Supply Chain Management Using Blockchain For Small and Medium-sized Enterprises

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***Abstract*– Supply chain management is the backbone of enterprises which deal in products. This process helps in determining errors, faults, stoppages, inventory, efficiency and many more projections. However, this management system needs a database, a database management system, database administrators and operators. Here, the database requires multiple layers of security to be built around it, the servers need to be rigorously tested for response time and stability so as to not betray in time of need, and trust needs to be placed in database administrators and operators that they would not be corrupted, with not many contingencies available to the corporation. This paper discusses how using blockchain can help alleviate the shortcomings of traditional supply chain management systems such as vulnerabilities and the need of trust, and demonstrates how it can actually increase productivity of those involved in the systems by enforcing authentication and authorization, and how the corporation can reduce expenses by employing this technology because of reduced failures, relatively less expensive infrastructure and minimum personnel required to maintain the system. We shall also discuss the challenges in implementing this approach and other shortcomings of it, so that the reader can have a comprehensive review.**

Keywords– blockchain, supply chain management, efficient, trustless, expensive, uniformity anonymity, smart contracts

I. Introduction

Supply chain management is defined as “the management of the flow of goods and services and includes all processes that transform raw materials into final products. It involves the active streamlining of a business's supply-side activities to maximize customer value and gain a competitive advantage in the marketplace.”[1]. This process is the lifeline of enterprises, requiring much attention when studying a business and encompasses the majority of business transactions done by an enterprise. With the emergence of blockchain technology, a possibility of revolutionizing the transaction recording processes has come to light and a lot of large enterprises are already adopting it.

Fig. 1: Supply Chain Management at a glance [12]

For small and medium-sized enterprises, this adoption brings about as many benefits as it does for large ones, however it is also true that it is not as easy for them to shift to this new paradigm as it is for large enterprises, because almost all participants of the supply chain management for large enterprises are already streamlined.

This paper elaborates on what blockchain can do for supply chain management, why small and medium-sized enterprises should consider using/participating in a blockchain powered supply chain management system and the problems that may come with it.

II. Supply Chain Management and Blockchain

Blockchain is a decentralized ledger technology that maintains transactional data. In this technology, a particular number of transactional data is hashed and compiled into blocks of data and then attached to existing blocks of data sequentially. This process is carried out by nodes of the decentralized network. A merkle tree hash of the blocks is maintained on each node to make sure of data authentication and sequence. The data in the blockchain, therefore, is transparent, decentralized and immutable. These properties make it exceptionally well-suited to be used as the base of supply chain management systems.

Supply chain management is often a centralized process for large enterprises, where storage is maintained to store the data, data administrators are appointed to watch over the data structures and correct records if necessary and a server is run so that all participants can interact with the system to track and update transactions.

In this scenario, using blockchain offers a variety of benefits:

- No need for data administrators as after a program is deployed on the blockchain, it cannot be edited and certain operations are reserved for certain users by encoding the public addresses of the privileged users into it.
- Records become immutable, that is, transaction data cannot be edited once it has made it into the blockchain.
- The data is stored in a decentralized manner and as long as even one node of the blockchain survives, the ledger survives.[3]
- A trustless environment is created, in which the program itself maintains preset parameters and authentication which make it so that participants need not place their trust in other users, but the program on the blockchain itself.
- The supply chain management in this way is sustainable because the architecture does not change with the increase/decrease in participants[2]
- End-to-end transparency in case of using public blockchains for management

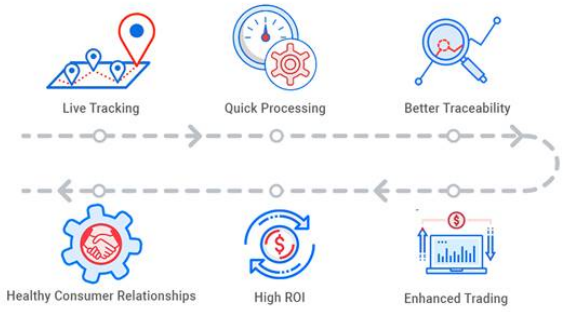

Fig. 2: Blockchain use cases in supply chain management[13]

These benefits of using blockchain as a base for supply chain management stay true for enterprises of every size. These benefits, however, can greatly help the small and medium-sized enterprises in growing and saving costs on personnel. Adopting or migrating to blockchain can boost enterprise productivity in the long run as well. However, the small and medium-sized enterprises face more problems in adopting this modus operandi than the large ones.

III. Supply Chain of Small and Medium-sized Enterprises

A. Small Enterprises:

For small enterprises, the supply chain data usually is recorded manually using physical/digital record books on the enterprise's part. This not only reduces management costs, but is the easiest to implement method for supply chain management and has clearly stood the test of time.

As for records and sourcing, such enterprises seldom know the complete history of their products, much less being able to provide customers with end-to-end transparency. Almost every participant in the supply chain is an independent operator, and the enterprise needs to trust that the rest are forthright and not malicious actors in this system. There will not exist a unified system of interaction among participants unless there already did or until the small enterprise on which such participants depend pushes for a consensus on a system to use. Since in the growing phase participants are uncertain and liable to change, the supply chain management system needs to be flexible with the possibility to swap out participants.

