Tampere University

SAGAR DAS

APPLICATION OF BLOCKCHAIN IN OUTBOUND LOGISTICS TRACK AND TRACE

Faculty of Engineering and Natural Sciences
Master of Science Thesis
June 2020

ABSTRACT

SAGAR DAS: Application of Blockchain in Outbound Logistics Track and Trace
Master of Science Thesis
Tampere University
Master's Degree Programme in Industrial Engineering and Management
June 2020
Examiner: Professor Jussi Heikkilä and Assistant Professor Mohammad Moshtari

Due to outdated practices, rising cost, low quality and poor customer service, the supply chain process has become more complex than ever. The power of customers has risen, and they are now considered to be the most important stakeholder. The 'Amazon experience' in retail sector has created ripples in supply chain network across all industries and the delivery along with visibility of products is of strategic importance for companies. Technology has also advanced to solve these problems, but the challenge lies in the implementation part as it is expensive and a cumbersome process. Digitalization of supply chain is a hot topic and various companies are have started to implement it to break the existing barriers and create an integrated system with the inclusion of all stakeholders. Appending to this, the introduction of blockchain has further intensified the need to track and trace products across a entire supply chain platform. Trust, immutability and transparency are the key properties of blockchain which is seen as a hyped as well as a potential solution for the existing problems within supply chain management network.

The main objective of this research is to understand the need for track and trace solutions in outbound logistics management and to develop a framework based on the proposal to create a potential application of blockchain in outbound track and trace of a product and to identify the challenges and opportunities in its implementation. To have a vivid understanding of the outbound logistics processes and available track and trace solutions, a thorough literature review is undertaken. Upon analysis of the case study, a blockchain framework is proposed with the aim to understand the integration of physical flow and information flow in the outbound logistics. Further, recent projects on the implementation of blockchain technology in the supply chain network is studied to apprehend the necessity of this research. The challenges posing to the implementation of blockchain are also discussed.

The research aims to understand the need of track and trace solutions and how blockchain implementation is feasible to achieve this solution. As a result of this study, the feasibility of blockchain technology to be used for tracking and tracing outbound logistics is proved. However, the discussed implementation challenges have delayed the adoption rate of blockchain in supply chain management and requires further research in this field.

Keywords: blockchain, outbound logistics, digitalization, tracking and tracing

The originality of this thesis has been checked using the Turnitin Originality Check service.

PREFACE

This thesis aims to understand the need for track and trace solutions in outbound logistics. There are numerous solutions and technologies available to implement the tracking and tracing of a product once it is in shipment phase. The implementation of such technologies is beneficial to the stakeholders in the outbound logistics network, most beneficial being the customer whose need to know the delivery schedule of their product is attained in an instant. At this juncture, it is seen that blockchain can provide groundbreaking solutions in this field. However, they are still in their early adoption stage and the true potential of this technology is yet to be measured.

My interest in supply chain management and blockchain technology propelled me to carry out this research. For his guidance , encouragement and advice during a master's thesis, I would like to thank my thesis supervisor, Professor Jussi Heikkilä, Tampere University of Technology. I would also like to thank my colleagues, who during my academic career in Finland assisted me with critical insights and help.

Finally, I would specially like to thank my parents for constant support, guidance and blessing in all phases of my life.

Tampere, 17, June 2020

Sagar Das

CONTENTS

1. INTRODUCTION

This chapter will present the reader with the background and the research gap that exists in the field. The research background will present the current scenario, which will be followed by the purpose of the research and the critical research questions. The limitations related associated with the research topic and the structure of the research will also be explained.

1.1 Research background

Globalization along with recent trends such as shorter product life cycle and tightened profit margins has caused the management of supply chain more complex than ever (Hidjaja, 2018). These challenges in the field of supply chain have become priority for organizations because they affect the overall efficiency, cost, quality of the business and most importantly customer service. Recent studies reveal that transparency in the supply chain creates more trust amongst the stakeholders and improves customer service, thereby instilling trust and long-term relationship (He et al., 2008).

In-time delivery of products to the customer is increasingly becoming a strategic goal for global companies. The age of digitalization and the ‘Amazon Experience’ from the retail sector has prompted customers to have a tool at their disposal which can track and trace their products at any given point of time (Wognum et al., 2010). Hence, companies have started to take serious interest in the field of tracking and tracing of their products for two main reasons: first is to improve the customer service and second is to keep track of their valued products.

Pizzuti and Mirabelli (2015) emphasize on the need to have a product traceability system in order to assure the linkage between the flow of product and the flow of information as well as secure the complete history for future restoration. The use of traceability can further provide metrics for evaluating quality and performance of the logistics system (Allata et al., 2017). A continuous monitoring system also ensures faster detection of any problems across the logistics process. (Narshimhalu et al., 2015). However, the cost and changes required in implementing traceability is one of the main barriers for small scale industries to venture in this field (Allata et al., 2017).

Sarkis et al. (2011) state that failures in establishing a robust communication channel is affecting the trust between a company and its customers. Hence, the need for information systems and technology to enhance the information exchange has become important. At the same time the integrity of the information should not have any uncertainties (Pizzuti and Mirabelli, 2015). This is where the blockchain technology comes into play as it can promise transparency, traceability and trust in inefficient business practices (Kim and Laskowski, 2017).

1.2 Purpose of study and research questions

The above section briefly outlines the current state and need of tracking and tracking in the present day business environment. The aim of this paper is to explore the technologies available to enable the tracking and tracing of products. In addition, the application of blockchain technology to outbound logistics is also being studied and a framework for implementation is being proposed.

Literature and case studies in the field of supply chain management are abundantly available. However, in the case of blockchain technology, the same is limited. Blockchain is considered to be a revolutionary technology and there is a need for a vivid picture of how this technology can be implemented to improve the efficiency of the supply chain. The Gartner Hype Cycle also supports the initial bold promises of blockchain and projects it to be commercially viable in the next 5-10 years (Gartner, 2017). Figure 1 shows that blockchain has already crossed the ‘Peak of inflated expectations’ and progressing toward the ‘Trough of disillusionment’.

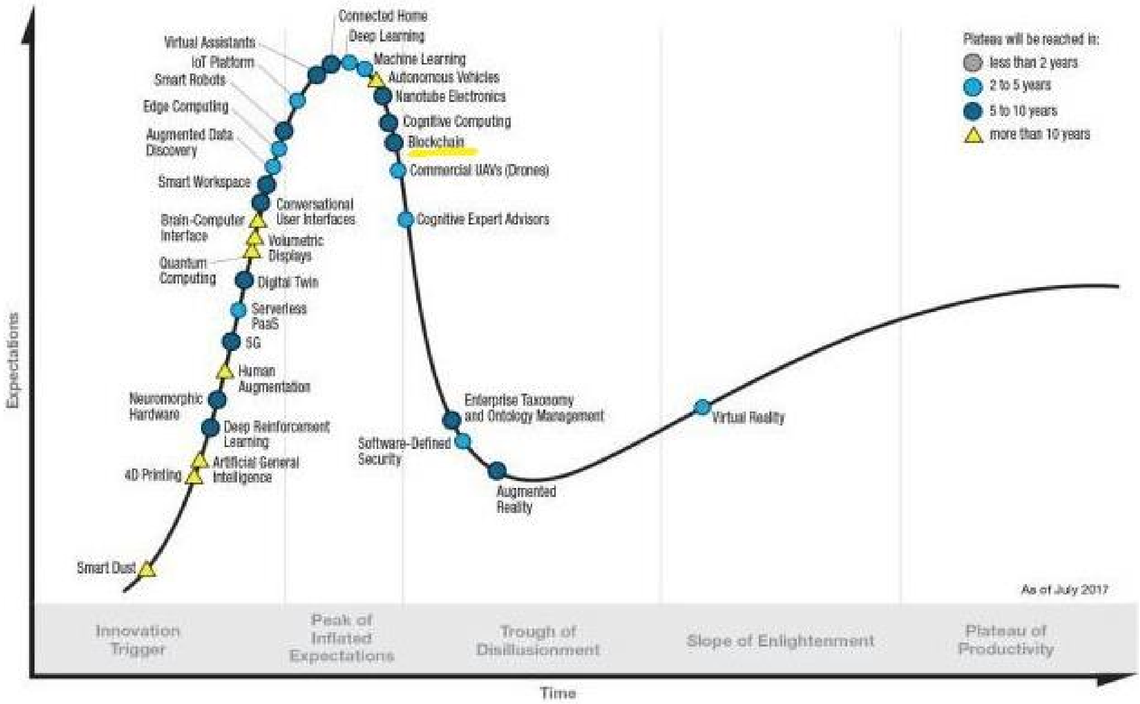

Figure 1. *Gartner Hype Cycle (Gartner, 2017)*

The main objective of this paper is…

… to understand the need for track and trace solutions in outbound logistics management and to develop a framework based proposing the potential application of blockchain in outbound track and trace of a product and to identify the challenges and opportunities in its implementation.

Furthermore, the research problem formulates the following research questions:

- **Research question 1:** What is the need of tracking and tracing of a product in outbound logistics?
- **Research question 2:** Which are the available technologies in providing solutions for tracking and tracing?
- **Research question 3:** How does blockchain technology fits in providing solutions in tracking and tracing?
- **Research question 4:** What challenges can organizations face while implementing blockchain technology in outbound logistics?

1.3 Scope and limitations

The study focuses on the potential application of blockchain in outbound logistics and analyses the projects undertaken for tracking and tracing solutions in supply chain management. The literature review is systematically narrowed down from the broader topic of supply chain to the tracking and tracing in outbound logistics.

1.4 Structure of the thesis

This research paper is divided into seven broader parts. The first chapter provides a brief background information on the subject and explains the purpose of the study, the scope and limitations of the study. The second chapter examines the relevant literature on the supply chain, outbound logistics and digital transformation in the supply chain. The literature then focuses on the blockchain technology and the features it provides in the context of research. The third chapter examines the research methodologies and sets out the methodology chosen for this study. The fourth chapter analyzes the case study and a brief summary is made. In the fifth chapter, the methodologies used in the case study are proposed for the blockchain framework. The sixth chapter on the applicability and challenges posed by the implementation of blockchain technology. Finally, the seventh chapter concludes the research and discusses the key findings of the entire process.

2. LITERATURE REVIEW

This section of the thesis analyzes the global outbound logistics and discusses new studies and ideas within supply chain track and trace technologies. Finally , this chapter will explain the blockchain technology concept, smart contracts and discuss the advantages and challenges it faces.

2.1 Supply chain and outbound logistics

The basic principle of supply chain has remained the same throughout. Supply chain mean a network established to distribute an product with different entities like producer, suppliers and distributors as its stakeholders (Londe & Masters, 1994). Walters (2007) notes that each company supplies its consumers with goods to match their needs. Businesses need to look beyond to address this requirement and decide how to provide an optimal supply of products and information to satisfy the consumer demands (Christopher, 2005). Stadtler et al. (2014) adds that the supply chain consists of at least two legally distinct organisations connected by flows of money, content and intelligence. It ties together supply chain end-product companies, distribution infrastructure, suppliers and end-customers (Stadtler et al., 2014).

The supply chain constitutes a network of partners responsible for the conversion of a product (upstream) into a finished product (downstream) which is valued by the end user, thereby, adding each partner to the value chain (Harrison, et al . 2008). Tyndall et al. (1998) adds the process or work as the fourth flow in addition to the product, financial and information flows, while Stank et al. (2001) notes that currency, information, valuation of goods / services and customer accommodation constitute a supply chain. The literature highlights a lack of understanding of the concept of supply chain management (SCM); therefore, the definition proposed in this research for supply chain management is the one proposed by Sim-Chi-Levi, et al . (2008), which states:

"Supply chain management is a set of approaches utilized to efficiently integrate suppliers, manufacturers, warehouses, and stores, so that merchandise is produced and distributed at the right quantities, to the right locations, and at the right time, in order to minimized systemwide cost while satisfying service level requirements".

