Blockchain Technology for Tracking Chain Supply

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Abstract: The adequate technology was the architecture that was distributed through the block chain technology which had authorizations for securing data storage and for accessing any piece of information anytime and anywhere. The objective of this study was to find out whether the issues of the supply chains and the block chain were able to be solved. The hypothesis of this study was suitable for the supply chain management in the block chain architectures. In this study, a survey was conducted to validate the issues of supply chain management and to obtain the requirement for a supply chain software system.

Keywords: Supply Chain, Supply Chain Management, Blockchain, Distributed Architecture, Security, Traceability, Information Integration, Interoperability

1. INTRODUCTION

Our society was turning to be more consuming. Most of people in developed countries had high consuming power and standards of living. Modern supply chains took the pressure of this growth causing the demand for efficient management [1]. The development of technologies filled the demands of supply chain management so that some industries had a high demand.

The significance of the study and the developing efforts of using the blockchains in the financial services were seen on the digital assets and payment systems [2,3], good contracts [4], supplying [5], Internet of Things (IoT) [6,7], and name systems [8,9]. This was often primarily due to the actual fact that the blockchains enabled to be operated for transaction and payment processes so that it disrupted effectively the conventional businesses. The blockchain was described as a "digital, decentralised and distributed ledger within which the transaction areas were logged and added in written account order with the goal of making permanent and tamper-proof records" [10]. Moreover, the blockchain technology was delineated as a distributed information of the records, transactions, and digital events that were shared among networked participants. The blockchain is not a standalone technology; instead, it is a configuration of multiple technologies, tools, and ways addressing specific issues or use cases [11]. In contrast to many digital solutions, the blockchain technology was an important discovery used to managing chain information across a distributed and interlinked network of nodes. The first application of blockchain was the cryptocurrency Bitcoin. It was the technology that underpinned the mechanism of recording transactions. The cryptocurrency system was the foremost vital use-case concept so that the blockchain technology was able to be applied to various fields like healthcare, insurance, identity management, good energy grids, supplying and provide chain management [12].

2. LITERATURE REVIEW

The blockchain technology was successfully used in many industries e.g., energy and financial industries. The authors determined characteristic the use-cases represented by the blockchain within the field of provision and provided and analyzed the chain management that were concerning their technology supported by 5 aware technology adoption principles e.g.,

engagement with the technology; technological novelty seeking; awareness of native context; recognition of different technologies; and anticipation of technology alteration [13]. Moreover, the authors also used the 'attributes of innovation framework' to spot the potential blockchain applications and the gift a framework explicating four transformation phases to categorize the known areas of application in line with their effects on structure structures and processes [14]. Besides, the authors classified attainable applications for adoption and supply a framework to spot blockchain opportunities within the provision industry.

2.1. Blockchain.

A blockchain was a decentralized, distributed, and public digital ledger used to record transactions over many computers so that the record was not able to be altered retroactively without the alteration of all subsequent blocks and the collusion of the network [15]

The blockchain concept represented a paradigm shift. It was seen on the capability of software engineers to write software applications in the future and it is one of the key concepts that needed to be well-understood.

2.2. Supply Chain.

A supply chain included all processes and activities that were started from the initial raw materials to the final finished product with all the functions and services within and outside a company. A supply chain was also be defined as the network of entities through which material flows. These entities were identified as suppliers, carriers, manufacturing sites, distribution centers, retailers, and customers' facilities and capacities [16]. As a consequence, the paths taken by the resources and information were not straightforward but were in the form of interlaced, divergent, and convergent points as they were exemplified on Figure 1.

SCM Professionals defined SCM as the planning and management of all activities involved in procurement, conversion, and all logistics management activities [17]. The supply chains competed each other so that they became the best integration and management processes.

