Opportunities for use of blockchain technology in supply chains: Australian manufacturer case study

Opportunities for Use of Blockchain Technology in Supply Chains: Australian Manufacturer Case Study

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Abstract

The arrival and capabilities of Blockchain is set to change the traditional supply chain activities. The tracking all types of transaction more transparently and securely using Blockchain motivate us to explore the opportunities Blockchain offers across the supply chain. This paper explores opportunities for use of Blockchain technology in supply chains. Particularly, examine whether Blockchain technology makes a good fit for use in an Australian manufacturer supply chain. Blockchain allows us to have permissioned or permission-less distributed ledgers where stakeholders can interact with each other. It details how Blockchain works and the mechanism of hash algorithms which allows for greater security of information. Case study focuses on the supply chain management and looks at the intricacies of an Australian manufacturers supply chain. We present a summary of opportunities for using Blockchain technology in supply chains in an Australian manufacturing case study. The summary is proposed in using private Blockchain in the case study. The opportunities using Blockchain technology has the potential to bring greater transparency, validity across the supply chain, and improvement of communication between stakeholders involved.

Keywords
Blockchain, Supply Chain Management, Distributed Ledger, Bitcoin

1 Introduction

Today's current cloud-based application services rely on a single trusted entity that manages the network, storage and software. The amount of data being created and collected in cloud-based applications is growing at an exponential rate. This growth is primarily due to technology advances in devices which are known as the 'Internet of Things' (IOT) and the significance of computer power and availability of storage resources. The emergence of IoT means an increase in connectivity and information sharing and therefore a need for increasing trust and efficiency in transactions which may impact the supply chain and its resilience to recover from all kinds of disruptions (Mondragon, Mondragon, & Coronado, 2018). Data is evolving and becoming part of everyday human activity, from product goods being sourced, product manufacturing and delivery of products to end consumers. The increase in data has provided opportunity for new approaches and techniques to create, store, analyse and obtain useful insight from the supply chain.

The emergence of blockchain technology has brought innovative possibilities extended from financial services to supply chain management, intelligent manufacturing and IOT. Supply chains represent all the links that are involved in the sourcing of raw materials, manufacturing of goods, and the distribution of a finished product to the end consumer. They can span from over hundreds of stages and multiple geographical locations which makes it complex to trace events in the supply chain and investigate any issues (Arshinder, Kanda, & Deshmukh, 2008). To date, customers have no reliable way to validate the true value and authenticity of a product purchased due to the lack of transparency, tracking, recording and sharing of information. This lack of transparency is due to an absence of information being shared about the manufacturing process of goods, assembly, delivery and certification of materials used that might pose risks and issues in the supply chain. This also poses a risk to fraud occurring in the supply chain such as counterfeiting of products, and the accountability of any illicit activities that may occur. Generally, consumers raise questions when purchasing goods such as where are these products coming from? Do they meet the expected standards and are they safe? Supply chains also suffer from inefficiencies in the recording of assets such as pallets, trailers and containers that are continuously moving between supply chain nodes. There are also issues in the tracking of purchase orders, receipts, shipment notifications and other trade related documents. In addition, the lack of assigning or verification of certain properties of the physical products or the linking of goods to serial numbers, bar codes or digital tags like radio frequency identification (RFID).

Blockchain technology allows for data to be written in files called Blocks. The Blockchain technology can record transactions of almost any type based on certain conditions that are agreed on by stakeholder which can solve record keeping issues, however, computer professionals remain sceptical about relying on this technology for complex and long-term transactions management. They remain unsure about the preservation ability of the system for trusted digital records. Lemieux (2016) and (Luther, 2016) identify threats and vulnerability of Blockchain as control base threats (Control of Blockchain, and Control of record creation outside of Blockchain), attack base threats (Man-in-the-middle attack, SYN Flood attack, Sybil attack, and Audit server attack), system base threats (Timing errors, and Preservation of original records), and process base threats (Change of bit rot to encryption, Collision of hashes, and encryption code Breakage). The Blockchain enables different organisations to collaborate and validate entries in the Blockchain hence giving stakeholders visibility of the overall activities taking place. This paper proposes using Blockchain technology to enable various upstream and downstream parties in supply chain to verify the authenticity of each individual Block and provide transparency across different stages of the supply chain. Various parties in the supply chain first provide input and agree on the content of a Block. Once in place, the Blockchain will include a set of constraints which cannot be violated by any Block.