The definition includes all the functions (logistics, development, finance , marketing, etc.) and takes into account the influence of suppliers and customers (Simchi-Levi, et al., 2008). This approach regards the supply chain as a system and incorporates the supply chain partners process (Simchi-Levi et al., 2008).

Figure 2 shows the complexity of supply chain management as it is pictururized as a pipeline. Ballou (2004) defines the supply chain management as a synchronization of different lateral flows (product, information, financial, forecast, etc.) through various functional areas within an enterprise (logistics, marketing , distribution, manufacturing, planning, etc.) and through external supply chain firms (Villalmanzo 2018). Mentzer et al., (2001) adds further that this coordination includes a degree of trust, risk, commitment and dependence on the viability of inter as well as intra-functional corporate sharing. Hence, the supply chain management can not achieve its full potential without sufficient teamwork (Villalmanzo, 2018).

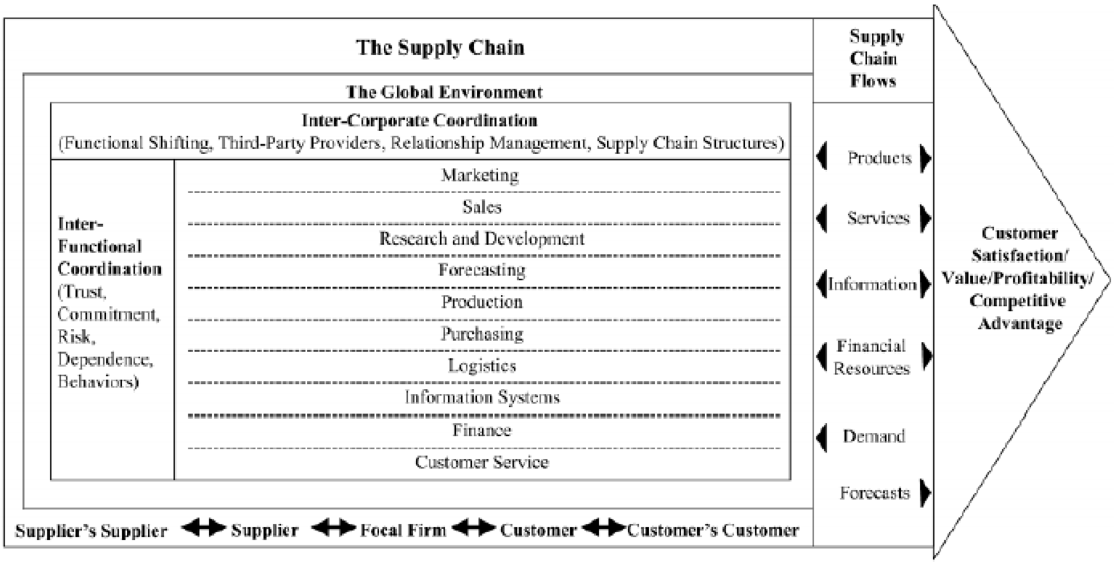

Figure 2. *Model of Supply Chain Management (Ballou, 2004)*

In order to achieve the interaction and intra-coordination, the main elements include the information exchange tools and the IT systems. Data flow is the interconnection mechanism between the different supply chain systems, which tends to minimize uncertainty by data on the actions of other participants by exchanging information between the supply chain partners (Harrison et al., 2008). This model emphasizes the value of the end customer. Harrison et al. (2008) notes that the activities of the supply chain allow the information and currency to flow through which makes customer satisfaction an important part of the the Supply Chain Management for the organization (Mentzer et al., 2001).

However, in a strategic context, this suply chain management model focuses on improving the efficiency and effectiveness of the system in order to gain necessary competitive advantage that ultimately brings competitiveness (Ballou, 2004). Mentzer et al., (2001) also notes that supply chain management's main goals are to maximize customer value and satisfaction, thereby, leading to an increased competitive advantage for the supply chain, and more significantly for the company. Moreover, the rivalry between the supply chains no longer exists as different firms can no longer contend against each other (Waters, 2007). The incorporation and collaboration of intra- and inter-organizations through a supply chain is thus not a primary aim of the supply chain management, but instead a requirement to achieve an effective and productive system. Hence, the key issues linked to a successful supply chain management are discussed briefly.

- Customer value and satisfaction: The current markets are customer-driven and the perceived value in relation to the company becomes a critical factor for the consumer (Simchi-Levi, et al., 2008). With more value added and reduced prices, customers are increasingly demanding goods (Waters, 2007). Emmett and Crocker (2007) claim that consumers mainly prioritize product consistency, lead time order period, expense and level of service
- Competitive advantage: The efficiency of the supply chain management is improved by constant customer demand fulfillment and adding value added services, thereby providing a sustainable source of competitive advantage (Waters, 2007).
- Integration: Upstream and downstream integration improves the performance of the entire supply chain and requires the necessary support to coordinate supply chain partners by establishing a common governance of materials and information flows (Harrison, et al., 2008). A single integrated function is a means by which companies manage the movement of material and information in a coordinated manner (Waters, 2007).

According to a theory of a value chain from Micheal Porter, consideration is the best approach to create a value chain at the business unit level rather than at the organization or divisional level. With a commodity going through the value chain, its value increases. Starting with manufacturers providing the necessary inputs for product creation and the use of networks such as retailers to the end customers, all these processes include the value chain or value system (Porter, 1985). Illustration 3 shows Porter 's proposed supply chain value system.

Figure 3. *Value chain and competitive advantage (Porter, 1985)*

Porter (1985) lists the following activities in the model as principal activities:

- Inbound logistics: covers all inbound operations needed to move raw materials as well as inventories from manufacturers to factories.
- Operation: includes all operations that is required in order to convert raw material, labor and other accessory inputs into goods or services based outputs.
- Outbound logistics: It includes all operations related to the storage and outbound delivery to the end customers.
- Marketing and sales: This deals with the promotion for the sale of products and services.
- Service: It covers all after-sales operations needed to retain an successful product or service status for the customer.

And in Porter's paradigm, the support activities illustrated are:

- Firm Infrastructure: It includes all key functional tasks that sustain the everyday operations of a organization such as marketing, administration, finance and accounting, etc.
- Human Resource Management (HRM): includes all practices related to the management of human capital and relations within a business.
- Technology Development: This covers the technological expertise, applications, processes and machinery used in the company's production process.
- Procurement: includes all activities which serve a company's needs by acquiring resources from the outside market.

Farahani et al. (2011) describes logistics as the handling of the movement of commodities and associated information transference. He further states that logistics includes several different processes, such as shipping procurement, warehousing, terminal management , distribution, and packaging. Logistic method requires a lot of people - to - people contact and it can be concluded that half the logistics work is related to an efficient comminication process (Farahani et al., 2011).

Karlsson and Reumark (2007) define outbound logistics as all logistics activities that occur after the manufacturing stage. Such activities relate to the delivery, preparation and material management of supplies to and from the customers (Karlsson and Reumark, 2007). The logistics operations have changed from the conventional cost-effectiveness approach to a shorter lead time and customer-oriented and strenghtened support strategy. Logistics is not just "saving money" action; it is now an integral part of customer-oriented service strategy (Farahani 2011, p.203).

Lai & Cheng (2009, p39) classifies the management of logistics into four broad sections.

- Customer service addresses the core of supply chain management by bringing the correct commodity in the correct amount to the right place at the lowest possible rate, and in good shape. A satisfied customer is more likely to be going back to the same supplier/producer and encouraging others to buy because of the quality of the service they receives.
- Order processing is one of the key components as it integrates operations originating from distribution to order fulfillment before the consumer gets their shipment. Burnson (2006) notes that the clients always demand uninterrupted results when it comes to the fulfilment of their orders. It puts the buying manager on the task of communicating with internal stakeholders (production team) and external stakeholders (logistic service providers (LSPs), etc.) and providing the client with an adequate lead time and related information.
- Inventory control is a company's ability to anticipate market demand and future growth as well as keep its stock rates as small as possible. With increasing globalization and longer lead time in delivery, inventory management practice has become even more important (Waters, 2002).
- Transportation is a central factor in the distribution process, as it deals with transferring content and finished goods from one end of the supply chain to another (Lai & Cheng, 2009, p.39). Organizations determine what has to be transported and what is the most effective method of transporting it, such as determining the modes of travel, routing and lead time.

Transportation and is seen as the focal point of this analysis and more thorough study is done. Transport management is described as the transportation of products from the manufacturer's warehouse to the end user (Bhatnagar 2009, p133, Sarkisov 2001).

Transportation management consists of two types: inbound transportation referring to the management of transportation from manufacturer to client and outbound transportation referring to the management of transportation from business to consumer (Lai & Cheng, 2009, p.133); Transport management usually involves at least three participants: the shipper, the carrier and the consignee. The shipper is the one who needs to transport the good; the courier is the one who lets the goods really transport and the consignee gets the goods. The government and the public could also be regarded as partners in the transport decisions in a broader spectrum. The shipper and the consignee 's goal is the same which is to transport the products for the least amount of time as quickly as possible. The carrier's goal, however, is to produce as many shipments as possible with the minimal effort and more benefit. The government has functionality like implementing rules, such as the length of time a truck driver can drive on a carrier without break or tariff charges. On the other hand, the public is more concerned about the impact of transport on their lives, such as safety issues, accidents and pollution of the environment (Bhatnagar, 2009, p.135-137).

There are five modes of transport in Bhatnagar (2009, p.133-141): water, rail , road, air, and pipeline. Companies decide the mode of transport, taking into account their needs and their customers' needs (Blanchard, 2010, p.70). In addition, considering the current competitive market, Teo and Shu's work states that a company can develop and effectively network distribution to provide service at the lowest cost. A company must consider two things when deciding on a distribution network; firstly, the method of delivering goods to customers and secondly, the intermediaries involved in the flow to the customer (Chopra, 2001). The distribution network and the design of channels pose the biggest challenge for the current companies. The main problem is that the connection points need to be installed with the supply chain network (Ballou, 2001). Figure 4 depicts a typical, designable supply chain network.

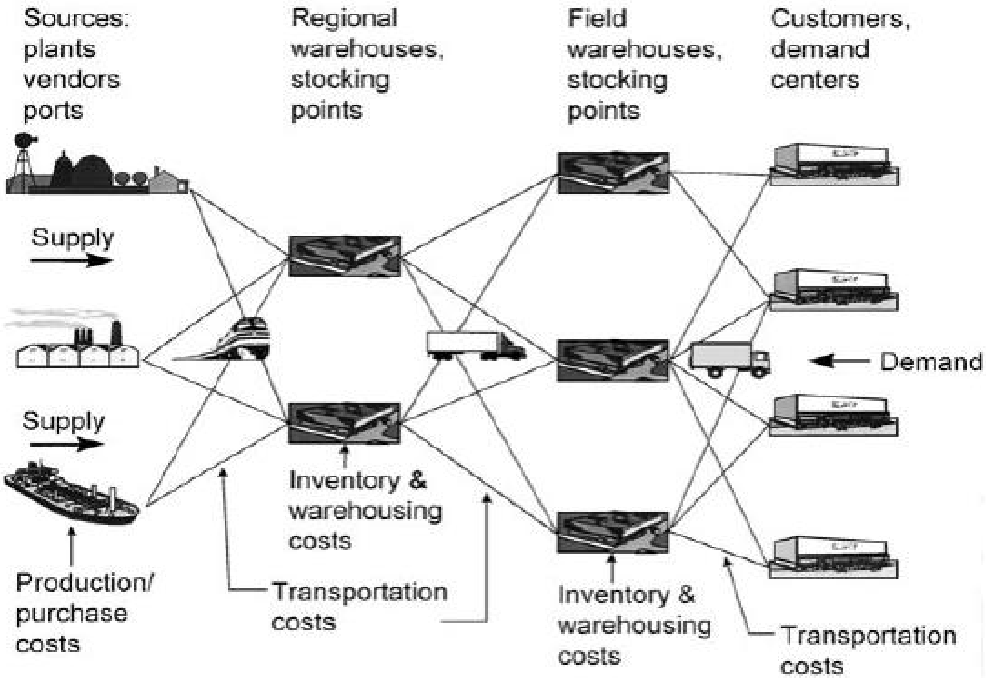

Figure 4. *A typical supply chain network (Ballou, 2001)*

Choosing a suitable distribution channel is a significant decision for businesses who wish to enter multiple market segments. Compatible channel connections help to structure distribution channel management (Ballou, 2001). Etzel et al., (2004) provide some simple and dominant channels of distribution from single to multiple levels, while Kotler and Keller (2008, p.490) proposed a hybrid channel of distribution where the producer / manufacturer uses multiple channels. Figure 5 illustrates the different channels of the distribution.