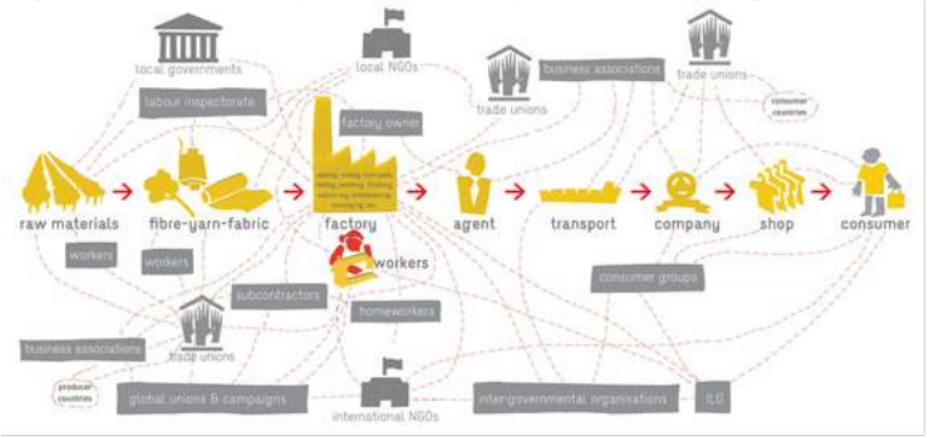

Figure 1. Representation of a supply chain and all the relationships. Taken from the International Training Centre of the International Labour Organization briefing on global supply chains [4].

2.3. Challenge

One event caused by delays was regarded as the synchronization problems occurred in the processes and information systems of a company. This was because the companies had privacy and security. This meant that they wanted to share too much information. They might only be able to share it through secure channels and had a lack of standards for sending information and communicating. Therefore, it was very difficult for anyone to have a global overview of the supply chain.

2.4. Blockchain Technology to Supply Chain

The invention of the blockchain for bitcoin made the primary virtual foreign money resolve the double-spending hassle without the poverty of dependence on authority or imperative server. The 2nd innovation became known as the blockchain which became basically the belief that the underlying era in operating bitcoin was separated from foreign money. It used for all varieties of different inter-organizational cooperation. The 3rd innovation was known as the "clever contract," embodied in a 2nd technology blockchain gadget that constructed little PC packages without delay into the blockchain that allowed economic instruments like loans or bonds represented in a place of the best the cash-like tokens.

It had come a long way sprouting multiple different uses and applications of the technology [18].

Blockchain's ability to assure the reliability, traceability, and authenticity of the information made the smart contractual relationships for trust less surroundings all port end as a fundamental rethinking of supply chains and grant chain management. In this section, the cost proposition of blockchain science and its applicability to items and manufacturing supply chain, its structure, and the feasibility of new elements for managing a grant chain were deeply studied. The blockchain functions inside the context of the provide chain were nonetheless open to interpretation and development. Figure 2 suggested a regular graphic of one usual furnish chain transformation to a blockchain-based furnish chain.

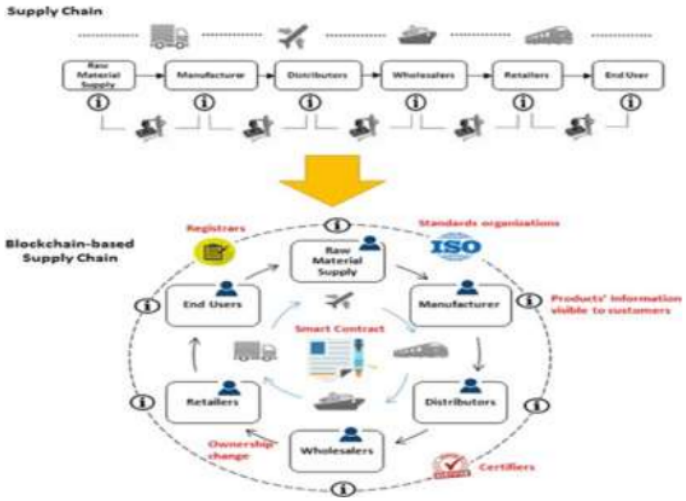

Figure 2. Supply chain transformation.

3. METHOD

This study was using a contextual analysis approach along with a broad writing review to satisfy the predefined research targets. The contextual analysis was reasonable for investigating supply networks inside a project based organization occupied with the energy business in Finland. The vital information assortment measure was intended to address the examination targets. Information was gathered from the case organization, spoken to by chiefs, business administrators and IT specialists in the field of supply chain and coordination, item originators and specialists, and undertaking chiefs. From the gathered information, different prerequisites, both practical furthermore, non-utilitarian, were recognized. This sort of exploratory research technique was applied to give a proof of idea of joining a few promising advancements to convey a continuous undertaking see. Programming plan and designing methods were applied to actualize and incorporate the components.