An Australian electrical manufacturer (AEM) has been chosen to address the issues of traceability, transparency and inefficiencies which are common in supply chain management. The supply chain chosen is also common among the fast-moving consumer goods industry. The remainder of this paper is organised as follows: Section 2 the related work is reviewed. The proposed model and case study are discussed in Sections 3 and 4, respectively. Finally, Section 5 provides discussion, conclusion and future work in this area.

2 Literature Review

Supply chains are a core area for organisations, they are known to be large, complex and often unpredictable as they include four essential functions: sales, distribution, production, and procurement (Arshinder et al., 2008). However, a problem in this area can lead to inefficiencies and delays in the delivery of goods to consumers and a loss of revenue. Organisations have automated their processes, which has contributed to an increase in the amount of digitised data both internally within an organisation and externally through distributors, freight and transportation providers. Blockchain is a distributed data structure that is replicated and shared among the members of a network (Greenspan, 2015). It was introduced with Bitcoin, which is a popular form of digital cryptocurrency which was developed in 2008 by "Satoshi Nakamoto". The technology underlying Bitcoin is named Blockchain which acts as the payments layer for Internet. This new form of general computational substrate is a mechanism for updating truth states in distributed computer networks (Swan, 2016). A recent survey has divided Blockchain-inspired technologies into two (Zyskind, Nathan, & Pentland) fully decentralized permission-less ledgers, (e.g., Bitcoin, Ethereum), and semi-centralized permissioned ledgers (e.g. Ripple). These ledgers are known as 'distributed ledgers'. A lack of studies in the applicability of Blockchain technology has motivated researchers to find the possibilities of this technology in other areas. Ølnes, Ølnes (2016) investigated the possible application of this technology in electronic governments. To this end, a case of storing academic certificates on the Blockchain was presented to highlight the innovation potential of the new technology for storing and securing vital information. He concluded that although Blockchain is a promising technology for validating many types of persistent documents, still there is a long way to implement this technology in public sector. Nevertheless, the implications and limitations of using such technologies as a software connector had been elaborated as well. Dierksmeier and Seele Dierksmeier and Seele (2016) provided rationale to address the impact of "Blockchain technology" on the nature of financial transactions from a business ethics perspective. They combined different business and society levels such as micro, meso, and macro to propose a framework for assessing current status of cryptocurrencies ethical debates. Several studies have attempted to find the performance and impacts of Blockchain in comparison with other systems. Focusing on their scalability limits. Vukolić (2016) made a comparison between proof-of-work (PoW)-based Blockchains to those based on Byzantine fault-tolerant (BFT) state machine. To tackle these limits, they reviewed recent proposed solutions developed for the ultimate Blockchain fabric. Based on the experience in several Blockchain projects, Xu et al. (2016) studied the architectural decisions in a system. In the situation whether to employ a decentralized Blockchain as opposed to other software solutions such as a traditional shared data storage.

Lemieux (2016) studied to what extent Blockchain technology creates trustworthy digital records by applying a risk-based assessment method to evaluate the implementation of Blockchain technology in land registry system. The results indicated that although Blockchain technology can be used to address issues associated with information integrity in the present and near term (Lemieux, 2016), the reliability of information and maintaining long-term preservation could not be guaranteed. In 2016, a study was conducted on interdisciplinary fields of Blockchain and the healthcare system to prevent data sharing and improve patients' privacy by enabling them to own, control and share their own data easily and securely. In this regard, an App named Healthcare Data Gateway (HGD) that was designed based on Blockchain architecture has been developed by Yue, Wang, Jin, Li, and Jiang (2016) with the capability to organize and categorize all kinds of personal healthcare data and secure Multi-Party Computing.

The growing use of sensors providing information in supply chains is providing Blockchain leverage to streamline and create an efficient supply chain track and trace management system. There are examples of Blockchain technology going beyond the realm of currencies and banking and evolving into industries such as real estate[10],for land registry systems, digital healthcare record systems(Kar, 2016) and government identification and registry systems (Christidis & Devetsikiotis). Many businesses have already begun accepting Bitcoin in their payments including PayPal, Apple, and Universal Air Travel Plan (UATP). In addition, firms such as Citi Corp, Goldman Sachs, Barclays, Overstock, and IBM started to pay attention to cryptocurrencies. Governments around the world are creating policies for cryptocurrency, including Brazil, Russia, India, China and South Africa (BRICS). The BRICS business council is also debating the possibility in creating a BRICS cryptocurrency as an alternative to other financial instruments Council (2017). USA has already deployed bitcoin technology for interbank payments and Australia has already began a trial for bank guarantees using Blockchain technology ((CIO)). Interoperability challenges between bitcoin and other ledger assets between multiple Blockchains have been addressed by creating mechanisms such as Pegged Sidechains (Back et al., 2014).