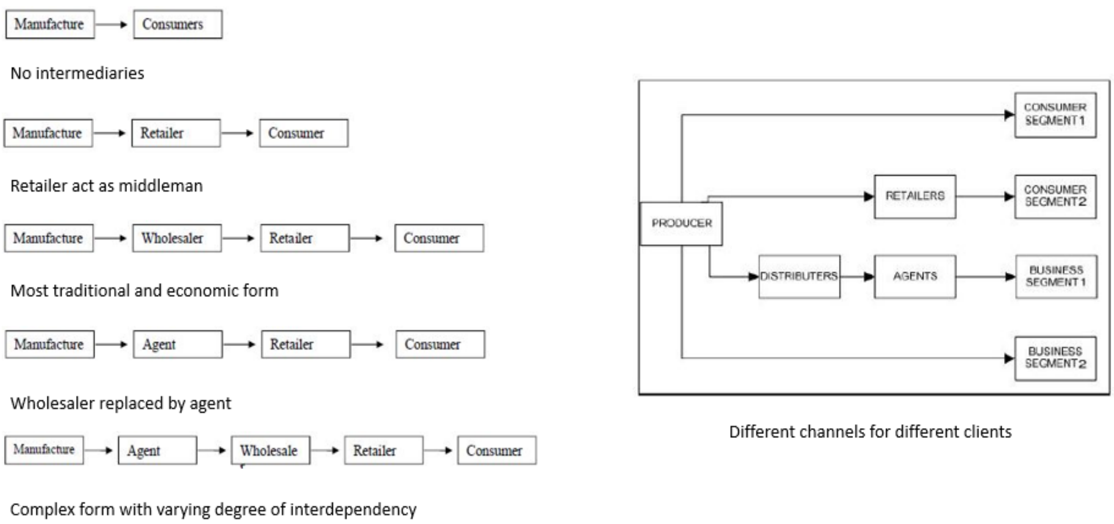

Figure 5. *Simple and multiple distribution channels*

Communication is another main factor in developing and sustaining relationships and more open communication between the parties concerned results in more chance of creating ideas and practices (Blanchard, 2010, p.85). In fact, customers have high expectations that can be fulfilled with great service, and better communications resources are a means of achieving them (Blanchard, 2010, p.134).

2.2 Digital transformation of supply chain

Digital transformation is one of the most significant business developments of our day (GT Nexus, 2016). This transformation has been observed within or between organizations and their clients. An organization's success now depends on the efficiency of running a supply chain partners' network to deliver goods and services that meet its customers' needs. This process generates an impressive amount of data and is critical for supply chain management due to the ability to manage data and information (Rushton et al., 2007).

75 percent of respondents believe that digital supply chain transformation is 'really necessary,' according to a survey conducted by GT Nexus (2016). The digital transformation of all processes and information flows between each partner across the supply chain is necessary in order to achieve a successful digital transition within an enterprise. Waters (2007) encompasses telephone, networking, data collection , data analysis, and information technology (IT) sharing. Enterprise Resource Planning (ERP) is a database that allows data capture from the entire business and plays an important role in enterprise development (Rushton, et al., 2007). Advanced Planning and Scheduling (APS) is a tool that uses real time information to support supply chain decision-making and operational planning (Rushton, et al., 2007). APS along with other information systems, such as Warehouse Management System (WMS), Transport Management System (TMS), etc., are process-oriented and can be built into the ERP system (Rushton, et al., 2007).

Harrison et al. (2008) notes that they could be inconsistent with each other given the common use of the above mentioned inter-organizational structures, thus having high implementation and deployment costs. Internet-based platforms provide platform-independent messaging and can be used as a business-to - business gateway to promote access to new customers and emerging business opportunities such as e-commerce and e-business. The key technologies currently revolutionizing the digitisation cycle are listed briefly below:

- Sensors and IoT: Data is automatically and in real time collected and documented via sensors, installed in virtually all commodity components and manufacturing equipment. The sensors are connected to the central systems via secure wireless networks, providing online data which is stored with historical data in a single information system (Villalmanzo, 2018).
- Autonomous guided vehicle: This technology is still under development, but the need for human drivers is reduced. Autonomous vehicles will be mainly used in logistics by driverless trucks, where they will rely on short-range mapping and radar software to assess the vehicle environment. They can also use cellular links to other cars and on the road to collect information to speed up the flow of traffic and minimize pollution and road injuries (Villalmanzo, 2018).
- Cloud computing: Cloud computing is a distributed network that offers a central commander hub linking end -to- end applications with DSN partners. As such, this cloud-based platform enables collaboration and offers various personalized delivery and network experiences (McKinsey & Company, 2015).
- Big data: Big data refers to databases whose size exceeds the capability to capture, store, manage , and analyze traditional data set software tools. Multiple data sources, including historical and real-time data, are identified, combined and managed by big data engines (Villalmanzo 2018). First, they define and link the most relevant data, then synchronize and combine the fragmented data before executing a cleanup operation and then bypass the missing information. The findings are also used for data analytics, analyzing Big Data to make rational decisions and to collect interest (Manyika, et al., 2011).
- Blockchain: The blockchain is an encrypted, open data record in which businesses can search physical assets and document all their transactions. It also provides common access to the same information for all approved parties, reducing the risk of contact or transmission of data errors. As a consequence, testing of the results takes less time, so these services can be dedicated to quality improvement , cost savings or both (Deloitte, 2018).

2.2.1 Track and trace solutions

Kunnari (2018) has carried out extensive research in the analysis of the various available track and trace solutions and states that the use of these solutions has increased significantly in recent years. Some of the main reasons for this are the evolution of new technologies, falling prices and the wider global scope. To this end, the the battery life in the smaller devices has made track and trace program implementation more common than ever (Schrauf and Berttram 2016; Kunnari 2018). Techniques such as real-time data management, which facilitates information, are now on dispense. Due to the removal of barriers that allow the sharing and synchronization of valuable information across the supply chain network, the motivation has increased in the supply chain context (Kunnari, 2018). The track and trace solutions available help companies share information to counteract the supply chain management bullwhip effect (Kouvelis et al . 2006; Kunnari, 2018). Lee et al., (1997) describes bullwhip effect as the deviation in orders that may be greater than that of sales, and the variation usually increases as one moves upstream in the supply chain. The following sections discuss the different techniques and systems used in supply chain administration.

- RFID: Radio Frequency Identification (RFID) was invented in 1948 but it took a long time for the system to be inexpensive and accurate enough to be used on a wide scale (Kunnari, 2018). In nature, RFID is wireless, and can be seen as the simplest concept that uses bar coding. A standard RFID network consists of three components: an RFID tracker that serves as a tag, a tag processor with an antenna and transceiver and, last but not least, a host machine that interfaces to the business system. The tag 's function is to gather and transmit data in real time via radio waves. The specific inventory or shipping information is contained in the sticker, which the reader then identifies and records (Kunnari, 2018). Angeles (2005) further adds that RFID has been used to track products and assets through the supply chain by transport in retail business. The reader portals are installed at main areas of the chain, such as retailer loading ports, consolidators, freight forwarders and delivery centres. The monitoring systems are periodically updated as objects that have tags move through the readers (Kunnari, 2018).
- RFID and GPS: Although RFID has many advantages when implemented inside warehouses for inventory and material handling purposes, tracking is often lost once it leaves the warehouse until the next identification is made. The GPS technology had its function here to track primarily freight and drug vehicles. (He et al. 2009, pp. 2-3; 2018). When used together, the use of RFID and GPS technology offers greater advantages as it assists in inbound and outbound logistics preparation and eventual alignment to resource planning systems. The benefits include flawless visibility, improved reliability, better decision-making of inbound and outbound loading and unloading activities, dynamic routing of goods, improved transport capacity and the automatic exception of reporting on shipment decision support (Kunnari, 2018). When these techniques are

integrated, a full precision for the supply chain monitoring is obtained (Wang et al . 2008, pp. 295-296, Kunnari 2018).

- GPS and GSM: The key explanation for using GPS and GSM technology for monitoring and tracing purposes is cost savings and reliability. Today, all smartphones integrate these technology and this is used to help track cars. GPS and GSM are used in car monitoring due to the variety of ways in which these systems can be employed, along with ease of use. (Lee et al. 2014, p. 353; 2018). Knowing the vehicle's location is one of the greatest problems in track and trace programs and this device aims to have the vehicle's location at any point in time and wherever on Earth. Price, accessibility and precision contribute to GPS use as opposed to other technologies. Lee (2014) says that the most common application is GSM and SMS technologies as wireless data transfer, like the use of SMS, and accessing the vehicle location data (Kunnari 2018).
- Fleet management system: Fleet management system (FMS) is a requirement for tracking vehicles. This system manages an enterprise 's entire transportation fleet. The fleet management system aims to improve the industry's efficiency and quality by providing information about the major road obstructions and tracking their fleet's real-time locations on a map. (Kunnari, 2018). The rising global oil prices are one of the major reasons for the rise in the implementation of Fleet management systems. This makes transport and logistics more effective, improving vehicle routes which leads to cost savings, risk minimization and increased fleet efficiency. Thong et al. (2007) argues that smart resource allocation is the key element in creating effective management of the fleet. In addition to improving the system, the Fleet Management System also improves myopic issues such as fuel economy, utilization level and maintenance costs for transports (Mohan et al. 2009). Fleet management system is a web-based platform that can make many vehicle- and driver-related decisions and provides metrics for companies to optimize their vehicle and driver distribution. Some of the metrics cover vehicle mileage, fuel consumption, maintenance problems and driver performance (Kunnari, 2018).
- Internet of Things: Macaulay et al. (2015) note that IoT is taking the track and trace system to the next-generation as it makes the operation quicker, more efficient, more safe and more accurate. The system enables logistics companies to have direct knowledge of product flow across their whole life cycle (Kunnari, 2018). The program would therefore ensure that the items arrive unharmed and are shipped in time and to the right place. IoT also stresses the level of protection and accessibility in transport (Macaulay et al. 2015; Kunnari, 2018) With the

> combination of sensors and networking technologies, a product's evolving and transportation status can be quickly monitored over the internet. The future is moving towards a phase in which almost every electronic device around us is connected to the internet, thereby creating cooperation, connection and communication with individuals. He et al. (2014) continues that IoT is supposed to provide an enabling approach for improving the entire transportation and automotive infrastructure networks.

