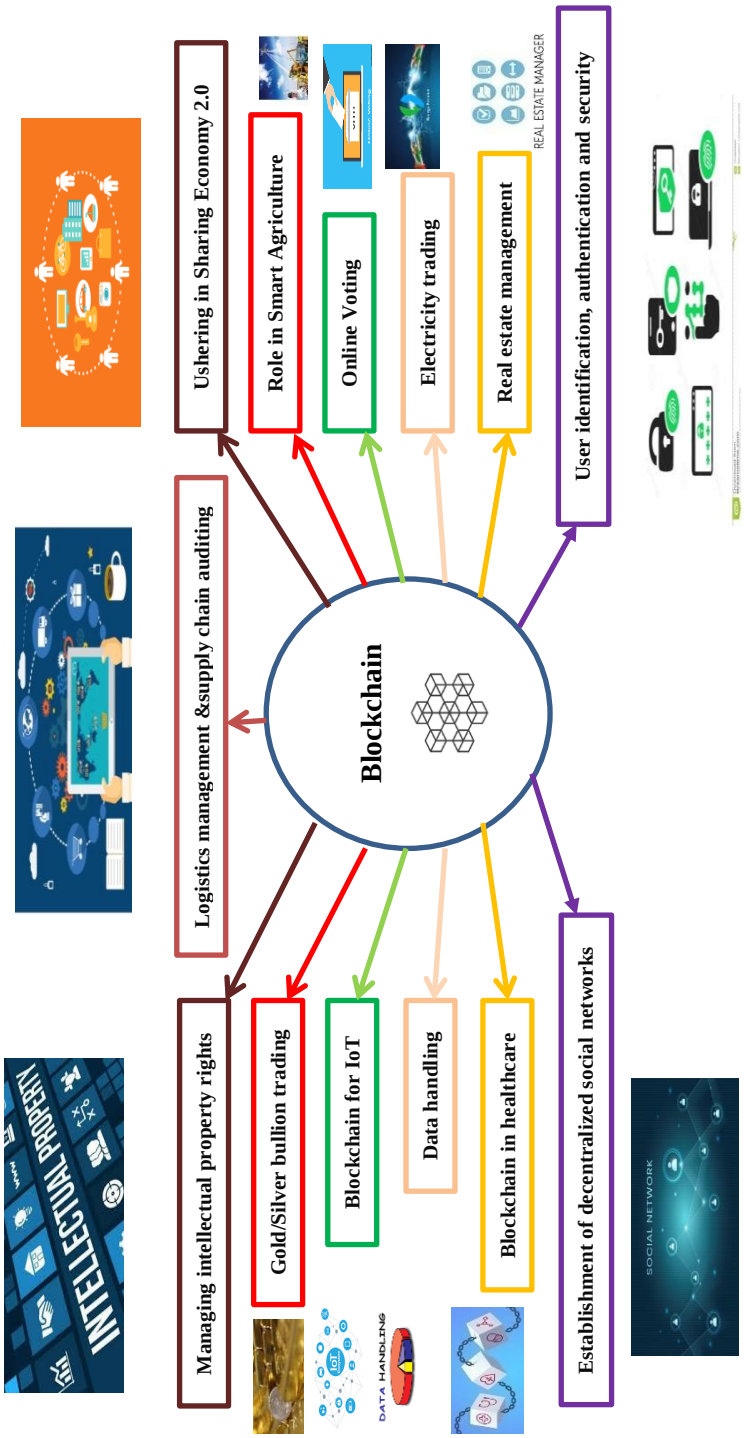

Fig.1: Block chain Applications

Blockchain has two kinds, permissioned and un permissioned. **Un permissioned** - it is shared cross over various PCs in the system so anyone can see & change or exchange what is recorded, the information put away is time stamped, that it can't be eliminated or refreshed further.

The enhancements to the record or new records are followed and refreshed continuously for everyone with every entrance. Although of its circulating nature blockchain is hard to hack, as everybody duplicates are situated at better places.

Permissioned - this work is like un permissioned, but it fit for limiting who can permit the exchanges in the system. A blockchain promotes secured online transaction using cryptography by making cryptographic key integrated with a wallet programming. In blockchain, to make authentication and non-renouncement, an advanced mark is used, the key-regulating element which can perform the exchanges from its related record [14]. Blockchain is widely used instead of traditional methods like SQL in e-SCM for the following reasons [15] which summarized in the next table (table 1).