The solution that Blockchain proposes is the use of a timestamp server that takes the hash of a Block of items, timestamps it, and widely publishes the hash (Yuan & Wang, 2016). This involves using hash algorithms to find a specific value. The Block is only accepted by users if all transactions in it are valid and the Bitcoins have not been spent previously (Yuan & Wang, 2016). Users show their acceptance by using the newly found hash in the "previous hash" section of the next Block they attempt to generate. This adds a new Block to the chain (the Block chain or transaction log). The chain thus contains the entire history of all transactions that have been carried out in the network (Yuan & Wang, 2016). The first Block of a Blockchain is called the genesis and has no parent as each block on the Blockchain is referenced or identified by its hash (Christidis & Devetsikiotis). A Blocks hash is typically a one-way hashing function used that maps an input to an output. There are different types of hash algorithms which may be used. For example, applying the SHA-1 hash algorithm function to a string "hello blockchain" will produce the following hash value "bdb9814fb8929bd976a8ba1a4e037992ca7111e0".

Applying a hash function to a string will return a new string and if that string remains the same, the same hash will be produced. Data integrity is optimal as one can verify their hash with a hash key that has been given when downloading a file. This is done by comparing both hash keys as this ensures the file has not been tampered with and every byte of data is exactly the same. The Blockchain, also known as the consensus protocol (Herlihy & Moir, 2016), serves as a public or private ledger for any transactions, and every user is able to connect to the network and send transactions to the Blockchain, verify transactions and create new Blocks. It is a data structure which is used to ensure secure and tamper proof distributed ledgers. Each Blockchain is made up of Blocks which are linked to a previous Block and contain exclusive data and a timestamp.

To form a Blockchain, sequences of bits encrypted as a Block are stored by networked computers (nodes) within a system and are chained together. The veracity of new Blockchain links are established by a decentralized mining process. Before new links are formally added to the Blockchain, a meticulous mathematical hash is derived by competing mining computers to verify their content (Yuan & Wang, 2016). When a bitcoin is transferred to the next user, it gets digitally signed with a hash value denoting the precedent transaction and the public key of the next owner. The hash is defined as a chain of signatures. These can be verified by the payee to authenticate the chain of ownership (Yuan & Wang, 2016). To become part of the peer-to-peer network, one needs to have a client software that runs on either an own device or on a cloud service(Yuan & Wang, 2016). Nodes in the network only accept the first authenticated transaction and reject any subsequent attempts to make any further transactions to stop malicious users from rewriting their history.

Processing transactions over a distributed network without a central node functioning as a bank or clearing house reduces the cost of the transactions. Processing transactions using the Blockchain is less costly than the traditional approach Chuen and Deng (2017). Moreover, the business of processing transactions tends to be highly concentrated and can be impacted with waiting for stakeholders executing their due diligence actions. With Blockchains, business transactions can be made to run in parallel potentially unleashing huge efficiency dividends e.g. businesses can unlock capital or value quickly rather than waiting for a transaction to be completed. The transactions volume handled by each payment processor can be increased manyfold but the added coordination costs to overcome network effects need to be considered. However there is an argument that the technology's primary benefit is security and not efficiency Dirkmaat (2017). The ability to use multiple Blockchains to improve efficiency requires interoperability between different Blockchains. Blockchains need to be able interact with each other as a single blockchain alone has limited performance (Kan et al., 2018). Various studies such as ("Cosmos | Cosmos Network," 2018), (Wood, 2016), (Ding et al.) and (Greenspan, 2015) have established a framework to exchange information between multiple Blockchains.

Rather than limiting a supply chain to regions, the utilisation of different Blockchains will make it possible to have global production chains that are visible remotely. This is in line with what Kietzman (Kietzman, 2017) observed the current unseen dimensions from the vast network of retailers, distributors, transporters, storage facilities, and suppliers that participate in design, production, delivery and sales will be transparent. Organisations will have a competitive advantage of open, transparent supply chains and sustainable manufacturing.