Simultaneously, taking care of data protection is a vital part for security concerns, as it shows that only authorized individuals can view and edit the data (Kunnari, 2018). Wireless networking plays an significant role in mitigating threats related to computer protection. Kunnari (2018) further adds that sharing data using cellular networks increases the risk of data misuse, since access to data becomes simpler for outsiders. But protection is a clear and important issue to tackle for IoT to prevail (He et al. 2014). Internet of Things software is considered a long-term track & trace approach, as it utilizes much of the same technology and hardware (Kunnari, 2018).

2.2.2 Conclusion of the solutions

The solutions discussed in the previous section can offer possible solutions for the organizations to implement a track and trace system. However, the decision to incorporate what type of technology depends on the need and policy of the enterprise. Usage of RFID systems will be a workaround in situations where the commodity or consignment need not be monitored in real-time. Yet, based on IoT 's claims, its deployment will provide organisations with long-term solutions. IoT has shown success and will revolutionize the whole supply chain operation. Therefore, it is important that companies analyze all emerging innovations in depth. The innovations mentioned have their benefits and drawbacks that are listed in Table 1.

Table 1. *Advantages and disadvantages of Track and Trace solutions (Kunnari, 2018)*

Solution	Advantages	Disadvantages	Sources
RFID	Cheap, popular and well investigated	Not a sole real time solution provider, old technology	Keen & Mackin-tosh 2001; Lehto et al. 2009; Sun 2012.
RFID and GPS	Provides real time tracking solution	Requirement of a communication technology to transfer data	Wang et al. 2008; He et al. 2009; Deshmukh et al. 2016.
GPS and GSM	Real time tracking solution, uses smartphones and customized apps to meet companies' needs, easy implementation	High deployment cost unless existing devices are at disposal	Thong et al. 2007; Chadil et al. 2008; Lee et al. 2014.
Fleet Management System	Custom-tailored technologies can be integrated into IT systems of companies, provide real-time solution	Expensive, convenient if the transport vehicles are company owned, integrating carriers is difficult	Mohan et al. 2009; Aljaafreh et al. 2011.
Internet of things	Long-term investment with huge potential, benefits yet to be explored, uses existing technologies, provides real time solutions	Expensive, requires changes in systems, lot of work	Coetzee & Eksteen 2011; Speed & Shingleton 2012; Palmquist & Leal 2016.

2.3 Blockchain Technology

Blockchain could be described in simple words as a way to store transaction information between multiple parties but in a trustable manner. Blockchain's origin can be traced to Bitcoin, which is a digital currency built on the works of previous innovations in finance, computing, networking and security. Our existing monetary systems consist of actual money such as bills and coins that are government-controlled and circulated. The Bitcoin, on the other hand, is a digital asset. Bitcoin's advent can be traced back to Satoshi 's paper "Bitcoin: A Peer - to - Peer Electronic Pay System," which laid the foundation for the first cryptocurrency. The currency code was shared a year later on the internet, which is known as blockchain technology (Cellabz, 2015).

The benefits of Bitcoin extended to the economic, humanitarian, and legal system, thereby making it clear that blockchain technology is disruptive in nature and has the potential to reconfigure the operations as well as the aspercts of society. The definition of blockchain is connected to Bitcoin. Blockchain is the public ledger which contains all executed Bitcoin transactions. The chain is growing as miners add new blocks to record transactions from recent times. Blocks keep applying sequential and chronological order to the blockchain. Every complete node, which is basically any Bitcoin-connected computer, has a copy of the blockchain. Full information about the balances and addresses will be stored in the blockchain. The blockchain's trustless proof mechanism is due to the trusted public ledger system that is stored on various decentralized nodes worldwide and maintained by miners (Swan, 2015).

Bashir (2017) also argues that the basic unit of a blockchain is a transaction, reflecting a value transfer from one address to another. Each transmitter and recipient has a unique identificator known as address for each transaction that is reusable or newly generated (Villalmanzo, 2018). By using mining operation, a list of transactions is documented in a block, which generates a ledger over a certain duration. Each blockchain has different sizes, times, and triggers for blocks (Laurence, 2017).

In other words, Bashir (2017) defines blockchain as a distributed ledger mechanism that may be interpreted like an authentication framework for the digital transactions and a place where data on transactions between network users can be stored. Table 2 describes the different levels of access; namely ’private’, ’public’ and ’consortium’; and Figure 6 shows distribution architectures such as ’centralized’, ’decentralized’ or ’distributed’.

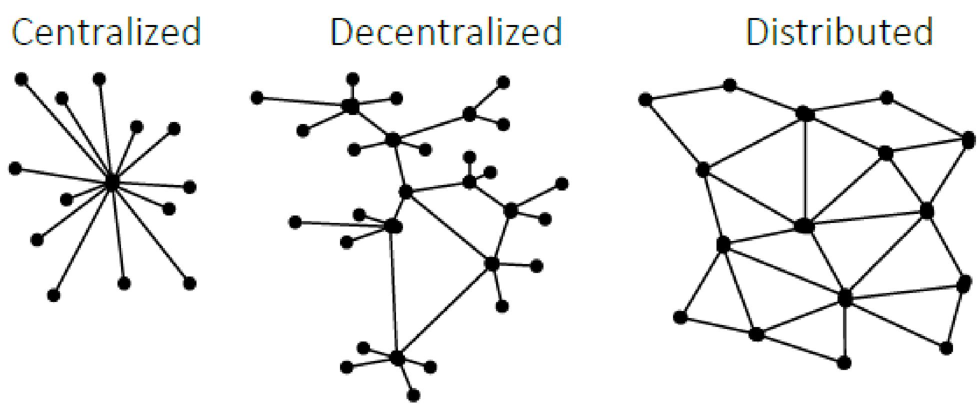

Figure 6. *Different network structures*

A blockchain network member is commonly called a node. This block contains the hatches from the previous block, thereby linking the blocks and storing data in sequential form, which forms a block chain in the network (Tate and Daniel, 2017). Each block can be defined as encrypted information with all transactions encrypted and referred to as hacking. Hash is the product of all block content's hash function. The hash function is a data-entering algorithm that can almost be reversed (Abeyratne & Monfared 2016; Villalmanzo, 2018). A consensus protocol is used to perform the hash function, which can be defined as a special procedure for confirming blockchain transactions. Transaction confirmation is a major feature of the blockchain because of the hacking risk.

A hypothesis called Byzantine fault theory deals with the risk of attack. The Byzantine theory of fault arose from the Byzantine generals' issue, in which several different forces could collectively destroy the city only if they all met at one particular moment and at the same time decided on the attack. A similar issue can be found in the digital environment where a hacking attachment will fail a node. So if a network of nodes is operating together, then a database can be compromised (Lamport et al . 1982).

This issue can be resolved by adopting different approaches. Table 2 lists in greater detail three consensus protocols: Proof of Job (PoW), Proof of Stake (PoS) and Conduct Byzantine Fault Tolerance (PBFT). Moreover, for the purpose of a transaction, the nodes provide a private key and a public key respectively, which are described in more detail in Table 2 (Kairos Future 2017). Consensus protocols are usually used to encrypt transactions but they take a lot of time and energy and are thus therefore made into instruments to strengthen cooperative processes (Holmberg et al , 2018). A chain of block is shown in Figure 7.

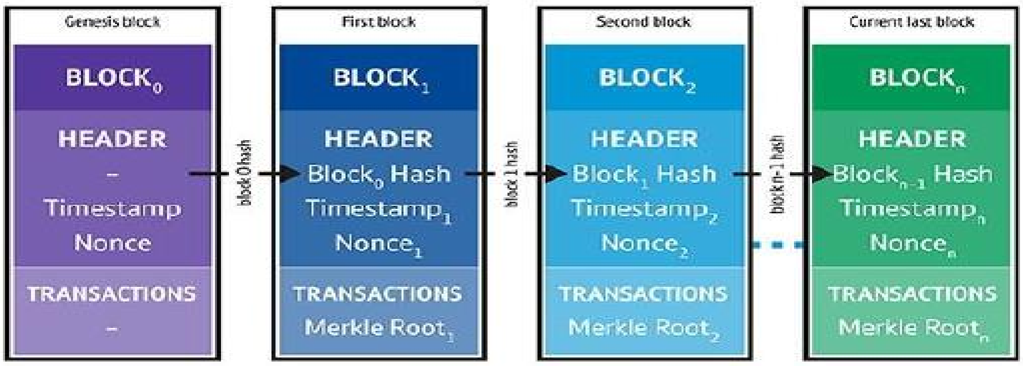

Figure 7. *A chain of blocks (Tate and Daniel, 2017)*

One main feature of blockchain technology is that information is stored in ways which prevent other users from changing, deleting, adding information or blocks without being detected (Villalmanzo, 2018). This ensures the transaction's origin and authenticity and thus increases the overall integrity and trust related to a particular product. One of blockchain's core advantages is that a blockchain network will enforce its own rules on its non-party network (Abeyratne & Monfared 2016).

Blockchain's enthusiasm is focused on features that help to achieve and preserve credibility and integrityin peer-to - peer networks that require intermediation (Drescher, 2017). The benefits envisaged for this system include decentralized trust, cost reduction, accountability and transparency (Bashir 2017). The characteristics of the blockchain technology are considered perfect for solving supply chain management issues, such as lack of trust from SC partners, proof of archiving authentication, inefficient process, etc. (Villalmanzo, 2018).

Table 2. *Terms related to blockchain*

Function	Type	Description
Access	Private	A private blockchain is centralized and controlled by one organisation, while members meet certain requirements and get various authorities assigned.
	Public	It can be accessed by anyone anonymously. Functionality lies in taking part in records and engaging in the consensus process (Lin et al . 2017).
	Consortium	A consortium model is a platform based upon the advantages of the public blockchain, but it has the main feature of the private blockchain with renowned players known as the approved actors (Gramoli 2017). In certain instances it can be called a hybrid type of blockchain.
Keys	Private	A private key is only identified, available and used for network access, nodes and transaction confirmations in the owner 's key node (Kairos Future 2017).
	Public	For other nodes within the network to interact with that specific node (Kairos Future 2017) there is a public key to the certain node.
Distribution architecture	Centralized	This outlines all data to be collected and stored in one single point (Larsson & Korsfeldt n.d; Lin et al. 2017).
	Decentralized	A decentralized network outlines by the data to be spread out globally to several local databases. The ledger content is agreed upon by all member nodes by using a consensus protocol
	Distributed	A distributed network outlines by a number of copies of data that is held by several nodes in the network. In the case of Bitcoin all nodes hold a copy of all transactions.
Consensus protocols	Proof of Work (PoW)	PoW is the consensus protocol used by e.g. the Bitcoin blockchain network. The confirmation process of transaction is made by performing a work-intensive task using information from the existing blockchain, called “mining”. (Investopedia 2018b).

	Proof of Stake	PoS outlines by validators that “mints” or “forges”. The chances of being the one validator to create and validate a block is linear with the amount of coins in their crypto wallet- the more coins in the wallet the higher the chance to validate. (Zheng et al. 2017).
Optimizing	Merkel tree	Merkle Tree is a data structure used to more efficiently and securely encode blockchain data in cryptocurrencies such as Bitcoin. Installed via the hash function of an entire block of transaction data, all transactions in a block are hashed, coupled and the hashed together, and so on, until one hash for each block is called the Root of the Merkle (Investopedia 2018a). Throughout the transactions made in one block, see Figure 4, the Merkle Root is the result of all hashes. Each time a new transaction is accepted, the root of Merkle is updated (Bitcoinwiki 2015). Merkle Trees are helpful since verification for a particular transaction is feasible without the entire blockchain having to download, but only the associated hashes for each of the branches and Merkle Root can be checked (Investopedia 2018a).

