Blockchain and IoT based Smart Container Management for Global Supply Chain Traceability

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ABSTRACT

Traceability have become an important factor for assuring product quality and safety, it is a tool that verifies sustainability claims associated with commodities and products, ensuring there is good practice and respect for people and the environment all the way along the supply chain. But the design of a traceability system requires thorough rethinking and reorganizing for better consistency. Hence this study propose the model of Smart Container Management system based on Blockchain Technology and Internet of Things which can help in creating consistent traceability of goods which will be the major objective for future supply chains.

Keyword: *Traceability, Blockchain Technology, Internet of Things, Smart Container Management, Supply Chain.*

I. INTRODUCTION

The global increase in demand for organic, fair trade and environmental friendly products has led to the demand of well-functioning traceability system. Basically traceability is the process by which a product moves from its original raw material extraction and production phase to the final customer. Today, traceability is a useful tool for companies to advance sustainability and prove claims of sustainable products. But it is often very hard for companies to trace each and every step in the journey of a given product. Multiple factors with different models and requirements may contribute to production across international borders, and some areas in a supply chain may be especially not transparent. This is a big issue as traceability requires the collaboration and engagement of factors along the complete supply chain to trace a product's history. Therefore better transparency, reliable documentation, end to end communication and consistency is required for efficient traceability in supply chain management. Hence for better functioning of traceability system in supply chains technologies such as blockchain and internet of things can be used.

Blockchain is the decentralized storage of transactional data. The storage of a transaction is organized in blocks, while following transactions are stored in new blocks. The sum of several blocks makes up a chain; a logical sequence of transactions. Every transaction contains a timestamp and is secured by a crypto logic process. This chain works like a database which is updating its information continuously, with the difference that the chain is stored on every hard drive or computer which is part of the Blockchain network. All changes are recorded and encrypted, in real-time. Therefore it saves time, money and paper and is less vulnerable to manipulation. In addition, it ensures transparency, security and trust, which make Blockchain relevant for future applications in Supply Chain Management. There are three major fields of blockchain which benefits Supply Chains namely Traceability, Smart Contracts and Secure transactions. Traceability can be automated and simplified by efficient use of Blockchain technology and corresponding electronic tracking technology (such as Wi-Fi, BLE or RFID). Smart Contracts is an electronic contracts based on automated actions that are triggered through predefined events for example automated execution of payments in case of an in-quality and on-time delivery. Secure Transactions are the capability of data validation in blockchain technology which ensures safe transaction of confidential business documents, transfer of shipping documents or orders and order confirmations. Blockchain technology can offer a public cloud service as an integration platform which can be integrated with Internet of Things.

Internet of things (IoT) is a network of objects equipped with radio frequency identification chips and similar technologies so that the objects could communicate and interact with each other. In traditional processes of supply chain management, information on demand was only passed to one's direct downstream partner instead of sharing this information with the whole chain. The new sophisticated RFID chips used in the Internet of Things allow the recording of all kinds of manufacturing information, production date, expiry date, warranty period, after sales details allowing real time and more efficient supply chain management. When it's possible to have a real-time look in the supply chain operation, production capacity can be raised, which leads to more productivity with the same investment.

Based on the above mentioned integrated IoT and Blockchain platform a Smart Container Management system can be formed to take the supply chain management to a whole new level of maturity.

II. LITERATURE REVIEW

Tian, F. in his research paper "An agri-food supply chain traceability system for China based on RFID & blockchain technology" published in 2016 have established agri-food supply chain traceability system based on RFID & blockchain technology, combined with WSN, GPS, GIS and computer data processing technology, etc. This system covers the whole process of data gathering and information management of every links in agri-food supply chain, which realizes the monitoring, tracing and traceability management for the quality and safety of the agri-food "from farm to fork", and effectively guarantee the quality and safety of the agri-food products. In future studies, with the rapid development of blockchain technology, building a decentralized traceability system in which the information can be completely trusted is the development tendency of the logistics industry. [1]

Research paper "Application of RFID Technology for Logistics on Internet of Things" published by Sun, C. in 2012 have greatly described RFID technology and its automatic identification method. It also broadly emphasized on integration of the RFID technology and the Internet of Things and using them to monitor and anti-counterfeit the products in the supply chain that can make the most use of the advantages of the RFID technology, and the enterprises can achieve real visualization management in products. [2]

Brandenburg, M., Govindan, K., Sarkis, J., & Seuring, S. in their research paper "Quantitative models for sustainable supply chain management: Developments and directions." published in 2014 have reviewed almost two decades worth of research focusing on SSCM quantitative, formal modeling. One hundred thirty-four articles were identified and utilized in the analysis of the research. Overall, the number of publications in this topical area is not as large as empirical and conceptual work, but it is growing. The findings included variations in focus by function, research perspective, methodology, and the type of sustainability focus of the supply chains. The results also provided opportunities to identify gaps in the research that could be addressed and potentials for further research directions. Some major findings for fertile areas of research include the integration of social issues into modeling, expanding the scope and diffusing modeling from one industry to another, and the need for more stochastic approaches in modeling to relay a more realistic uncertain decision environment associated with these many and complex environmental factors identified with SSCM. Although this study was rigorously completed, there are still limitations that we encountered, but these limitations provide opportunity for future research. Despite the fact that several researchers were involved in the validation and the content analysis of this study's paper sample, the categorization of these papers remains interpretative and hence subjective. [3]