3 Method

The supply chain management involves many internal and external stakeholders which makes Blockchain suitable as it can accept inputs from lots of different parties. Fig.1 demonstrates a traditional supply chain, where a series of interactions occur in sequence between various stakeholders.

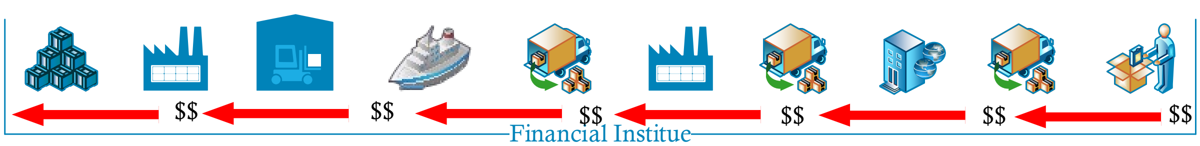

Fig. 1. Traditional supply chain where transactions are verified by a third party such as a bank.

Transactions between each of these nodes is only verified once payment is made through a third party financial institution. The flow of information occurs between various stakeholders, with consumers, to retailer, to wholesaler/manufacture to transportation and freight provider to supplier and finally to resource provider. These transactions occur through multiple systems and the passing of accurate information between them depends on the trust from one stakeholder to another. There is a risk of information being incorrect or altered along the way of the supply chain where there is also a lack traceability. The proposed model is for organisations to develop a Private Blockchain. In addition to this, organisations will need to ensure governance and business standards are in place in a virtual community.

The Blockchain proposed in Figure 2 is a Private Blockchain. The Blockchain model is decentralised with all stakeholders involved in the supply chain are connected via the Blockchain network. All the transactions which go through the supply chain are stored and verified by all the users. All stakeholders of the supply chain can save all their transaction in the Blockchain which enables greater security and transparency. The data in the Blockchain is decentralised where each member of the supply chain can read important information at any given time. For example, the manufacturer can view where the raw source materials have come from or the consumer who is at the end of the supply chain can trace all the steps the product has been through from its raw material state through to manufacturing and delivery to the consumer.

Given this Blockchain is private it allows for stakeholders who are only involved in the supply chain to enter information such as the sources of the raw materials, the factory of where the components are being produced, the stock availability, minimum order quantities. The supplier of the produced components can also enter any of their quality assurance and testing which has been performed. Finally, the freight forwarder enters details of the goods being picked up and details of expected delivery timeframes and any delays that may be experienced.

The decentralised blockchain operates on a network which is not centrally controlled by a single entity, transactions which are carried out on the blockchain are secure and it is impossible to forge data as validation is required by the different network stakeholders. Once the record is duplicated on all network servers it becomes impossible to alter the content of the block without authorization from all the connected nodes.