2.3.1 Smart contracts

For blockchain, smart contracts mean blockchain transactions which go beyond simple transactions for buying or selling currencies, and which may include broader instructions. A traditional contract is an arrangement between two or more parties for doing something else or not. To fulfill its obligation, each party must trust the other party. Smart contracts show the same type of agreement, but do eliminate the need of the parties to have a single type of trust. This is because smart contracts are defined by code and run (or enforced) by code, without any knowledge or wisdom. Indeed, autonomy, self-sufficiency and decentralization are the three smart contract elements that make them different. Autonomy means that the contract and the initiating agent do not have to connect further after launching and operation. Second, the ability of Smart Contracts to collect resources, namely to collect funds through services or equity and expend on resources necessary, such as processing or storage power, is independent. Third, smart contracts are decentralized because they are not distributed on one centralized server, and are executed on all network nodes (Swan, 2015).

2.3.2 Properties and Benefits of blockchain

Whereas blockchain technology was originally associated with Bitcoin, it can be used in a range of industries like banking to medical care to supply chain management. Blockchain can be applied in virtually any industry in which assets are managed and transactions are made. It can provide a secure chain of custody for digital and physical assets through its functional features that facilitate transactions through trust, consensus, security and smart contracts. These aspects of blockchains are explored in the following sections (Sultan et al., 2018).

- Consensus: In order for a transaction to be received and recorded on the blockchain, all participants must agree to follow the same rules. This is consensus. If a transaction violates one of the rules approved by the network, the transaction will be considered invalid. The consensus allows each participant to trust the network because they know that each transaction will follow the rules they ratified when launching the network.
- Provenance: Participants know where the assets are coming from and how their property has evolved over time. The origin of each asset (whatever it may be, material, intangible, digital) must be traceable. If we have a blockchain designed to follow the route from a sea fish to a restaurant, one must be able to know where it was caught, by whom and when. One also need to know how many middlemen have been involved during the fish trip. Until the moment when the restaurant bought the same fish.
- Immutability: No participant can change the transaction after it is recorded in the ledger. It doesn't matter who you are, you just don't have the power to do that. If an error occurs, a new transaction must be used to reverse the error. At that time, the two transactions will be seen in the ledger. The first transaction, considered an error, will always be seen after being recorded.
- Truth: In a blockchain network, there is only one source of truth which is the ledger for the entire network. To find out who owns what, or study certain transactions, there is only one place to visit.

Blockchain offers several advantages and opportunities and researchers have backed this statement. Until the discovery of the blockchain, the most practical way to achieve transparency and data security was through a centralized supply chain. One concern with a centralized structure is the possibility of an entity being the weak link and become the cause for the sole point of failure (Abeyrate & Monfared, 2016). Supply chain members rely on a single Information Provider to store, transfer, and share all information in a centralized supply chain traceability system. This centralized approach to the system poses problems because it is a monopolistic, asymmetric and non-transparent approach to the system that can lead to confidence, fraud, manipulation and falsification of information between actors in the custody chain (Tian, 2016). However, the introduction of hash functions in a distributed network make the architecture resistant to hacking attacks. For data safely backed up, a blockchain provides the right to retain unchanging inventory records, supplying consumers for accurate knowledge to behave in a more efficient manner (Saberi et al., 2018).

But, if a decentralized network defines the framework with only a few players facilitating the system, then the solution becomes vulnerable to hacker attacks that may target a few members (Kshetri 2018). The technology is still in its infancy, however, and faces problems of scalability in terms of performance, latency and efficiency (Lu & Xu, 2017, Tian, 2017). The platform allows for multinational partnerships that include compliance with global legislation, rules, and market laws, which makes the application of blockchain a complicated process. Moreover, there will always be a distance between the physical environment and the virtual environment, which will allow the reliability to be deceived by allowing an actor not to perform the actual and physical action as promised in a digital contract (Kshetri 2018, Lin et al 2017).

Smart contracts could be implemented and integrated into the system to provide the blockchain with incentives to control the progress of a business process and streamline and automate supply chain processes further. By reducing the number of individuals involved in running a contract, smart contracts will decrease costs and improve insurances (Abeyratne & Monfared, 2016). All parties must come to an agreement for the blockchain to work effectively, which can be a challenging task to handle. Not only do supply chain participants decide on a shared approach, but also retailer suppliers are also based in developed countries, which is a step closer to entry into the blockchain (Kshetri 2018).

This technology achieves high levels of supply chain immutability, integrity of the processes and transparency. Even, when attached to IoT devices, it is able to provide high support for efficient operation of a traceability system. To the degree that the system provides greater connectivity from one business to another by allowing a high level of knowledge exchange, it enables companies to achieve a deeper understanding of the value chain of which they are part, thereby enhancing marketing, distribution , logistics and product quality practices (Abeyratne & Monfared, 2016; Kshetri, 2018; Khan & Salah, 2018; Tian, 2017). Such practices allow for better resource-saving prognoses, thus maintaining social responsibility and thereby saving resources on systems and promoting more environmental action (Saberi et al. 2018).

This would also save expenses by saving time, as blockchain technology increases performance, for example, by being able to remove paper records and replacing them with real-time data (Abeyratne & Monfared, 2016). As with the blockchain deployed in a distributed network, this can eliminate third-party participation, such as banking financial services or validation services (Korpela et al., 2017). At the other hand, the use of blockchain can require third parties to carry out data checks, such as governments and certification bodies, and thereby control their certifications (Tian, 2017). While the data must be obtained by IoT devices and connected to the blockchain, no external infrastructure, such as hardware tools, is needed by the blockchain itself to archive and preserve the data (Saberi 2018). Even in complex foods, the Blockchain can store unit-level data which tracks the origin of each ingredient (O'Marah, 2017). Additionally, blockchain technology requires some IT infrastructure in the supply chain, such as Internet access, which may currently be impractical for some remote suppliers of commodities. Manual or automatic processes, such as clear tags or RFIDs, will keep digital identities up-to - date (Abeyratne & Monfared, 2016).

By providing dignified and authorized registration and ownership, as well as proper monitoring and reporting, blockchain should have the opportunity to resolve some of the proprietary and identity-related issues of IoT devices used in the industrial sector, goods and services industry and innventory tracking. (Khan & Salah, 2018). Blockchain technology also has benefits for customers because they can obtain precise and reliable commodity data (Abeyratne & Monfared, 2016).

3. RESEARCH METHODOLOGY

The main objective of doing research is to establish new knowledge or enhance existing knowledge using systematic methodology. Here, “systematic” refers to doing research based on logical relationships rather than belief (Saunders, et al., 2009).

By focusing on business and management research, new knowledge can be gained that can not be obtained separately for these disciplines through the use of expertise from a variety of disciplines. Furthermore, research into business and management must not only provide results that promote knowledge and understanding, but also address business and practical issues. Research may be used as a management model, with an emphasis on transitioning from concepts to action (Saunders et al. 2009).

In general, research methodology describes the process of how any research is undertaken. Research methodology not only elaborates the methods used for conducting the research, but also explains the logic used in every research approach or technique (Saunders, et al., 2009). Moreover, research methodology enables us to understand as to why researchers select certain tools over others, and also provides the means to compare the research results of one researcher over others (Ponomarjovs, 2013).

Here, the different methods and approaches for conducting business and managerial research are examined. The research purpose and context, not only provide the basis for analyzing the existing research designs, but also provide the tools to establish reliability and validity in the study. In the end, this leads us to the actual research strategy that is selected for this study, which entails the methodology, philosophy and data collection methods used (Ponomarjovs, 2013).

3.1 Research purpose and importance

By focusing on business and management research, new knowledge can be gained that can not be obtained separately for these disciplines through the use of expertise from a variety of disciplines. Furthermore, research into business and management must not only provide results that promote knowledge and understanding, but also address business and practical issues. Research may be used as a management model, with an emphasis on transitioning from concepts to action.

The purpose and context of a research project can be very different in the business and management related research. In order for researchers to generally establish new theories or to test current theories, research has to be conducted within the limits of the development of science, to solve market and management problems (Saunders et al . 2009, Ponomarjovs 2013).

This thesis seeks to some extent to resolve current management problems by building and testing a new theory. The aim of this thesis is to develop a framework to use blockchain technology to overcome or mitigate the outbound logistical problems. A case study is first analyzed in order to understand the current state and use of outbound logistical track and track technology.

The significance of the research target lies in the fact that an applicable analysis recognizes how this technology can also be used to address today's outbound logistics problems and the entire supply chain. Limited information on this matter includes the need for studies aimed at producing realistic outcomes for corporate administrators and making track and trace technologies feasible. The findings of this study aim to provide insight on potential applications of this technology in outgoing logistics and how this can be a way to enhance inventory management and monitoring between the storage facilities and the end-users.

3.2 Research philosophy and approach

Each layer of the research onion is defined, according to Saunders et al . (2009), by a broader investigation process , which results in an effective progression in the methodology to be developed for the research process (Figure 8).

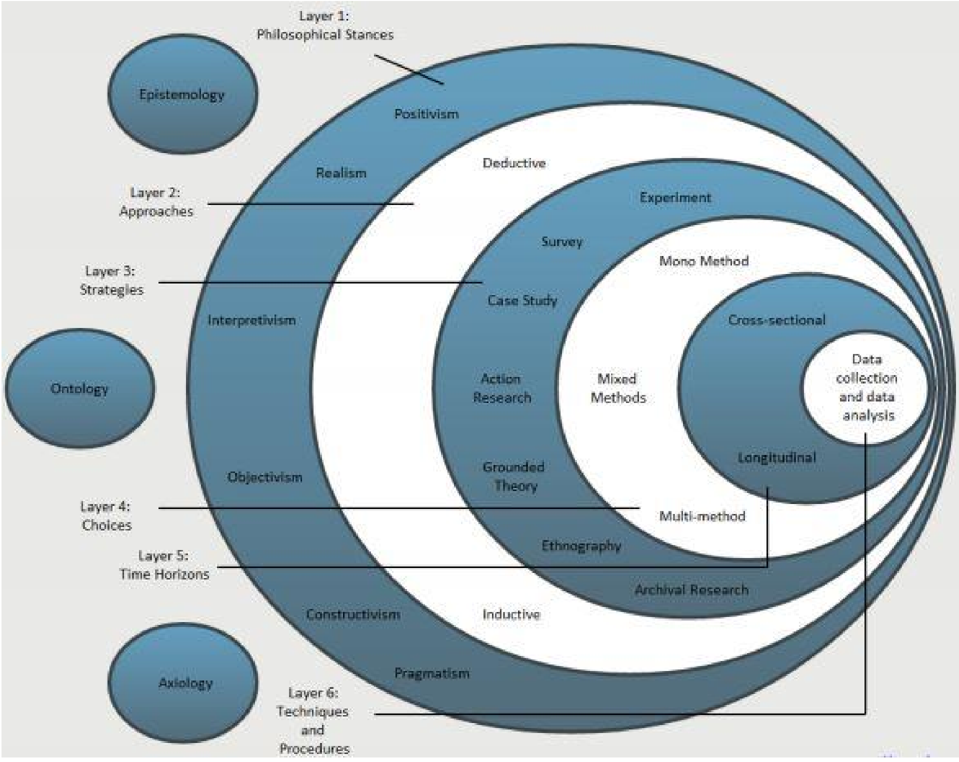

Figure 8. *The research onion (Onion Derby, 2019)*

The outermost layer is the philosophy of research which includes the assumptions used by the scientist in viewing the world. This is the basis for choosing research strategies and research methods (Saunders , et al. 2009).

In addition , the research methodology affects reasoning, data usage, generality and theory analysis. Deductive and inductive methodologies are the major approaches to market research analysis. The first approach includes the development of a theory and hypothesis and the development of research designs to test the developed hypothesis.The latter relates to data collection and analysis and then to data analytical theory development (Saunders et al., 2009).

3.3 Research design

The design of research is about how research questions can be answered. It is essential that research strategies, choices and time horizons be developed during the research design process (Saunders , et al., 2009).