Table 1: Blockchain Vs SQL server

Blockchain	SQL server
Decentralized architecture	Clint-server architecture
Permissions are distributed – no need for centralized control	Permissions are centralized – point of vulnerability
All transactions are maintained – only new transactions are added	Anyone with permission can alter the records
Decentralized verification	Clients have permission to Create/ Write/ Update/ Delte
Cryptographically linked – hard to alter	Needs redundancy and disaster recovery
Disintermediation	Confidentiality
Superior replication and redundancy	Superior performance
Trust in data	Confidentiality in data

3. The Meaning of Supply Chain Management and its Development

In today's business environment, no enterprise can expect to build a successful product, process, or service advantage without integrating their strategies with those of supply chain systems in which they are inextricably entwined. Supply Chain Management (SCM) is a network of a supplier, manufacturing, assembly, distribution and logistics efficiencies that give the function of procurement of material, transformation of this material into end product and distribution of this product to clients. So, SCM is the management of material, money, men and information within and across the supply chain to maximize client satisfaction to give competitive effectiveness. SCM is the management of upstream and downstream communications with suppliers and customer to distribute superior customer value at less cost [16].

It is the best application area for internet technologies and electronic commerce. Logistics has always been about controlling the synchronization of the requirements of individual companies for product and service acquisition with the valid resources from suppliers, on the one side and distribution functions to meet the orders of the customer, on the other. The SCM concept, improved by the power of Internet technology, is the maturation of these basic value-added functions [16]. The supply chain system concept can be described as a network of interdependent partners, who not only supply the necessary products and services to the channel system, but who also stimulate demand and facilitate the synchronization of the

competencies and resources of the entire supply chain network to produce capabilities enabling a level of operational excellence and marketplace leadership unattainable by each business operating on its own [17].

As companies focus on core competencies and becoming more flexible, they shorten the ownership of raw material sources and distribution channels. These are given to other companies for better or effectively performance. So, less control and more supply chain partners generates the concept of SCM which helps to enhance trust and collaboration among supply chain partners. SCM has two main components:- **Front-end Component** (This Component has processing and information flow to present strength to backend components operations. It uses the internet for management of supply chain partners.) and **Backend Component** (it has supply facilities, retailer, distributors warehouses, and logistics facilities.) [18] The main objective of SCM is to extract a strategy which helps firms to build up and increase sustainable competitive advantage by cost reduction but maximum customer satisfaction. In SCM firm's managers have to manage different areas whose effectively running led to successful SCM [19].

- **Customer Service Management**: Fruitful SCM needs downstream integration of the customer as well as management of the supplier. So customer relationships have a vital role in an organization.

  In this management, efforts are made by organization to present best service to their customers which are the source of customer information. For this, their requirements are predicted and fulfilled to induce positive feelings for organization.

- **Procurement Management:** It includes resources planning, supply sourcing, negotiation, inbound, transportation handling and order placement i.e. coordinating suppliers for the purpose of supply continuity. For these strategic plans are done to enforce manufacturing flow of new products.

- **Information Management:** inappropriate communication can derive to disaster in business, so SCM models must be designed, which present suitable flow of information ERP (enterprise resource planning) helps in delivering high achievement. Information sharing protocols gives manufactures more right demand information so IT architecture helps SCM to build a base in the modern era for successful working.

- **Performance Measurement Management:** It is very essential tool which present long-term success. According to experts, measurement of achievement internally on externally important in creating and maintain the competitive edge. Measurement can be made in many ways like on the basis of cost and efficiency, return on investment, return on sales and enhancement models by organization. It should be consistent with overall strategy of the supply chain. It must be easy to understand and enable the supply chain to fix standards for each element so that bench marking of performance is done.

- **Financial Management:** SCM also contains managing finances of organization. Accounts payable, inventory management, billing acquires, possibilities of sharing costs are few key financial activities that require to be defined well in SCM model.

- **Outsourcing/Partnership:** In the modern era, companies make sub-contracts with specialists or logistics partners for saving of transportation, warehousing and inventory control. So, for controlling and monitoring partnerships of several suppliers/partners strategic decisions are taken very accurately. These collaborative partnerships can be handled through trust and commitment which is another big issue in SCM. So careful

development of supply chain partnerships helps in reducing cost, enhance service and to win competitive advantage.

