

# **Blockchain Technology in Logistics and Supply Chain Management**

by

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## **Abstract**

Due to the increasing globalization of the world economy, organizations are now working with foreign companies, making sales and exchanging internationally. The supply chain network is getting more complex and fragmented than ever. Contracts and agreements are more difficult to reach. This leads to a problem that customers question the authenticity and origin of the products they are purchasing. A reliable supply chain network becomes increasingly important. Blockchain, a technology under controversial successful Bitcoin, is believed to be the solution to the lack of supply chain transparency and trust. This thesis is to look into the benefits of Blockchain as well as smart contracts and how it can address the challenges of logistics and supply chain management. A number of previous research papers have been collected, compared and analyzed in order to investigate the advantages of Blockchain. A case study has also been conducted to clarify the positive influence that Blockchain has on logistics and supply chain management. Blockchain has its immaturities and the technology is still in experiment phase so there's a lot to look forward to in the future. There are challenges and risks that it holds. But the benefits that Blockchain provides to logistics and supply chain management are very promising.

**Keywords:** Blockchain, Supply Chain Management, Logistics, Supply Chain Transparency, Smart Contract

## **1. Introduction**

### **Current Problems in Supply Chain and Logistics**

Supply chain was one of the most remarkable revolutions in the business world that could enhance the visibility of goods and products flow from upstream (supplier) to downstream (customer). An effective supply chain management provides competitive business advantages by enabling organizations to track movement of raw materials, controlling manufacturing process, synchronizing supply with demand, and reducing transportation cost. However, in today's production and supply cycles, the old technology and concept can no longer support the more complicated and

fragmented supply chain. It has become so hard to control and manage the whole procedure. There is a need of an emerging technology that can solve the problems of transparency and efficiency to a variety of industries.

End customers want to know where their products have come from and track down the movements of items. Some people were not satisfied with their products and wanted to check on every steps to ensure the company follow the whole process as they claimed. For example, if there is a foodborne disease outbreak, retailers might find it difficult to figure out where the bad ingredients came from or from which process it was contaminated. The industry is hoping that Blockchain could be a solution to solve the transparency and traceability problems by facilitating origin tracking.

In logistics, the complex process with intermediary freight brokers is also an issue. Many intermediaries charge more fees and increase the shipping cost. The problem is that the process is too complicated and unclear to put checks and balances in place. Freight brokers are the ones who control the logistics industry and facilitate transactions of loads from shippers to carriers. This leads to increases in costs for carriers and also the downstream prices that directly affect consumers. Moreover, the paper-based system throughout the supply chain has not been effective since forms have to be approved through many different channels, which leads to numerous cases of loss and fraud. The idea of smart contracts will help parties “agree upon terms and trust that they will be executed automatically, with reduced risk of error or manipulation in the paperwork process” (Deloitte, 2017).

## **Blockchain**

There are many researchers addressing the needs and convincing that Blockchain Technology will be the solution to the problems according to the fact that there is existing need on the development of Supply Chain and Logistics. However, a survey suggested that among 41 primary papers from scientific databases researched on Blockchain, approximately 80% of them are related to Bitcoin platform and less than 20% are focusing on other Blockchain applications such as smart contracts and licensing (Yli-Huumo et al., 2016). Therefore, this thesis will be examining and discussing on the beneficial implementations of Blockchain on other industries beyond financial transactions. The purpose of this study is to discover the effective use of Blockchain technology in logistics and supply chain management and potential changes in transport procedures and documents.

This section is to describe the methods of how information is obtained and interpreted. A sequential method was designed with 2 phases: the first phase is literature review on current research on related topic; the second phase is a business case evaluation.

## **2. Literature Review**

The first phase consists of building the theoretical foundation for the research through a thorough literature review. A literature review summarizes research on a particular topic and how well people know about a subject. It creates an essential knowledge base at the beginning stage of the project. The purpose of a literature review is to gain opinions of experts on the research topic and expand the knowledge or disagree with those opinions. The researcher uses literature review to give credit to those who have come before and highlight their new contribution to the given area.

The main terms used in the search string were “Blockchain in supply chain”, “supply chain transparency”, and “smart contract”. Since the topic of Blockchain in logistics and supply chain management is rather new to many people, the term “Bitcoin” came out with more results. Most of the papers are related to economic topics of cryptocurrency rather than the application and use cases of Blockchain in other industries. Since the goal of this research is to focus on Blockchain technology application in logistics and supply chain management, “Bitcoin” term was cut out. However, related researches on Bitcoin were using as a supporting tool for better understanding of the topic. The scientific databases were chosen for the searches in order to ensure the authenticity of information. Most of the information in the literature review was secondary data derived from reliable papers published in conferences, books, journals and other thesis papers related to the research topic.