The research questions and priorities, the extent of established expertise, needed time and other available resources will guide the selection of a special research strategy. The following are briefly introduced the main research strategies widely used in research on business and management.

- Experiment: An experiment is structured to investigate causal connections. In other words, when an independent variable is changed, a different dependent variable is changed. In more complex experiments we take into account the magnitude of changes and the relative value of two or more independent variables (Saunders et al., 2009).
- Survey: Surveys are structured questionnaires that make for an simple comparison. In the surveys, who, what, where, how many questions and how many are answered. In addition , it allows vast volumes of data to be obtained in a very economical way from a limited population (Saunders et al. 2009).
- Case Study: The case study is the empirical analysis of a current trend in its actual context, according to Saunders et al . (2009), using many evidence-based sources.
- Action Research: Action and learning from experience is the best way to enhance comprehension by undertaking action research.That is why an action is taken to consider situations by modifying them and learning and reflecting on the effects of the action before taking a new action again (Fisher, et al., 2004).

It should be calculated by combination or selection of qualitative / quantitative techniques and data collection procedures and further data analysis, as soon as the research strategy has been established. Every data collection analysis approach has its own data analytical process (Saunders , et al., 2009).

- Questionnaires
- Panels, with focus groups included
- Comments, including observation of the participant
- Existing Documentation
- Databases

Finally , research design considers the time horizon of the study that does not depend on research strategy or methodology choices. Cross-sectional research is being used at all times for research based on the study of specific phenomena. The longitudinal research is called Saunders, etc., if the study is focused on a trend which persists over a period of time.

3.4 Chosen research strategy

The objective of this study is to select the most effective research strategy. After review of various research methods and methodologies and taking into account the validity and reliability, the research strategy for this master thesis is selected and presented in Figure 9.

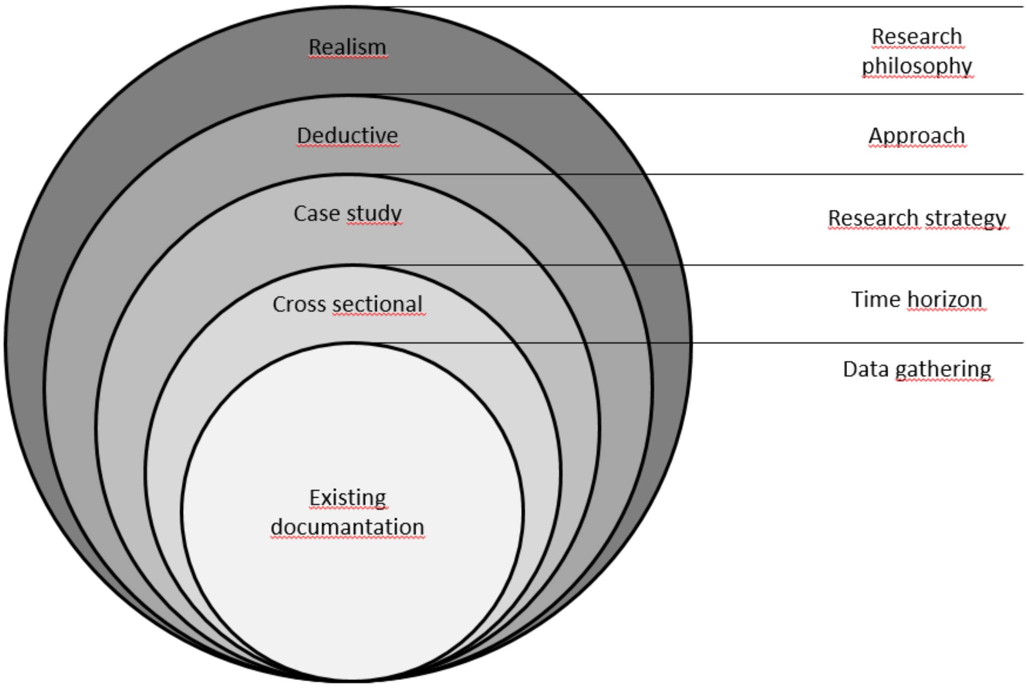

Figure 9: *Research design*

A deductive research approach will be used to answer precisely the research question. Deductive analysis is the simplest to address the research question as the key concept is to explain blockchain technology in the monitoring/tracking and tracing of outbound logistics solutions by establishing a system. Thus, a theoretical framework will be developed to determine this reality, provided the hypothesis of this research is deductive. This approach will be based on a literature review concentrating on the issues relating to how the supply chain management and the foundations of blockchain technology can be digitized.

Through evaluating the case studies using an explanatory approach, the deductive argument can be further explained. This approach has been chosen to establish the basis for research using proven case studies to demonstrate current research status (Saunders , et al., 2009). The lack of information on this subject further influenced the decision to discuss a variety of pilot projects briefly.

The starting point of the study begins with various readings on the topic of digitalization in supply chain management, tracking and tracing technologies used, blockchain and its proposed applications in the fields of finance, supply chains, and others. This led to research on certain cases of pilot project in the track and trace solutions for products in a supply chain network. Then, the proposed research questions mention in chapter 1 were formulated. Based on these questions a literature review was carried out on topics essential for building a framework. Then a case study was chosen and analyzed to understand its potential applicability in the proposed framework. The case was carefully selected and the scope of the framework was limited to tracking and tracing in outbound logistics.

The research tries to present an alternative method for the implementation of a track and trace solution, using a blockchain system, after analyzing the event. Instead the study analyzes the used cases of blockchain deployment and addresses the issues of blockchain technology implementation in supply chain management. The research strategy adopted in the study is shown in Figure 10.

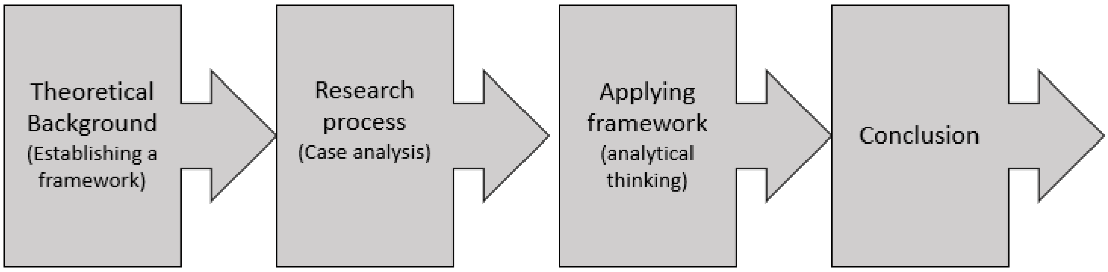

Figure 10. *Thesis analysis*

All focus was placed on validity and reliability in science when designing the research. For each case study, a variety of sources of knowledge are used to ensure internal validity. On the other hand, external validity is maintained as other organisations can easily implement the findings of the analysis. This analysis is also reliable as most sources of information come from the companies studied.

4. CASE ANALYSIS

This chapter aims to present the setup for an outbound logistics tracking of a product. The configuration includes the physical and information flow, as well as devices and software setup used by the members. The case study is carried out by Shamsuzzoha et al . (2015) where the recording and monitoring of a commodity by a Finnish corporation is carried out as a pilot experiment. The goal of the pilot project was to use existing multi-channel supply network technologies.

4.1 Physical flow in outbound logistics

The scope of the case study starts when the product is ready for shipment at the end of the producer. It began its journey from Vaasa by truck to the port of Mäntyluoto in Finland, for storage, then by truck to the port of Turku in Finland and then by boat to Singapore. The physical movement of the supply chain is shown in Figure 11.

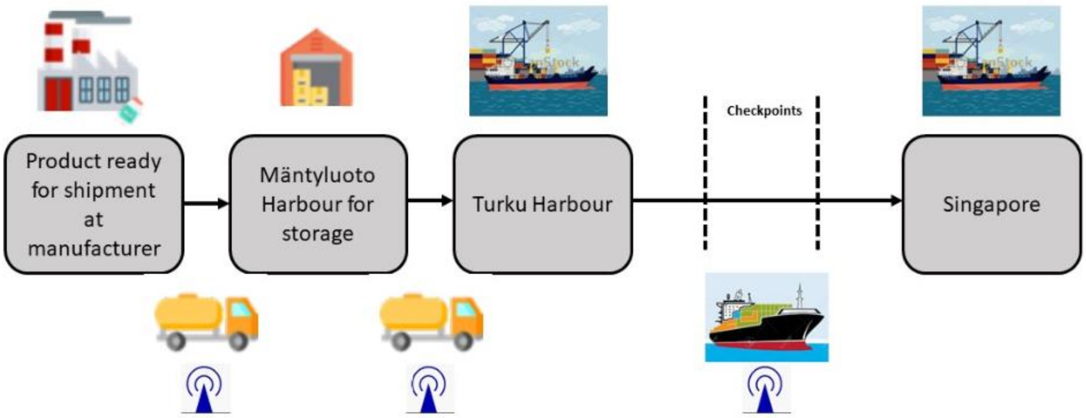

Figure 11. *The case supply chain*

Different trackers available in the market were analyzed and the following three were selected and used;

- TINO: These are the extended-battery trackers used to transmit positioning and tracking data. The lifetime exceeds more than a month which makes it a viable option for international tracking. In addition to its positioning functions, TINO trackers send conditional data, considered as important criteria for product quality and customer satisfaction (humidity, temperature, dew point temperature, vibration etc.), for the products on the shipment.

- GPS trackers: These are navigation devices which are normally carried by a moving vehicle. It uses the Global Positioning System (GPS) to track and locate the device's position.
- AIS system: This system provides the tracking data of a ship when in the sea. The receiving range of AIS antenna is 70 kilometers and it does not transmit when data sharing stations are too far.

4.2 Information flow in outbound logistics

The case company has an ERP (SAP) setup for managing their information flow in their everyday business and uses emails for communication with transport companies. When the product is ready for shipment at the manufacturer's end, the information is updated in the ERP. The logistics team gets confirmed and contacts the transporter for carrying out the shipment from the company's warehouse. The subsequent tracking information is collected by the transport company and available for display.

Upon implementation of the pilot project, an online platform was created, which displayed the overall information related to the tracking of the product. The portal was customized to include various tabs like customers, purchase orders, projects, shipments, handling unit, etc., which are essential to enable the tracking process. Information received at each point of the journey of the product was readily accessible to the related stakeholders. The process is shown in Figure 12.

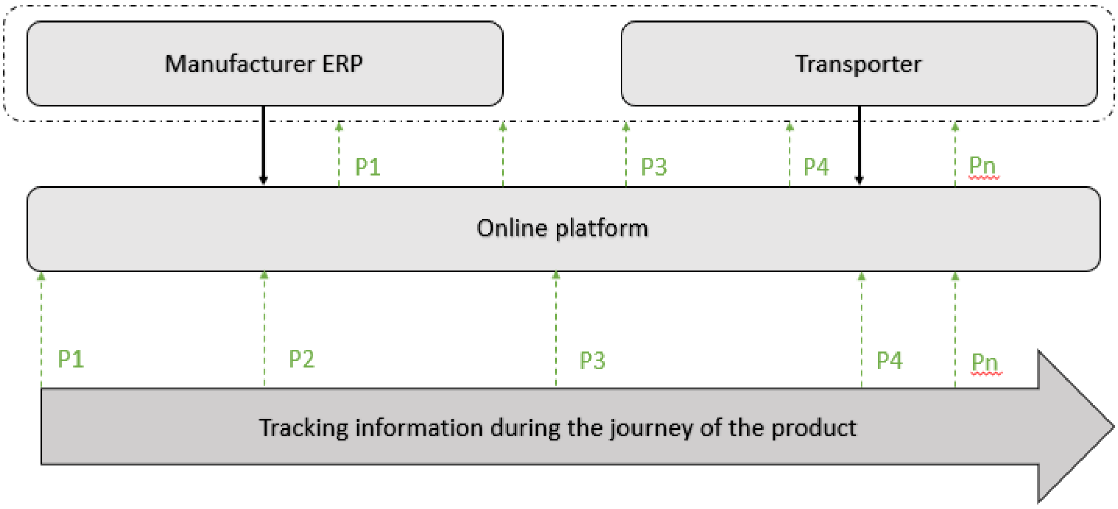

Figure 12. *Information flow after implementation of pilot project*

Data (P1, P2,…Pn), which in this case is primarily location and time details, is generated and uploaded onto the online platform. The information on the online portal is accessible to the concerned actors at the manufacturer's and transporter's end. This enables faster and accurate information sharing with the customer, thereby enabling better customer service.