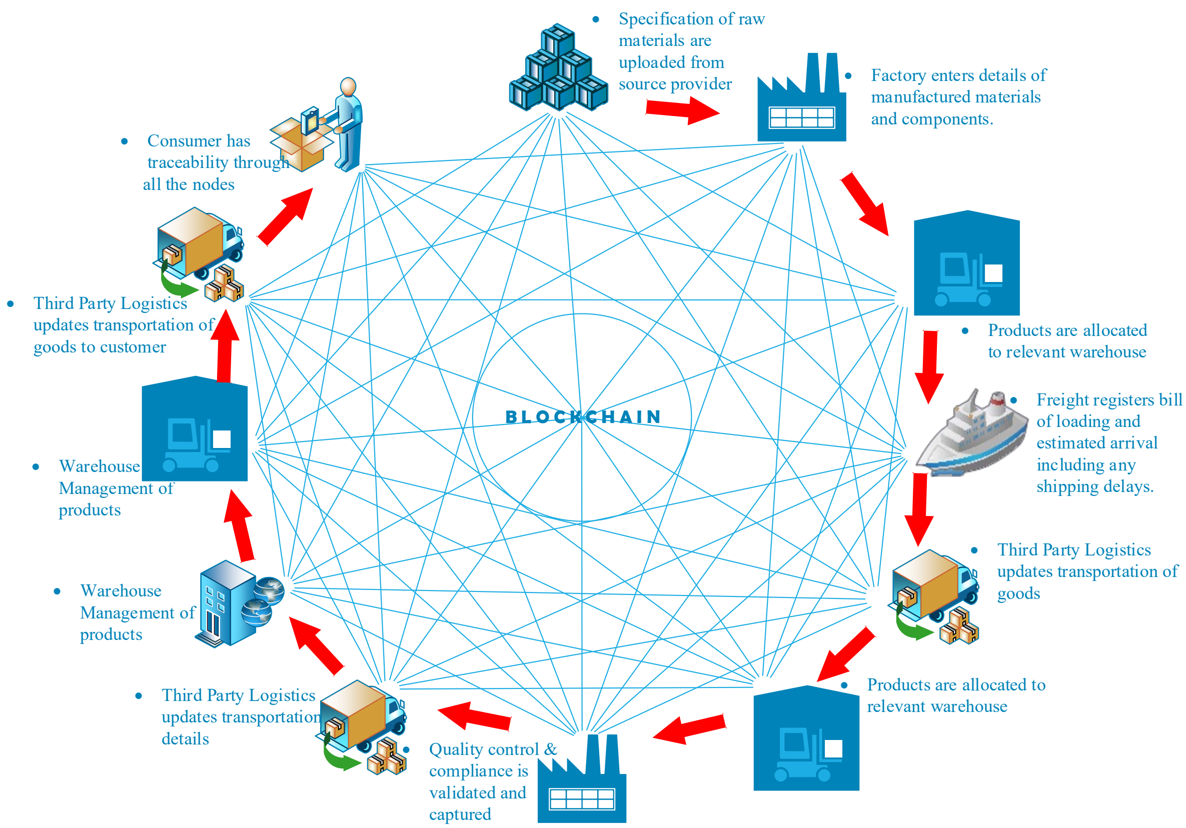

Fig. 2. The use of Blockchain technology allows for a more transparent supply chain of goods or services.

When each activity moves along the supply chain, all parties on the network are linked together through the private Blockchain. This brings transparency, validity and reduces the risk between all parties. However, this method requires all stakeholders to participate as it will not work without full participation. For example, if we do not have the freight organisation on the blockchain, essentially there will be a gap and a lack of complete transparency from start to end.

The use of Blockchain technology allows for a more transparent supply chain of goods or services. Each Block in the chain provides stakeholders the ability to control information through secure, auditable, and immutable record.

The method proposed captures all parties involved in the supply chain management and ensures there are no missed transactions, or errors, or even a transaction is not done with the consent of all the stakeholders involved. The most crucial area where the Blockchain helps in is the guarantee of validity and accountability of a transaction by the relevant stakeholder. The Blockchain gives the business the ability to view the entire supply chain.

4 Case Study – Australian Electrical Manufacturer

Australia's leading electrical manufacture and distributor (AEM)[1] has a wide range of brand portfolios targeting the roadway & infrastructure, commercial & industrial, consumer and retail market segment of the electrical industry. In a very competitive market and with the availability of cheap imports easily accessible via the internet, organisations need to continuously streamline and optimise their processes to remain competitive. AEM is vertically integrated, incorporating, engineering and design, research, manufacturing, global sourcing, importation and distribution. This allows AEM to develop new products and produce prototypes for customer approval. It also gives the flexibility to design variations and bespoke designs from a single unit to thousands of units. The supply chain consists of three warehouses, one located on the west coast of Australia and the other two on the east coast.

The electrical industry has intensely changed in the past 5 years due to the rapid advancements in technology. The lifespan of products has also changed to as low as 6 months, hence the speed to market is crucial. The supply of products is an intricate part of the business as it consists of multiple segments of the electrical industry, currently the flow of information in the supply chain is siloed where information can't be easily shared and accessed.

A technique used to try and improve the flow of inventory between the raw material and component suppliers to the manufacturer is a contract to commit. This guarantees payment to and provides comfort for international suppliers to purchase the materials required based on the contract. This technique is also used to minimise any delays the supplier may face in sourcing the raw materials. The Roadway segment of the business involves luminaries for roads, tunnels and bridges. It is run by contractual agreements with customers which governs which products are required and when. These product demands are added onto the forecast based on the agreements in place. At times, there may be delays in obtaining goods from suppliers however this information is not always relayed back to all stakeholder's due to the intricacies of the supply chain.