The SCM concept could be consisted of five different stages management. The 1st can be defined as the era of internal logistics departmentalism. In the 2nd stage, logistics began the migration from organizational decentralization to centralization of core functions driven by new attitudes relative to cost optimization and customer service. Stage three showed the dramatic expansion of logistics beyond a narrow concern with internal warehousing and transportation to embrace new concepts calling for the linkage of internal operations with analogous functions performed by channel trading partners [20]. In 4th stage the old logistics concept is replaced by SCM. Today, with the application of Internet technology to SCM concept, it can be described 5th stage which is called e-SCM [20].

4. e-SCM

The e-SCM is a tactical and strategic management philosophy that deeps into the network the collective productive abilities and resources of intersecting supply channel systems through the application of Internet technologies in the search for innovative solutions and the synchronization of channel capabilities dedicated to generation of unique, individual sources of customer value [21].

In the place of a preoccupation with optimizing and accelerating the flow of material and information up and down the supply chain, web-based channel management is concerned with the generation of new kinds of customer value for both the internal and external customer. The web-enabled supply channel can be presented as:- the application of Internet technologies concentrated on continuous recreation of networks of businesses empowered to make superlative, customer-winning value at the lowest cost through the digital, real-time synchronization of product/service transfer, service needs and request priorities, vital marketplace information and logistics delivery capabilities [20].

The concept, continuous recreation of networks of businesses, indicates that successful supply channels are constantly mutating to respond to the dynamic nature of today's ceaseless demand for new forms of customer/supplier collaboration and scalable product and information delivery flow. This element extracts how supply channels will organize to compete. Customer-winning value refers to the marketplace's need to continuously reinvent unique product and service configuration and agile delivery capabilities. This element illustrates the mission of the channel. Finally, digital, real-time synchronization, refers to the application of technology process enables that network internal firm systems, decision support systems, and data warehouses [20].

Java, XML, and other Internet and e-commerce technologies have now made it possible to override external firm integrators with low cost, inclusive Web enabled tools that merge, optimize, and effectively direct supply channel competencies. This element shows the mechanics of how enabled supply chains will compete [20].

The e-SCM is about speed, reducing operating costs and customer's predictions. There is a several of challenges for e-SCM like:- delivery time, availability of goods, fluctuation in demand, software applications, shortage of information and communication technology infrastructure, geography and reverse logistics [21].

5. The Benefits of Blockchain in e-SCM

Blockchain being a technology that reinforces a trusted, secure and transparent technology has the potential to solve some of the current problems with supply chains today. An example is a blockchain application that registers all transactions of goods on a blockchain: The parties included, date, price, location, state and quality of the product and other information that is relevant to management of the supply chain [22]. The Blockchains implementations public availability means that it will be possible to track every step in the supply chain of every product. In a supply chain that has implemented blockchain, everyone can potentially follow a product back to the raw materials used to generate it [23]. In a blockchain application, a blockchain based the smart contract can trigger automatic value transfers depend on conditions. Transactions in the supply chain often need third-party firms such as banks and clearinghouses. These are normally brokers and middlemen who are paid a fee and trusted to control or process a transaction. Blockchain implementations has the potential to present automatic blockchain-based smart contract systems that gives a higher degree of trust than these brokers and middlemen [23].

The brokers and middlemen might lose their competitive advantage of trust to a blockchain application that is more trusted and makes the job more professional. In every contract, or business work, or any transfer of ownership three most common hurdles are coming to dismiss the process or do it in a wrong way [23].

- In that one is trust on each other, that no one is ready to trust on another without any reasonable guarantee.
- Second is mediation, that in most deals the parties does not agree on some or other rules and conditions and thus the process fails before reaching to the end.
- Third is deviation, that there is a lot of people and computer that tries to deviate someone from a right way.