Value of smart container monitoring services and Benefits of smart container for the various factors involved in the transport sector are broadly explained by authors Vannieuwenborg, F., Lannoo, B., Verbrugge, S., & Colle, D. in their research paper "Smart containers: quantifying the potential impact." published in 2016 they have concluded that currently the market for container monitoring services is still in development phase. But because of the additional revenue these services could generate, interest is growing fast. On top of that, it can be expected that the efforts of regulatory organizations and programs such as WCO, C-TPAT, AEO, etc. to install secure and transparent trade lanes will drive the adoption as well. [5]

Dabbene, F., Gay, P., & Tortia, C. authors of research paper "Traceability issues in food supply chain management" published in 2014 have together concluded that Increasingly stringent requirements for food safety, as well as a growing demand for food characterized by a certain identity, call for the development of increasingly large and efficient traceability systems. The efficiency and the performance of TS can be improved by orienting management policies to account also for these needs. If on the one hand, traceability by itself cannot change the quality and safety

of the food products, on the other hand it can be an important element in the more general control scheme of production and distribution. A traceability system, coupled with other tools (HACCP, production planning, logistics), may indeed lead to significant improvements on the performance of the whole supply chain. In addition to the interesting results already obtained so far, the immediate future in research and industrial applications is very promising. The growing diffusion of new technologies for automatic identification & sensing, together with the availability of new computational and simulation models and of new mechanical systems for the segregation of lots, pave the way for new solutions able to guarantee a higher level of control of the supply chain. [6]

III. PROPOSED SYSTEM

Smart container is the advanced hi-tech container build by using blockchain and IoT technologies. These container are equipped with sensors which transmits all quality related data like Temperature, Pressure and Vibrations to an integrated IoT platform. The Real-Time collected data is visible to all members of the Supply Chain through this platform which guarantees data availability and manipulation security. Companies can monitor real-time quality data which enables them to minimize their response time to events. Furthermore, the destination can be aligned or additional quality checks can be assigned. It is imaginable to automate this processes with Smart Contracts. A change in temperature which poses a breach of contract can trigger automated processes like an insurance proposal, a contractual penalty for the forwarder and a reorder at the supplier. At every point in time, the history of the product and its place of origin are uniquely identifiable, and additional information (e.g. on compliance with the required cool chain of goods) can be secured. In this concept it is imaginable that reactive processes are automated by Smart Contracts. If there is a negative effect on the goods, posing a breach of contract, processes like an insurance proposal or a contractual penalty for the forwarder can be triggered automatically.

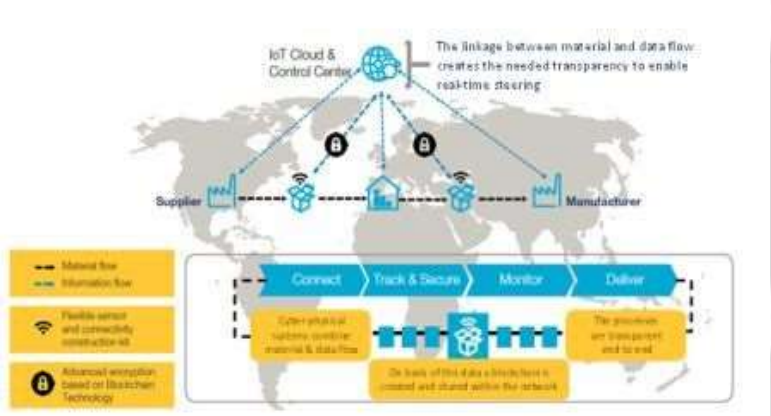

Fig-1: System Architecture

IV. FUTURE SCOPE

Internet of things (IoT) and blockchain both are in their inception stages, with the future where machine-to-machine communication will be effortless. Currently, efforts are being made by the companies to merge these two technology powers together. Once combined, Internet of Things (IoT) and blockchain technology will let several industries flourish by easily monitoring, tracking and securing data. Then, the possibilities are endless, and you never know what's next. The proposed model can be extended to another dimension of machine learning techniques where the traceability of the supply chains can be advanced by working on integrated platform of smart containers.

V. CONCLUSION

The objective of this paper was to review the ideas of combating traceability issues in supply chains and to propose IoT and blockchain based smart container management system for the advancement of global supply chain traceability. The proposed system has the potential to transform supply chains into highly integrated smart supply chains in which supply flow can be simulated virtually. The system integrates physical processes and enables automation. This system enables end to end transparency and communication which can transform the supply chain into an agile cooperation network.

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