ABC analysis also known as selective inventory control is a term used to define inventory into categorisations. The grouping in to three or more categories (A, B and C) is carried out to manage the different stocked keeping units (SKU's) that are not all in equal value or customer order frequency. Special consideration is taken for new and critical items such as components required to manufacture make to order products. There are two types of purchasing instruments which are used, customer demand driven purchasing and system forecasting. Forecasting is based on policies setup in the enterprise resource planning (ERP) system and relies on historical sales; these items may not necessarily have customer demand but are required to meet customer's availability expectations. Customer demand driven orders (Indent Stock) don't consider historical sales, however, the purchasing team do need to contemplate lead times and the suppliers' minimum order quantity. These are generally not considered when a sales representative makes a sale to a customer. The demand unpredictability causes series risks with procurement and can lead to a rapid increase of obsolete stock.

Material Requirements Planning (MRP) is a planning and inventory control system which is contained in the enterprise resource planning (ERP) system. Its aim is to safeguard adequate inventory levels are kept and assure that the required materials needed to manufacture goods are available when needed. Consideration also needs to be taken if stock is ordered and it does not meet the minimum requirement; does the organisation proceed with the sale and purchase excess stock and risk having an overstock which results to additional overheads. The retail segment of the business is also based on projects and project plans of what and when the products are required. As these products are generally one of the last parts that are installed in a project there is a risk of miscommunication in the business, for instance if a project falls behind plan or over budget the product requirements may change and the sales representative does not inform the planning department, products which are no longer required could end up in the warehouse and take up

[1] Name is fictitious to maintain confidentiality

valuable resources and space. These physical actions which take place can be reordered in a Blockchain in the form of digital information.

The category team manage product categories and their performance, they set the objectives and targets for the category and devise an overall strategy and specific tactics to achieve the required sales. The team oversees new products for 12 months from the date the product is received. Overall between the category team, forecasting and marketing they advise the purchasing team of what the business is expecting to sell.