Several manual and digital techniques were proposed to tackle these problems, but no one presented the applicable and satisfactory solution and thus got fail. The only Blockchain is considered who can tackle the problems given above and can give satisfactory solution [23]. In other words a blockchain is a distributed database of records or public ledger of all transactions or digital events, that have been achieved and shared among all participants of the network. Records in the database are synchronized and uneditable. As a digital currency established on the internet for the internet, a Bitcoin is correlative from its blockchain. They can be regarded as several definitions of the same reality; the blockchain is the consensual database of input/output transactions, and a unit of Bitcoin does not and cannot exist regardless of it. On the other hand, the smart design of the first blockchain is taken from Bitcoin, and its spin-offs are transmitted into those areas of economy where there are needs for trust, consensus, security, transparency, storage of value, etc.; one of them being supply networks. e-SCM is the most popular example of a system that is tied to the blockchain technology [24].

Typically, there are various supply chain members each with their private information systems, but communication between these systems is limited at best. The main barrier was (and still is) the shortage of trust in exchanging information. Blockchain technology promises great trust issues and preventing trustless, secure and validated system of logistics and supply chain information exchange in supply networks. Based on these features and blockchain

development in general, the pace of new implementations within the supply chain is rapidly accelerating which is called e-SCM [25].

Master projects are launched worldwide and supply chain industry is expecting changes. Blockchain can add a huge deal of value when merged with Internet of Things (IoT) devices, tracking actual-world events and uploading the information to the chain [25]. Applications include:

- Automating payments on completion of delivery.
- Detecting temperature changes and voiding products that have been adversely affected.
- Recording security logs for items in transit.
- Reverse logistics.

Blockchain can associate to authenticate items by tracking unique identification codes, either assigned to them or that characterized their properties. For example, Ever ledger has a system that tracks 40 characteristics of diamonds, including color and clarity, in order to give them a unique diamond ID.

Blockchain technology enables real-time, multi-party tracking as well as allowing a comprehensive, immutable audit trail, that can be extended to include the management of outsourced infrastructure. By automating monitoring and authorization, blockchain technology can dramatically simplify auditing and reconciliation in logistics, thereby saving time and earasing errors and miscommunication. By decreasing and facilitating auditing, blockchain systems can enable dramatic savings – which, on their own, may well cover a logistics firm entire investment into the technology [26]. Current electronic data systems can leave containers in receiving yards for weeks, awaiting sign-off. Online monitoring and automated data exchange via blockchain can produce this process instant, accelerating the payment cycle and saving unnecessary storage costs.

These developments will enable organizations to enlarge their liquidity and enhance manage risk. Continuous, end-to-end monitoring of the supply chain using blockchain technology decreases the risk of inferior and misidentified materials entering the system. This is critical in fields such as pharmaceuticals and high-end manufacturing, where counterfeit products can cost lives [26]. Blockchain technology can supply improved visibility into the state of goods and delivery. This makes business better understand slowdowns and to identify where incidents of damage and theft are occurring. Transparency presented by blockchain technology strongly incentivizes good behavior. As there is a shared source of truth (via the distributed ledger), it is very hard for organizations within the network to game the system or to commit fraud [26].

By enhancing transparency, blockchain can be used to certify organic, green and animal-free products, and to mitigate risks around:

* Counterfeit goods * Food security * Conflict minerals * Child labor * Corruption

By speeding turnaround, increasing efficiency and making it better to connect with partners via digital platforms, blockchain will lower barriers to entry across the supply chain – driving innovation and dynamism in the industry and enabling reverse logistics without any extra cost. Using blockchain technology does not necessarily need to be disruptive [27].

6. The Integrated Information Systems

Large organizations and businesses are composed of different functional areas, such as finance, HR, customer management, engineering services, product manufacturing, storage and warehousing. These functional areas carry out different operations in order to fulfill the goals of the business and often use a variety of different IT systems (e.g. stock control, accounts, HR, etc.) from a range of different suppliers and vendors to service their needs [28]. In today's universe economy, the various process steps are increasingly executed by people in several locations throughout the world. That is, a company will manufacture its products in various countries, acquire the materials to make these products from various locations, sell the products in several countries, and so on. The success of any large business or enterprise in achieving its goals depends on the ability of IT systems to effectively communicate with each other. However, IT systems from different vendors or suppliers often use different hardware and/or software platforms and services, thus creating the need for systems integration [29].