With the help of blockchain, a system can be put into place where roles can be assigned and reassigned by an administrator, providing all the required benefits such as authenticity, transparency, immutability and accessibility. However, convincing all the participants to take part in a brand new and unified system may prove to be the greater challenge.

B. Medium Enterprises:

Medium enterprises may have a better supply chain management system in place than small enterprises, and may have some control over some of the participants in the supply chain as well. They use centralized systems like large enterprises but control a much less percentage of their supply chain.

As such, they would still need to persuade the other participants to adhere to a unified system in order to leverage the benefits of a blockchain-based supply chain management system in order to ensure end-to-end transparency. This would be easier for them than for small enterprises, but they themselves would have to overhaul their centralized system.

The system that they require would have the same requirements and benefits as with small enterprises, but with such a sustainable supply chain system in place they would be able to scale rapidly as this system would accommodate any number of participants that they might have. Therefore, with some compromise, the medium enterprises may be able to set themselves up with a small backbone to face the future with.

IV. Supply Chain Uniformity Challenges

Small enterprises	< 50 employees	< 10 million turnover
Medium enterprises	< 250 employees	< 50 million turnover
Large companies	> 250 employees	> 50 million turnover

Fig. 3: Difference between enterprises by size

A. Uniformity of Supply Chain for Large Enterprises

For small and medium-sized enterprises, the primary challenge in establishing a reliable supply chain management system is unification itself. This is not as daunting an issue for large enterprises because they already exert a degree of control over the other participants of the supply chain, so they can bring about reforms relatively easily, albeit at the cost of overhauling their existing system. The process for them could be something like this:

1. Establish a new supply chain management system using blockchain
2. Communicate the need to comply along with benefits to each participant
3. Instruct each participant with proper instructions
4. Each participant adopts the new system

Other than unification, large-sized enterprises are unlikely to face any other obstacles.

B. Uniformity of Supply Chain for Medium Enterprises

In the case of medium enterprises where only a few of the participants are directly controlled, it is a tricky task to get the others to follow such a suggestion without showing them the merit of such an approach. There are a number of methods of handling this, with enlightening and incentivizing being the most common ones. The process for them might go like so:

1. Communicate the need to comply along with benefits to each participant
2. Upon confirmation, establish a new supply chain management system using blockchain
3. Instruct each participant with proper instructions
4. Each participant adopts the new system

The development, information circulation, tutorials and/or compensation would be a significant expense on top of the time everything would consume to get into a working pace again. These expenses would only be one-time and eventually the enterprise will start benefiting from the system put in place as upscaling would be easier.

C. Uniformity of Supply Chain for Small Enterprises

For small enterprises who do not have too much control over the other participants, it is highly unlikely that they would be able to persuade other participants who do not directly depend on them for livelihood. Like medium enterprises, the small ones will have to rely on enlightening and incentivizing the participants with the hopes that they are ready to adopt. The process might be as follows:

1. Communicate the need to comply along with sufficient benefits to each participant
2. Upon confirmation, establish a new supply chain management system using blockchain
3. Instruct each participant with proper instructions
4. Each participant adopts the new system

The development, information circulation, tutorials and/or compensation would be a significant expense on top of the time everything would consume to get into a working pace again. These expenses would only be one-time but very significant for a small-sized enterprise. So, unless the enterprise possesses significant reserves or already has progressive supply chain participants, it may not be wise to try to implement such a system.

On the flip side, with a robust and sustainable supply chain management system in place, scaling up would not be an issue of infrastructure anymore. This takes pressure off of the enterprise and assists in focusing on other matters.

V. Results and Discussion

While the large and medium enterprises may be able to afford this, it is highly unlikely that the small enterprises would be able to develop and deploy a system, and succeed in gaining compliance of every participant in their supply chains easily. Therefore, the process of acceptance of a uniform supply chain management by each member of a supply chain is the primary challenge in adoption of blockchain for supply chain management for small and medium-sized enterprises.

This becomes a tiring exercise when every participant of a supply chain needs to be convinced of the benefits and reassured that the costs associated would be worth it in the long run. Public awareness about the benefits that come with this may be able to mitigate the extent of this exercise.

A. Pros:

- Decentralization of transactional data makes it safer and more robust
- Transparency helps in efficiency of the supply chain
- Trustless environment helps take stress off of participants of the supply chain
- End-to-end transparency helps the customer choose products
- Immutability makes the ledger a reliable source of information

B. Cons:

- Development of such systems requires significant funds and hiring specialists as the technology is still new
- A public blockchain may stall and slow down the supply chain management
- Adoption of a single supply chain management system by every participant of the supply chain may be a princess that small-sized enterprises may not be able to bring about.

VI. Future Scope

With the rapid implementation and innovation of supply chain management using blockchain by various enterprises, it is likely that enterprises of every scale will at least consider the benefits and feasibility of using such a system, rather than discarding the idea completely.

This alone will have a significant impact on how supply chains and logistics are managed by enterprises all around the world and may even cause the obscurity due to centralized systems to be shed, allowing a time when it is easier to trace and account for any product, than to even contact a responsible party about it directly.

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