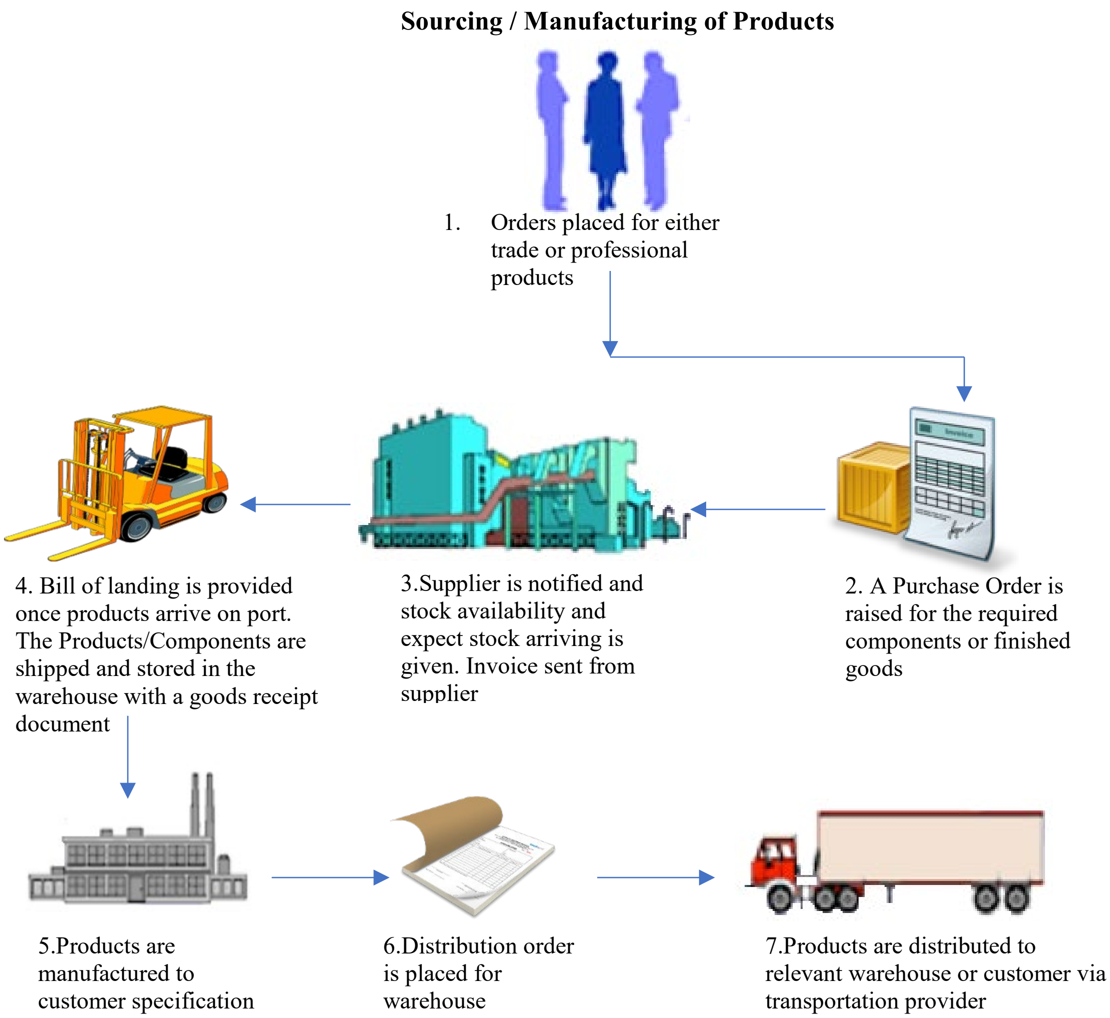

Figure 3 Flow of transactional data taking place at each step of sourcing components or products from suppliers to the manufacturing of finished goods.

Generally, the top 80% of customer required products are stored in the warehouse and 20% of the products (SKU) is 80% of the business (Coyle, Langley, Novack, & Gibson, 2012). At times when products ordered by a customer cannot be located in the one warehouse a distribution order is completed to relocate the required product to the one distribution warehouse. However, if a product is not located in either warehouse an inventory sourcing purchase order needs to be raised to the supplier. A common issue faced is whereby sales representatives may not know the lead times required or are reluctant to tell the customer that there is a 10-week lead time and then pressure is put back on to the purchasing and supply chain teams to ensure the product can be sourced with minimal amount of time. Also, if a customer order is cancelled by the sales representative and the distribution order is not this causes the purchasing team to have no visibility of the cancelled order and the purchases may still proceed. This is an issue where the chain of events occurring are not connected and transparency of information is not present to all stakeholders.

It is generally easy for the organisation to place an order with the suppliers but extremely difficult once a purchase order has been approved and sent. The organisation is simply locked in at that stage and committed to the purchase of the goods. It is also possible for the purchasing team to miss any cancelled orders made on the distribution orders. Traceability and transparency are the most important in logistics.

The safety stock applicable to certain products will only cover a small amount additional orders, however it will not cover any spikes in sales; therefore, communication between marketing, sales, supply chain and procurement team is crucial. At times the marketing team may run promotions on certain products and this may cause an influx in orders which quickly depletes the safety stock and customer orders are held up in backorder. The previously forecasted purchase order which may be expected to arrive may only cover the backorders and not any new orders. This creates a cycle of where the purchasing team try to catch up to customer orders. It is important to calculate it accurately, because having too much stock will increase the inventory costs and having too little will cause stockouts as inventory will be exhausted. There is a standard calculation which is used for safety stock, however the lead time is also considered and hence the higher the lead time than the higher the safety stock is. A key system issues faced in such an environment is when a product is deemed as "I" (Indent Stock) and has a safety stock. This should flag for an alarm to sound and no safety stock should be purchased. It is ideal to be running a lean supply chain with the aim to balance customer service goals and the inventory costs. The transparency and accuracy of information is vital to achieve this and ensure no wastage.