7. Proposed e-SCM framework depending on blockchain and IIS

Within the e-SCM all the interfaces of the corporate towards its stakeholders should be scalable in manners that are standardized and automated this is made by technology of IIS. The transparency and the reverse logistics problems in e-SCM are solved by blockchain which is linking CRM with SRM through communication message that translate all transactions from clients and suppliers. Collaboration needs many of trust between partners as the desired result could only be reached together. If only one shared database exists in the distributed network, recording all past transactions as a single source of truth for all participants, that is the aim and that is useful in the operation of reverse logistics without any charge. Blockchain is a database technology for saving transactions within a network of peer-to-peer businesses. Blockchain has the feature that data can be recorded in the several "blocks" in a tamper-proof way, which means that participants in the Blockchain are capable of verifying the authenticity, origin and integrity of the saved data. As a peer-to-peer network, merged with a distributed time-stamping server, Blockchain databases can be controlled autonomously.

There is no requirement for a single administrator as administrator rights are distributed to all network participants. The proposed framework consists of several steps (five steps) based on different functions (as seen in Figure 2) as follows:

The main step to evaluate e-SCM based on blockchain which is outer-company processes—that is, process that take place between and among customer side and supplier one of IIS as:- supply chain management (SCM) and supplier relationship management (SRM) systems, which connect an organization's ERP system to those of its suppliers. SCM connects a firm to other firms that supply the materials it needs to make its products.

Typical SCM systems help firms plan for their production needs and enhancement complex transportation and logistics for materials. SRM systems typically control the overall relationships with the materials providers. SRM systems contain functionality to control the quotation and contracts processes. These systems work as extensions to the procurement and material planning processes of ERP systems.

On the other part of the manufacturing and sales processes, customer relationship management (CRM) systems connect a firm's ERP system to those of its customers. CRM systems supply firms with capabilities to control marketing, sales and customer service. These

systems are an extension of the fulfillment process of ERP systems, and its main role is the process of reverse logistics. Product lifecycle management (PLM) systems help firms administer the processes of research, design, and product management. In impact, PLM systems help firms take new product ideas from the virtual drawing board all the way to the manufacturing facility. The group of these inter-company systems and the underlying intercompany ERP system is called an application suite.

The next step is blockchain which depending on communication message in its technique to handle reverse logistics that method comprises: acquiring a communication message transferred between a first terminal and a second terminal; determining whether the communication message includes a preset schedule word; when it is determined that the communication message contains the preset schedule word, sending prompt information to at least one of the first terminal and the second terminal; and when at least one terminal receives the prompt message, showing the prompt information [30]. At least one user is reminded to obtain contact information of an opposite user when two users present on a schedule; the prompted user can be guaranteed to subsequently communicate with the opposite user according to the obtained contact information, thereby avoiding communication inconvenience due to the fact that the contact information of the opposite user is not obtained [31]. This step consists of four layers.

The 1st layer is data input layer, in this layer, GPS is used to locate the products in logistics process. Quality information, assets information and transaction information are recorded with RFID technology. In this layer a blockchain is created and safe distributed ledger. In blockchain, there are four kinds of data: quality data, logistics data, assets data and transaction data.

The 2nd layer is smart contract layer. Only data sharing are not enough. Privacy issues require to be considered for data sharing. Because competitive firms are operating on the same supply chain, some information requires keeping confidential for their own competitive advantages. Therefore, digital identity is used to control the access authority to the data. With the actual time data about qualities, smart contracts can execute real time quality monitoring and control.

In ledger layer which is the 3rd layer, all the recently created transactions are putted in a distributed pool across the network and stay for the next block miner to package all of them into a new block and append into the ledger.

The last layer is business layer. This lay includes various business activities in enterprises. Each firm on the supply chain is capable of control and manage the products qualities with the support of blockchain and smart contracts.