4.3 Challenges

The available tracking technology was tested on the basis of its functionalities and the principle as well as supply chain and logistics network tracking requirements. In today's difficult logistic climate, the pilot project is an online approach to collect and distribute tracking information. The project also provides a recipe for overcoming the current lack of tracking systems in a short-term multi-company network.

This case study as well as other similar pilot projects in different industries encounter certain challenges when implementing this solution across the entire supply chain network. Complying to regulations, paradigmatic change in shop floor, change in IT structure like interfacing of ERP with other portals, cost of implementation and data security are some of the challenges to the implementation of track and trace solutions in outbound logistics (Bonardi, 2017).

5. PROPOSING A BLOCKCHAIN FRAMEWORK

This chapter is intended to address the research question 3, as it offers an alternate framework by using the blockchain technology. It examines and visualizes the creation of different blocks and the interaction between different layers.

This section provides an alternative view of how a product described in the previous chapter is to be tracked and traced. The framework is based on the theory findings. As described in chapter 2.3 and in Table 2, actors (manufacturers, transporters, customers) can register in a network using their own private key and use the public key to identify and authorize. The actors can enter data manually or automatically into the network, the outbound logistics flow in this case, by authorship of their private key on the hardware devices that are connected to the software application and thus provide an interface for new data entry. The blockchain is selected depending on the level of security. While a public blockchain is better than a private one, a collection of a private blockchain is made, which allows you to choose which individuals can have input and can control the chain. Figure 13 shows the proposed framework for blockchain application in outbound logistics.

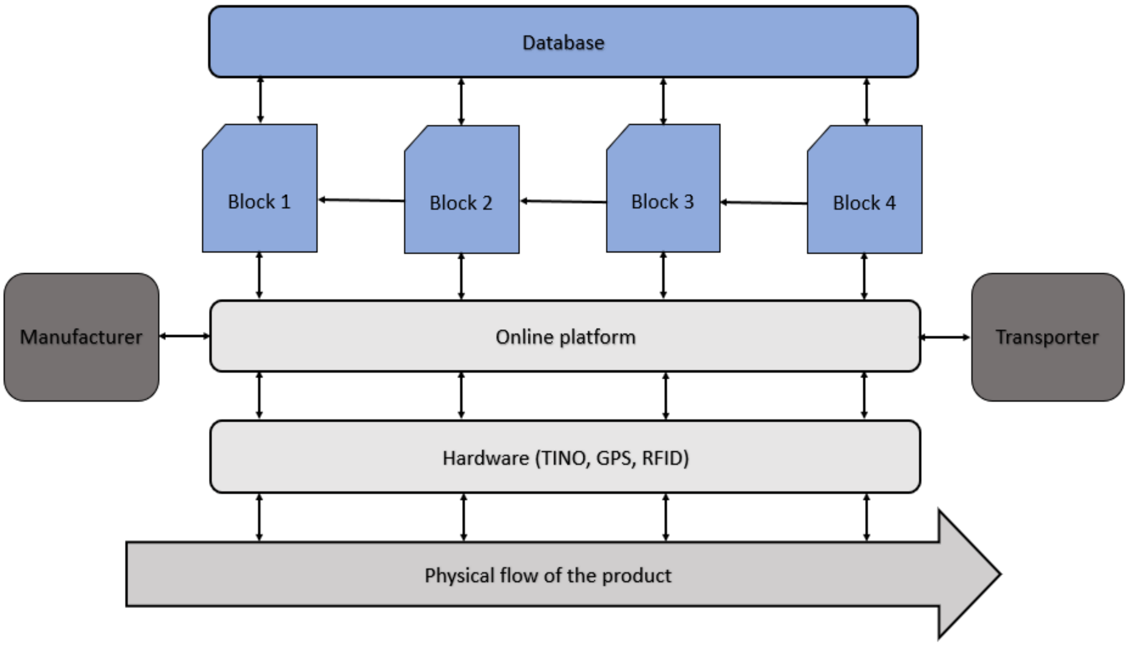

Figure 13. *Proposed framework for blockchain supported traceability system in outbound logistics*

The framework offers a blockchain layer connected to the online platform. In addition to the current blocks, the new blocks gather, bind and handle information on the commodity during the outgoing logistics. A unique digital summary is provided to each product which gets updated throughout its journey. The information related to the product can be visualized by the concerned stakeholders. The reason for considering blockchain for confirmation of such transactions is due to its secure nature and the layer of database included offers secure backups with permissioned access. Figure 14 goes a step forward to includes the entire supply chain.

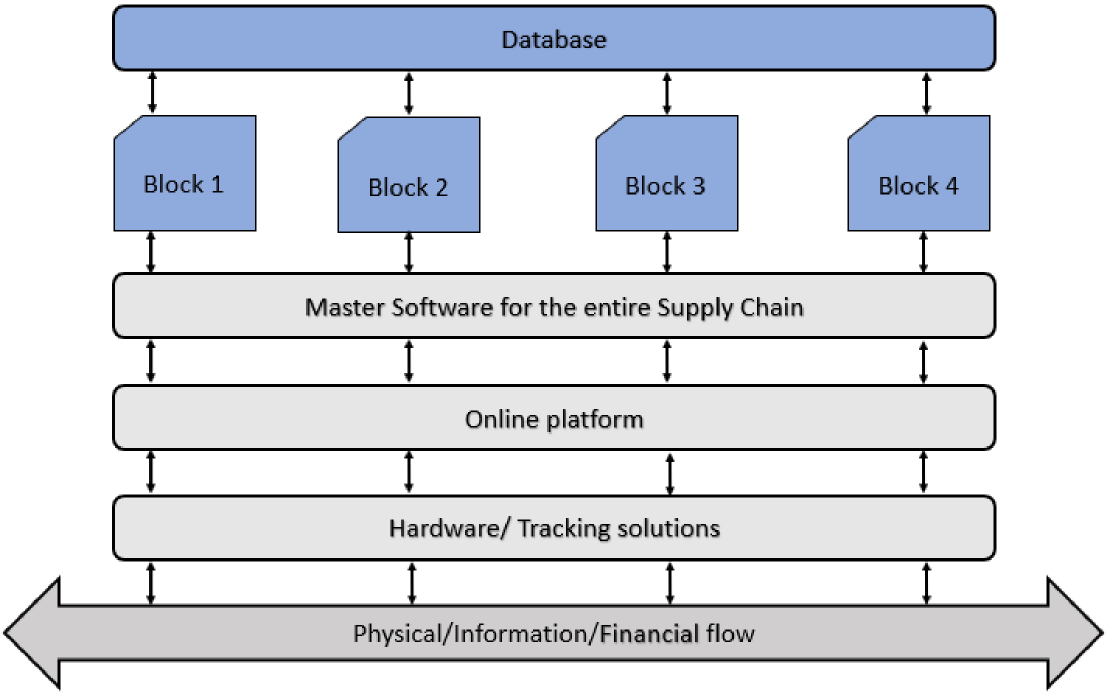

Figure 14. *Modified blockchain framework for entire supply chain*

The pertinence of blockchain is more important in this situation. Specific supply chain stakeholders are included in the Master Program and all supply chain operations can be performed and monitored in a secure manner.

The framework proposed in Figure 13 must be logically sequenced and smart contracts are the means for achieving it. The process flow of an intelligent contract applied to the case study is illustrated in Figure 15.

Each block has a smart contract connected with the specifications which must be met, such as product arrival time stamps or current location, to complete a block and cause the formation of the next block in the chain. Figure 15 also shows the new data and data from previous blocks used to create a new block while constructing a new block.

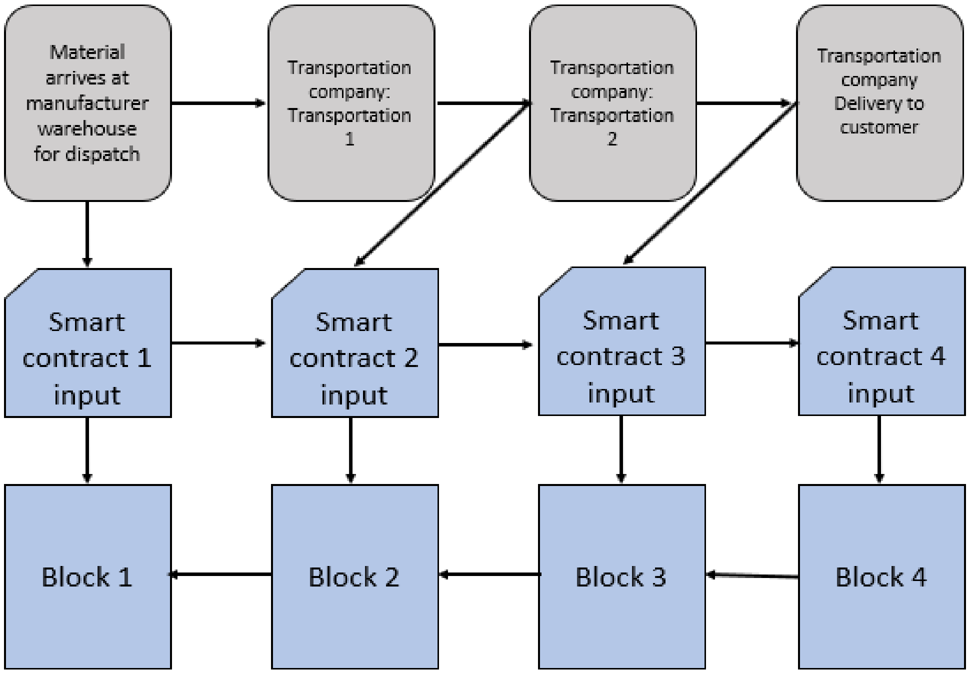

Figure 15. *Proposal for interaction with smart contracts in a blockchain*

As described in the previous section, a smart contract can be a software which has the attribute to automatically trigger a certain function to take place when a predetermined event occurs. For example, in Figure 14, when the transportation company completes the transfer of the product from one point to another, the hardware technology (RFID, TINO, GPS) transmit the information which is updated in the online portal. This fulfills the condition in the smart contract and the information is added to the block, which in turn is added to the blockchain and the information is secured.

6. DISCUSSION

This chapter seeks to address research question 4 and a debate is being conducted using blockchain technologies on the practical aspects of the track and trace approach. It then addresses the possible problems of incorporating blockchain technologies in track and trace solutions.

6.1 Applicability of blockchain in track and trace

The proposed blockchain framework in chapter 5 provides for the possibility of tracking and tracing a product from the warehouse of the manufacturer to the end customer. In order to implement such a framework, investment in both hardware and software is required, and it has been observed that the costs incurred will be significantly low due to the constantly falling price of IoT devices (Mattila, et al . , 2016). Companies also face difficulties in incorporating track and trace approaches given the reduced cost consequences. Some of the reasons point to the inefficient scanning, recording and sharing of data between the stakeholders. Added to that, the lack of standardized processes, the use of various technologies and the information system further makes the process of tracking and tracing more complex. Nevertheless, some global as well as localized firms realized the importance and efficiency of the track and trace solution and started pilot projects using blockchain technology. Table 3 enlists the uses blockchain technology in some successful pilot Track and Trace solution projects.