The proposed method of using a private Blockchain optimises the manufactures business transactions and trading relationships with its suppliers, transportation and consumers both locally and globally. Blockchain creates a greater connectivity across they supply chain network. A Blockchain on the supply chain can give clear visibility to all parties and allow for decisions and actions to be made quicker. Compared with conventional databases, using private blockchain costs more to add records. Calculations and experiments have been performed in literature and show that the cost for business process execution on a blockchain can have a two fold increase than a traditional database on a cloud platform (Rimba et al., 2017). However, data becomes globally replicated and the blockchain ecosystem will retain this data indefinitely as long as the blockchain exists, at no additional cost (Staples et al., 2017). The current supply chain model as depicted in Figure 1 has a significant amount of trapped value, largely stemming from the fragmented use of systems. The Blockchain creates a chain of events or transactions that occur between the end customer, manufacturer, and supplier. A Blockchain that can directly interact with the sales team within the business and the suppliers will provide assurance that performance and correct communication is achieved in obtaining stock for the customer when needed. By using Blockchain the manufacture will have traceability from the source of the raw materials through to the components and the quality assurance and checks which have been performed. In addition to this the supply of goods can be tracked through with the freight provider. This transparent level of information provides a link between the manufacture and the external stakeholders involved all recording and sharing information that can be assigned further down the supply chain. This Blockchain solves the issue of not knowing when a purchase order of goods is arriving and the properties and details of the products that it contains. The use of Blockchain provides links between the customer order and the final manufactured goods for the customer. This Blockchain creates visibility on where products can be found in a warehouse, the quality control performed and if the products has been allocated to a customer order. This traceability also helps with the inventory management in ensuring there is adequate stock available for an order to be made. The record keeping and linking of this chain ensures customers receive the order in full, on time and from the correct warehouse. Due to the absence of other available alternatives to solve the communications problem in the supply chain, blockchain is likely to become an attractive and cost-effective option [19]. The use of Blockchain within the business also provides transparency for the sales representatives who will have visibility on relevant information such as the components being used, the supplier its coming from, the lead times required and stock availability.

The use of Blockchain in AEM enables the organisation to secure the supply chain. It provides authenticity, origin, and a place of storage on all the necessary information that is in a single ledger. The records in the Blockchain are indestructible and guarantee a tamper proof record. Blockchain also have the capability of detecting fraud from the very first transaction where there is inconsistency with the validation of information. Information within the supply chain will have validity with the use of Blockchain and the assurance that the creation of multiple versions of a document will be avoided by all parties involved.

5 Conclusion

The general spread of the Internet of Things (IoT) makes the idea of integrating Blockchains in existing transaction supply chains the more significant. It will facilitate the creation of new supply chains to support the spread of sensor technologies. Supply Chains are highly complex as they involve many stakeholders who conflicting interests and priorities as well as the use of multiple systems. This paper presents an opportunity to use Blockchain to improve the current supply chain. Blockchain can enable various upstream and downstream parties in supply chain to verify the authenticity of a block of items. When stakeholders agree to work with Blockchain technology they are agreeing for an intensely collaborative journey. For this to happen, the paper describes where Blockchain can integrate its use in the flow of the supply chain. The supply chain demonstrated in the case study is a large part of an organisation and it involves internal and external stakeholders. It is possible that not all parties will participate in this technology, however, the idea is compelling as it enables private deployment of Blockchains in supply chain management. The novelty of this paper lies in where Blockchain can store all transaction information in the supply chain of the proposed case study. This will allow organisations to leverage a variety of Blockchain applications and solutions to help in the transparency, traceability and authenticity of information. The use of the Blockchain technology also creates a culture of collaboration between all stakeholders. Recently, IBM is experimenting with a system called Adept that permits exchange among billions of interconnected devices using a Blockchain approach. It has developed a semi-autonomous device based on Internet of Things concept integrated with the Blockchain with the collaboration of Samsung. This device is a kind of intelligent washing machine which can manage its own consumables supply like ordering detergent as required, perform its own self-service and maintenance, and even optimize its environment by negotiating with other peer devices in the home or outside. Technology leaders believe that Blockchain will do for transactions what the internet did for information. One potential issue that needs to be considered in the use of Blockchain is that if the first Block in the chain the geneis is created without a trustworthy source and each additional Block thereafter is also agreed on by the Blockchain stakeholders then theoretically this chain of events can be unreliable. Compared to conventional centralised databases and computational platforms (on-premises or cloud), blockchains can reduce some counter-party and operational risks by providing neutral ground between organisations [20]. Blockchain within supply chain can improve transparency and traceability from how goods are made, where they come from and how they are managed. Data in the blockchain becomes permanent and is easily shared, giving supply chain stakeholders a more comprehensive track and trace capability. For future studies we will invite domain experts to evaluate the proposed method in a real-world application. There is still much that is unknown about the blockchain-based systems [20]. Further research is required to improve our knowledge about how to create blockchain-based systems that work and creating Blockchain-based systems that work as required.

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