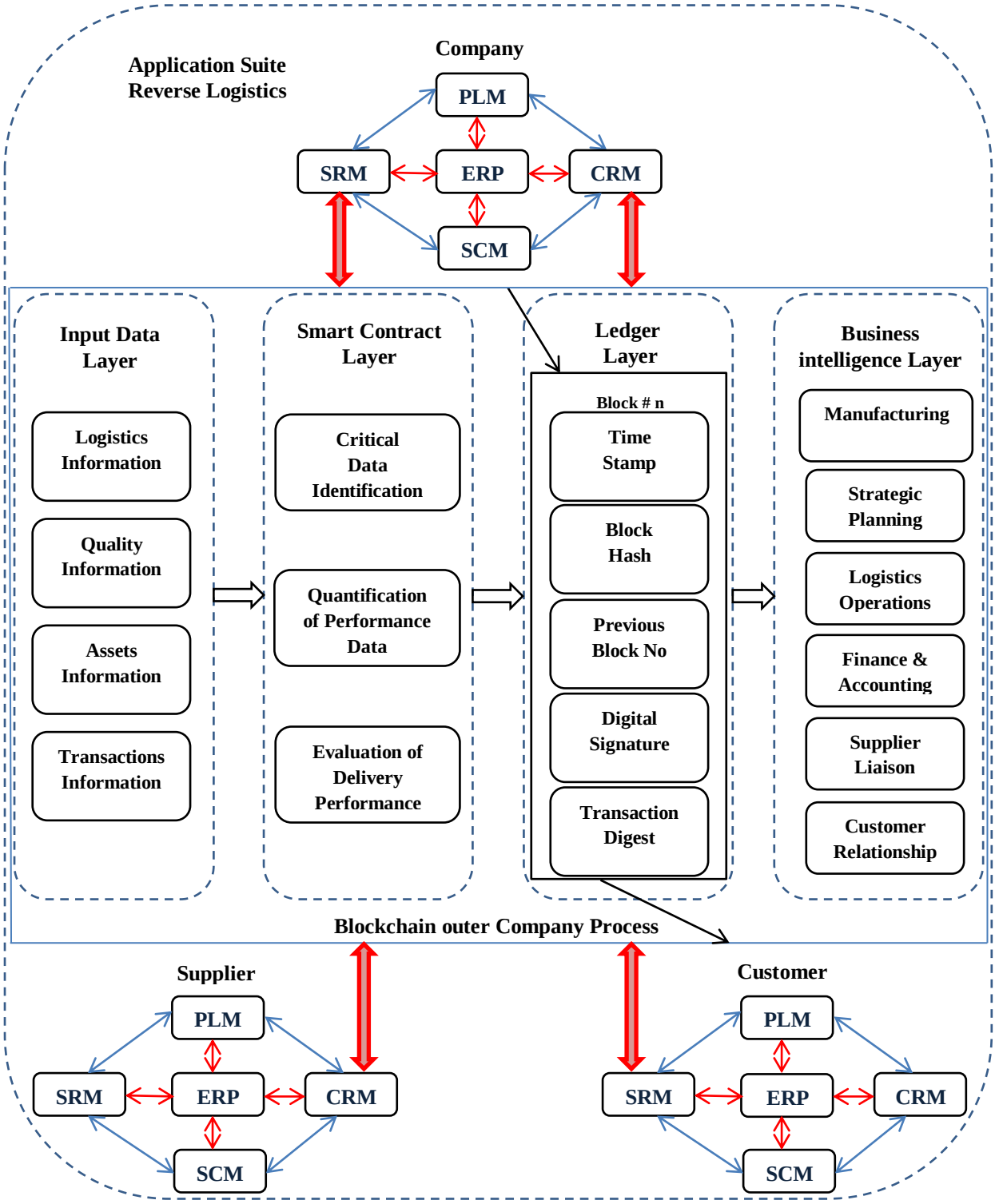

Fig. 2: Proposed e-SCM framework depending on blockchain and IIS

8. Conclusion and Future Work

Blockchain as a technology can't replace supply chain technology, but its characteristics of a secure information storage and exchange, as well as fulfillment of transactions, could assure its place as an essential support and upgrade in e-SCM.

Blockchain technology with communication message can present the required trust with transparent transactions in addition to a record of the product, so that the individuals know the true value of the product. The clear gain of blockchain in e-SCM is trust in all parts of supply chain spatially in reverse logistics. The proposed framework is introduced to enhance e-SCM using blockchain and integrated information systems to solve the problem of reverse logistics without cost or any difficulty. The result of applying the proposed framework is to increase customer satisfaction in all parts of e-SCM because of complete trust which presented by blockchain and in case of reverse logistic there is no need to spend extra money or effort which prevented by integrated information system. This solution linked supplier, customer, and company with outer join of blockchain technique to tie CRM with SRM in one side with another side and vice versa to present e-SCM with integrated information system.

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