Evidence of idea created during the execution project was not founded on reproduction or numerical model however tried on real project coordination climate. To encourage the case organization's coordination and inventory network with ongoing notices, an on the web gateway was created. This entrance was worked by the Cloud and incorporates different innovations, for example, RFID, IoT, GPS and blockchain.

Different information identified with the case organization's inventory network, for example, clients, projects, shipments, conveyances, taking care of units, and so forth, were populated on this entrance. From this entrance, inventory network partners were capable to picture significant following and following information of their delivered things.

Innovations, for example, RFID, scanner tag and IoT provided information as it was gotten from different sensors joined to the conveyance things. Moreover, the blockchain innovation guarantees validated and were convinced about information exchanges between store network partners.

3.1. Problem Statement

The customer was not aware of all of the entities concerned within side the entire state of affairs and the recognition to approximately his/her product patron desires to request to the third-celebration vendor. For some reason, it offered an upward push for the problem of centralized entities existed in the system. There were many purchasing web applications running as the 3rd celebration in logistics.

In SCM, a product's life cycle was able to be roughly divided into the many phases of the product. It started from the raw materials to the finished product for the consumer.

- **Speed of delivery**. The faster the products arrived in their buyer, the faster the buyer satisfied their needs. This was true not only for the final customer of a product, but it also provided products and services to other enterprises, be it in the role of supplier, manufacturers, distributors, or retailers for any enterprise.
- **Synchronization**. The real problem had occurred when the companies had no common ground and the data was not transmittable in an automatic way, leading to a lot of unnecessary manual work to export the data from one system and import it into another as follows:
- **Lack of data integration standards development in the supply chain industry.**
- **Lack of a common technology to store all data, from where each company could have its own software extract the information from.**
- **Tracking**. During a product's lifetime, a lot of alterations occurred and sometimes the records about the product flow were lost, falsified, or flat out in a registry. This caused unreliability in the goods the consumers' use every day and it was occurred that some products were falsified and it was not an actual product to be advertised to be. Additionally, it was also able to happen that the products were not being properly tracked

and it did not hold up to the conditions or required quality standards. This frequently led to safety hazards.

- **Security**. Information in a supply chain was highly sensitive and it should be controlled so that the trusted entities were able to access it. Therefore, the information was generated in the process of managing a supply chain might be too sensitive to share, in order to keep an edge on the competition.

3.2. Design and Implementation

Although a few initiatives construct completed or partly customized blockchain community software, the use of a framework like Hyperledger was a mile extra streamlined manner to get a quick functioning prototype. The layout might be divided into four elements namely, Model Design for a Business Network, Access Control Design and Identity Management, Network Topology and Deployment, Integrating Existing Systems, and Building External Applications.

These elements were not always sequential. However, following the indexed order might also additionally result in the best consequences in improvement. Since time changed into an issue and the dissertation already blanketed elements different than the improvement, the scope of the improvement itself could no longer be broad sufficient to encompass a deep exploration of all of the elements indexed. Therefore, the project here offered focuses extra at the first-class and useful elements of making use of blockchain to the deliver chain, and now no longer a lot at the quantitative part, which could encompass exams to the performance of the community.