Table 3. *Used case studies*

Case No.	Case	Description	Status	Sources
1	BASF, Ahrma, Quantoz	Smart pallets tracking system	Pilot project completed	Press release
2	Provenance and COOP	Real-time data to demonstrate and track the fresh product journey	Pilot project completed	Webpage
3	Provenance and Fairfood	Use blockchain technology to track ethical claims and anddigitally prove fair trading practice	Pilot project completed	Webpage
4	Walmart and IBM	Using blockchain technology for collecting information on origin, protection, and food authenticity and to track the entire supply chain in real time	Pilot project completed	Press release Brochure
5	Marine transport international	Container streams system	PoC completed	Press release
6	IBM and AOS	Truch tracking solutions	Prototype	Press release

BASF is the biggest chemical manufacturer in the world and, in 2017, along with the start-up, Ahrma is undertaking pilot studies to test the applicability of the smart pallet of Ahrma (case study 1). The smart pallets use IoT sensors that capture information relevant to the transported goods' location and orientation, and offer additional information on metrics such as temperature variations, load and some kind of impacts on the products. A blockchain network is used to collect information, and approved partners are granted access to pallet movement analysis (BASF, 2017).

Provenance is a blockchain solution provider that partners with companies from different sectors and offers track and trace solutions. Provenance and a co-operative piloted a project in 2017 (case 2) to track fresh produce from producer to supermarket. Data was collected along the entire supply chain and information was stored in the blockchain regarding the supplier, product location and environmental and social impacts, thus providing a real-time product journey (The Provenance Team, 2017).

In addition, Provenance piloted the use of blockchain technology to track ethical claims and the digital poof of fair trade practices in case 3. The pilot study was to show a decent pay for 1000 coconuts to farm workers. The payment and product of 55 farmers was registered in the blockchain, and the proof of payment and the product's journey from Indonesia to Europe was shown on a platform using a certification approach (The Provenance Team, 2017).

In 2016 Walmart began a track and trace pilot in the agri-food industry along with IBM (case 4). Digitally tracked pork products from a single farm into different stores in China. Supply chain members were able to visualize the product 's journey, such as farm details, batch number, factory data and expiry date (IBM, 2016).

Sea Transport International (MTI) finished its Container Streams pilot in 2017 (case 5). This case is similar to the case study analyzed in chapter 4, however a blockchain platform was used to share data on suppliers, shippers, customs, load details and terminal and all supply chain stakeholders were able to access the information (PRNewswire, 2017).

In 2017, IBM along with AOS developed a blockchain and IoT solution for Columbia logistics activities (case 6). Cargo-related transactions were digitized, and sensor-generated information was registered in the blockchain. For tracking purposes information on truck location, goods shipped, movement variables and vehicle load was available. This application helped improve the process of tracking and tracing and provided a better estimate to predict the delivery time for the customers. The IoT further helped capture external information such as weather, temperature , and humidity that shortened the lead delivery time.

6.2 Challenges in implementation

Within this section, the key obstacles faced by businesses when integrating blockchain technologies within their supply chain and more generally in track and trace solutions are highlighted.

- Scalability: The use of the blockchain on the supply chain is not a particular concern, but it is also the main problem for the entire architecture of the blockchain. Scalability is not an problem for the supply chain network, but it is also a major obstacle for the entire blockchain ecosystem. The term "scalability" refers to a system's capacity in terms of both user and transaction capacity to cope and work in an increased or expanding way (Villalmanzo 2018). If it is evaluated for greater operating needs, a device that progresses well will sustain or improve its level of success or productivity (Investopedia, 2018). The disparity between wider use of the blockchain and restricted private use (Bashir, 2017) is therefore of interest to blockchain technology.

The use of blockchain in supply chains was evaluated for realistic applications mentioned in the previous section, while scalability was a problem in actual implementation. The majority are still pilot projects in the PoC or small scale, without addressing large-scale projects. The blockchain should be technologically and socially progressive to achieve widespread implementation. Technology scalability is based on number of nodes, data quantity and transaction numbers, and social scalability is related to user numbers and types (Ge et al . 2017; Villalmanzo, 2018).

Bashir (2017) notes that in recent years the scalability issue has been the focus of considerable conversation and media interest, proposing multiple approaches to the scalability problem of the blockchain. In Case Study 4, IBM's report highlighted the importance of blockchain approval for all SC partners in addressing the issue of social scalability and in developing policy recommendations (Ge, et al . 2017).

At the other hand, technological scalability is difficult to introduce in the face of workload and without sacrifice in decentralization, as blockchain requires to meet the goal rate and latence (Gencer, 2017). Any solutions to the solution refer to using alternative consensus structures and alternative function algorithms because they do not match the number of transactions well (Swan, 2015).

- Privacy concerns: Although blockchain technology offers a seamless and transparent records database, any transaction can be seen in all blockchain nodes (Cagnazzo, 2017). In digital transactions and sharing of data through SC 's collaborators this feature causes several privacy concerns (Villalmanzo, 2018). All transactions are open and transparent by default in public blockchain networks. Therefore, anyone can follow a transaction path, including its interest, and its source and destination addresses (Mougayar, 2016).

  For blockchain applications requiring a higher degree of privacy and secrecy, such as in the financial or health industries, this transaction view is not feasible but is important to the supply chain (Bashir, 2017). Cryptographic technology allow the authentication of transactions without exposing the owner's identity, in order to protect user confidentiality (Mougayar, 2016). Therefore while the transactions can be seen in the blockchain, the off chains are not bound to virtual addresses, so that a pseudo-anonymity property is provided (Mercer, 2016). Although confidentiality is secured, cryptographic keys linked to off-line identities may be stolen or exposed if the confidentiality problem is to be fixed (Villalmanzo, 2018).

- Interoperability: As a solution for the interoperability of data and structures in the new SCs, blockchain technology is evolving. To order to connect, transfer data and knowledge across organizational borders, interoperability requires the ability of knowledge system managers to interact and exchange data and information within and across organizational borders (Gray 2017). In several current SCM applications, interoperability also remains a requirement for internal hardware or in private cloud environments. Failure to interoperate is related to hierarchical procedures, lack of consistency, auditability and control, causes difficulties in covering a whole product's CS and is sometimes unable to capture the first kilometer (Provence 2016).

  It aims to provide a shared database for all members in the SC in which all parties can view, read and archive information without central control (Ge et al, 2017) (Switzerland, 2016). This technical obstacle can be solved with the adoption of blockchain. The data is thus interoperable across the whole SC. On the other hand , it is important to tackle the interoperability between blockchain and legacy SC systems. In order to remove interoperability hurdles, supply chains are essential to the availability of standards which allow connected systems to communicate using the same language, architectures and identifiers (Bashir, 2017).

  Finally, interoperability between blockchain systems must be taken into account in a increasing blockchain environment (Villalmanzo, 2018). The existing restriction on blockchain interoperability contributes to the development of many protocols that can work across various blockchains, as well as a range of organizations' efforts to establish blockchain interoperability standards (Bashir, 2017, Ge et al., 2017).

- Adoption: It is a known truth that the blockchain technology still remains fairly immature and far away from conventional supply chain acceptance (Villalmanzo 2018). Although innovation in small scale projects in real companies is growing to show that supply chain processes have a blockchain viability, however a gap persists between the technology and the investment (Luu, 2018). Early adoption will only be possible if the deployment engines are solid, the technology tools are ready and solutions are found to the problems (Mougayar, 2016).

  The introduction of blockchain technology in the supply chain area of industry leaders could speed up the dissemination process. Moreover, businesses will gain substantial advantage over their slower competitors by the rapid introduction of this technology now, before being commonly adopted (Curtis, 2018; Villalmanzo, 2018). Failure to recognize the possible utility of blockchain technologies or upcoming challenges stops market leaders from implementing big pilot programs in their supply chains, reducing the broader diffusion.

Many questionnaires have been conducted by several organizations, in order to better understand the key challenges and concerns of the industry leaders in incorporating this technology in their operations (Villalmanzo, 2018). A survey was carried out in April 2017 by Chain Company In-Sights to address these questions. This is the first in a series of ongoing studies on blockchain creation and usage in the supply chain area (DeCovny, 2017).

The questionnaire was intended for international supply chain experts, including consultants, travel companies, technology providers and advisors (Villanmanzo 2018). Consequently, the survey indicates that businesses are fairly well-informed about blockchain, with over a third of respondents adopting this platform. SC technical use cases primarily concentrate on SC stock monitoring, knowledge sharing, payment processing and buying, all targeted at increased SC transparency and traceability (DeCovny, 2017; Villanmanzo, 2018).

The key advantages alluded to by the respondents are transparency, reduced processing costs, trust between the SC partners and security. While the blockchain in SCs could theoretically be applied, the blockchain implementation is already met with many obstacles. Budget, inter-operability and lack of requirements, a lack of understanding / consciousness, a lack of value production, lack of industrial support and regulatory concerns were the key obstacles found by the companies surveyed (DeCov-Ny, 2017).

Finally, businesses were asked about the prospects of potential of the blockchain connectivity and the complementary technologies available. As to be predicted, Big Data, Scientific Analytics, IoT and Cloud Computing are the innovations most likely to influence the decision making of the company (Villalmanzo, 2018). The findings of the study underline the competitive value of blockchain technologies in the field of supply chain. The initial process of implementation is still in progress (DeCovny, 2017).

7. CONCLUSIONS

The aim of this chapter is to present the research findings and the contributions to the theory. In accordance with the research goal, the findings of the analysis are discussed and some recommendations for future studies are made.

The study started with the reviewing of the theory in order to find relevance to the research and set grounds for qualitative data collection and further literature review. The research utilizes a case study which was done to navigate the success of track and trace of a product in outbound logistics and understand the technologies used in the process. Additionally, an understanding was developed on the working practicalities of the process along with the correlation between the information flow and physical flow of the product's journey. The literature review on the technologies were iterated with practicality in the case study.

Since blockchain technology has the potential to provide similar solutions with better efficient process, a framework was proposed based on the case study. The reason to carry out research on blockchain technology was largely due to its traits like transparency, security and trust. The proposed framework is neither tested nor investigated in the course of the study. However, the proposed framework is user-friendly and is welcomed to supply chain role players to further investigate.

The research is now able to answer the questions formulated in the beginning. The reader can get to know the current scenario of the digitalized supply chain and especially in outbound logistics. Further, the case study assists the reader to have idea on the various technologies available in the tracking and tracing of a product and understand the practical implementation in real life. Based on this understanding, the concept of blockchain is introduced and the reader is presented with a framework which implements the blockchain technology in outbound logistics tracking and tracing solution. At this juncture, the reader is introduced to some of the pilot test done in tracking and tracing of a product/pallet/container using blockchain technology. The idea behind this to make the reader aware of the development undertaken in this field and validate the usability of the framework.

The study makes an attempt to address the issues raised by Saberi et al., (2018) regarding the development of frameworks to that can make the supply chain management more efficient. The research also projects the application of blockchain technology in supply chain as a value adding entity. However, the greatest constraint is the lack of knowledge and research in this field. The proposed framework in this research is limited to the tracking and tracing of products in outbound logistics only.

With the recent outbreak of Covid19 and its potential connection to wet markets, this paper can provide a basic understanding of the use of blockchain in tracking and tracing of items, especially food items. This outbreak has also changed the buying nature as the dependency on e-commerce has increased. This provides an opportunity for companies to test the track and trace functionality of blockchain in order to gain customer confidence. There is no doubt that the application of blockchain in the supply chain industry has immense potential and the benefits can be shared accross the supply chain network.

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