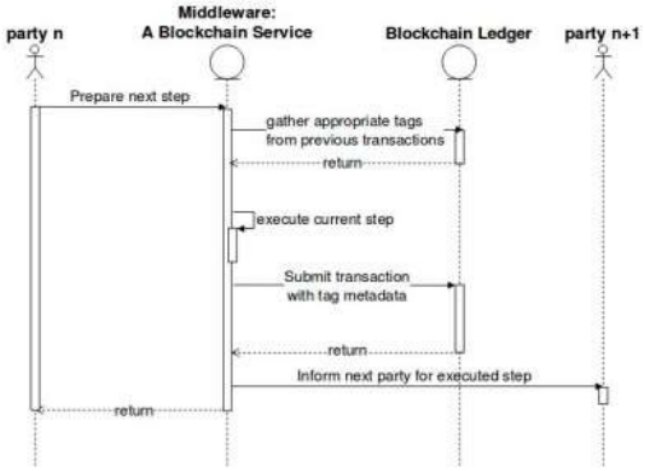

Figure 3. Case Diagram for Design Blockchain Tracking Supply Chain

Figure 3. One supply chain (stage number n+1) was a blockchain transaction. Every stage's functionality was automated by the "Middleware". Thus, the parties that participate in each stage (a single one in the input and another one in the output) had a small interaction with it; for instance, confirmed that the transportation was completed by receiving the appropriate transaction hash, or the employee confirmed that certain materials were kept refrigerated, as expected, by collecting the corresponding transaction hashes and others. Here, party n participates in stage n+1 input (and already in stage n output) while party n+1 participates in stage n+1 output (and stage n+2 input).

4 RESULT AND DISCUSSION

4.1. The Objectives:

a. To develop tracking the products.
b. To develop SC using Blockchain Technology.
c. To increase the trust between various participants and bringing transparency in the supply chain.
d. To use blockchain technology in tracking applications can achieve cost savings by more automated, error-free, and less of paperwork processes.
e. To manage the ownership of digital assets and facilitate asset transfers.

The question, "**Was it possible to build a feasible architectural design, by using such a tool, to implement all these requirements?**" required that the elicited requirements be formed into a list and an architectural design to be built and implemented using the chosen framework. This chapter dealt with explaining these tasks sequentially. These functionalities were directly based on some points of focus from this paper: **synchronization, security**,and **tracking or traceability** so that it was based on these attributes that the framework should also be selected.

Security: the improvement of information privacy in supply chains was not very important in itself. Some fraud verification checks should be supported.

Traceability: For the traceability requirements, the proposed system should be able to track all information, including changes in the system, registries of assets, transactions, network participants and organizations. Thus, the selected framework must support the management of data in the form of assets, entities and organizations, which should be accessible only to specific entities, including auditors.

Synchronization: As the source of fact, any external needed system to query or insert data should be easily accessible by the blockchain. The resulting synchronization specifications were included by the implementation of standards and devices interoperability for the exchange of information in real time.

Transaction Enforcement and Financial domain: There was an interest in financial applications, and cryptocurrencies were part of this. However, for financial applications to be feasible in the delivery chain, the use of blockchain, local blockchain cryptocurrencies was not always necessary. It was because cryptocurrencies were able to be simulated in the use of balances, depending on the layout of the blockchain network.

For this, the different functionalities to work, clever settlement capability had to exist, though. Thus, the chosen framework had to either have a local cryptocurrency or permit for the layout of a few forms of virtual stability or token. Additionally, it had to help clever contracts. These facts were summarized in Table 1.

Table 1: Summary of the framework requirements
Framework Requirements

Area	Framework Requirements
Security	Highlycontrolledenvironment
	Authenticationand authorizationmechanisms
	Fraudverifications(bysmart contracts)
Traceability	Managementofdata: assets, entities, organizations
	Dataaccesscontrolled,butaccessible toauditors
Synchronization	Exposedata totheoutsidesystemsthroughAPIs
	Allow theuseofpredefineddata formats
Transaction Enforcementand Financial domain	Smart Contracts
	Native cryptocurrencyoraway tosimulatecurrenciesor accountbalance

4.2. Frameworks Choice

Firstly, the required private blockchain framework seemed more adequate because of all the security control mechanisms. Second, the framework must allow for a highly customizable network including not only asset management, but also identity management as well. It was done because blockchain participants can be granted special permission. Lastly, the framework needed to allow the use of the API.

Hyperledger Fabric - It had the needed mechanisms for authentication and authorization, and, similarly to the other frameworks, had smart contract capability. It was highly customizable, allowing for all the statistics and identity management needed. As for synchronization, it featured easy to deploy rest servers, which was also important. However, it had a setback, such as though it was customizable, it did not feature a native cryptocurrency. Therefore, financial transactions were possible, but only if designed from scratch to be simulated by the network

4.3. Requirements Specifications

The structure for this specification was able to somewhat resemble the organization of IEEE 830-1998 requirements specification standard (Oliviera, et. al., 2018), but in a simplified way, without some of the unneeded clutter and information. The specification was divided into the following way:

a. Introduction - Product purpose, scope, overview, and users;
b. Requirements - Specific requirements including functional requirements, non-functional or quality requirements, permission list, and design constraints.

4.4. Result

Result of this paper, it should be an application based mobile with following script of Solitude

```
import "./Manager.sol";

contract ShipmentTracking is main{
```

```
    event DepartedFromOnePort(uintshipmentId);
    event ArrivedAtAnotherPort(uintshipmentId);

uintshipmentId;
uintorderId;

    function stateRequiredTimeToNextEntity(uint _orderId, uint _requiredTime){ // Give
Estimate;

statsMap[_orderId].timeToNextEntity = _requiredTime;
    }

    function arrived(uintshipmentId) public
    {
       require(msg.sender==flowOfObject[orderId].Addresses[currentaddress[orderId]]);
statsMap[orderId].checkPoint="ArrivedAtNearestPort"; // Updates currentStatusOfOrder.
statsMap[orderId].timeTheEventCalled=now;
transferPossesion(orderId);
ArrivedAtAnotherPort(shipmentId);
    }

    function departured(uintshipmentId, string shipagentname) public
    {
statsMap[orderId].checkPoint="DepartedFromThePort"; // Updates currentStatusOfOrder.
statsMap[orderId].timeTheEventCalled=now;
DepartedFromOnePort(shipmentId);
    }
}
```

4.5. Discussion

An important issue between blockchain and supply chain use case was the decision on the use of the consensus mechanism which introduced several concerns that were addressed.

In such consensus mechanisms, all peer nodes in the system make a joint decision in a twofold consensus were based on both a selection mechanism and a process through which the various nodes were called upon to choose the final block to enter the chain and compulsorily demonstrated their credibility in the system.

It was clear that it was necessary to consider various parameters in choosing which consensus mechanism was suitable to be implemented in a blockchain.

In addition, a permission or private blockchain brought its associated management costs especially when we had more complex blockchain architectures i.e., separating the consensus mechanism from transaction management.

It seemed that modern blockchain implementations took into consideration the limits at their design phase as to be able to follow large scale global deployments, however, up to now, there was no real-world experimentation with the real limitations of blockchains.

5. CONCLUSIONS

The blockchain is introduced to achieve the supply chain's objectives, by reducing the risk emerging from the tracking system and data management.

- Deploying blockchain in the supply chain ecosystem brought many benefits, notably:
- Created more transparent and accurate end-to-end tracking
- Increased trust between the producer and consumer, by improving visibility and product compliance with international standards
- Reduced paperwork and administrative costs
- Reduced or eliminating fraud and counterfeit products
- Facilitated origin tracking
- Recalled a product in a time-efficient way.

However, integrating the blockchain into the supply chain ecosystem brings important new challenges notably on the blockchain level. Moreover, the properties and capabilities of available blockchain implementations are also importantly considered before choosing the most suitable blockchain for such an ecosystem. In building a blockchain-based supply chain management, the blockchain technology should be considered suitable to our business and it relied on the reliability of collected data.
Storing reliable information requires a reliable interaction between the blockchain and all ecosystems' constituents (These consisted of tracking devices and actors).
They are requirements to build a blockchain-based supply chain, e.g.,:

- Selecting a blockchain according to different key criteria notably: Throughput, latency, capacity, and scalability (A multi-criteria decision-making can be applied to choose the most suitable blockchain into our deployed ecosystem.) [19].
- Implementing a dual storage architecture to handle a large amount of data, without degrading the blockchain performance (An additional private blockchain could be introduced to the system architecture.)
- Choosing the tracking devices based on the main product criteria we want to track or monitor
- Choosing the communication protocol based on the speed, data rate, communication range, power consumption, cost, or any criteria deemed essential in the supply chain environment Try to fill the security vulnerabilities found in the communication protocol to provide a secure and reliable traceability system
- Creating a secure tracking environment beginning by authenticating the system tracking devices and making sure all transferred or collected data is encrypted and signed.

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