After searching for information in the scientific databases, all papers and articles from reliable sources were then going through the stage of screening. As Rowley and Slack (2004) recommended, the sources should be new and relevant to the research subject and they must be written by an authoritative author. At the screening stage, the titles of papers were to be checked first and studies that were not related to the research topic or research questions were excluded. Sometimes, it was difficult to determine the relevancy of a paper only by its title. In these situations, the papers were passed to the second phase in which abstracts were screened thoroughly. It is necessary to check for keywords and concepts to ensure that the information is appropriate to use in this study. These were used to develop a higher level of understanding of the topic and open for new ideas. After reading the whole papers, information needed to address the research questions was collected and analyzed in detail. It is also important to save the gathered sources for reference part. For those researches that were screening out at the first phase, their citations could be useful in finding relevant articles in the literature review. With the approach explained above, Table 1 shows an example of three sources in the literature review.

**Table 1** Example of Sources in the Literature Review of the Research Study

<b>Author(s)</b>	<b>Year</b>	<b>Title</b>
Deloitte	2017	Using Blockchain to drive supply chain innovation
Hua and Notland	2016	Blockchain enabled Trust & Transparency in supply chains
Loop	2016	Blockchain: the next evolution of supply chains

### **Business Case Evaluation**

Blockchain technology is a new, emerging trend in the recent days. Using case study as a methodology will significantly help explain the importance of Blockchain and the reason it is used in businesses. As described by Schramm (1970): The purpose of a case study is to clarify a decision or a set of decisions: why they were taken, how they were implemented, and with what result. In order to understand the research questions, the need to see understand the lack of transparency in supply chain is essential as well as the benefits and potentials in applying Blockchain to supply chain management. To answer how Blockchain will improve the transparency in supply chain, units of analysis should be companies that overcome supply chain current problem by using Blockchain. The food shipment process of Walmart in China was chosen to be evaluated.

The case study was conducted at Walmart for a few reasons. First of all, Walmart is a multinational retail corporation that operates a chain of hypermarkets, discount department stores, and grocery stores (Form 8K – Walmart Inc., 2018). Walmart works with many other partners such as suppliers, regulators around the world. It implies that there are many parties in the middle that create a complex integrated supply chain that Walmart has to deal with. Secondly, the demand for food safety in China is very high since Chinese take their food safety seriously. It is obviously that the customers want to be ensured that the food they are purchasing is original and safe. Thirdly, Walmart has recently announced that it is partnering with IBM, Tsinghua University and JD and trying to create a new method of collecting data about the origin, safety and authenticity of food. Walmart wanted to investigate whether Blockchain could be an alternative to the original paper tracking and manual inspection systems (Craik, 2017).

The steps in this methodology include Data Gathering, Data Interpretation and Analysis.

### Data Gathering

A Google search was performed to find highly reliable sources of newspaper and magazines, articles, reports to collect information and facts. Watching Youtube videos will also be considered to support the creation of background understanding. Walmart Case study method will enable researchers to closely examine the data within a specific context. Most of the case studies related to Walmart adopting Blockchain to its supply chain, whether it is descriptive or explanatory ones, will be collected.

### Data Interpretation and Analysis

The information collected will be reviewed, compared and rated based on the level of credibility and relevance to the research topic and research questions. The qualitative and quantitative data integration is conducted through analytical and logical reasoning ways of examining. Researchers identify important facts and key issues surrounding the case to study the existence of the problem, what could be the effective solution and why.

## **3. Results and Discussion**

This chapter presents the results of the conducted research methods. The information gathered is carefully analyzed so that it can be used to answer the research questions.

RQ1: How does Blockchain enhance the transparency of supply chain management?

RQ2: How do smart contracts improve the logistics performance?

### **Findings from Literature Review**

The majority of the search results were related to Blockchain technology in supply chain and its most use case Bitcoin (cryptocurrency). The information found on Blockchain technology in logistics and supply chain management was quite new and up-to-date because the idea of applying Blockchain in supply chain was recently discovered. However, there is a lack of books, research and academic papers within the subject of Blockchain and logistics. Most of the articles explained the concept of Blockchain technology and how it could transform the whole supply chain picture. There

are still some arguments on the limitations and possibility of the idea which will be discussed in the later part of this chapter.

The definitions of supply chain, Blockchain and smart contract derived from original research papers of the person who came up with the idea, or so called “founder”. “Bitcoin - A Peer-to-Peer Electronic Cash System”, the original work about Blockchain written by Nakamoto, was cited in almost every material and chosen to be a good reference point. The same was done with smart contracts and Nick Szabo, who was the first to think of using Blockchain in digital contracts. The book “Blockchain: Blueprint for the new economy” was also a useful detailed description of Blockchain technology and its application. The information was gathered from many sources to find mutual understanding and definition of Blockchain technology.

All of the chosen material was critically analyzed by looking at the similarities and differences between authors to narrow down the findings and only focus on the scope of study.

The literature review is an important character of the research because it provides readers with understanding of the content before going into details of analyzing data and answering research questions. Therefore, the main purpose of the research is to study on the application of Blockchain in supply chain which can help to enhance transparency and the performance of logistics.

### **Blockchain in Retailer’s Supply Chain: Walmart & IBM**

Customers do not know whether a T-shirt is made from good quality of materials and in a legal manufacturing factory or in any illegal sweatshops. They have no choice without trusting the tag attached on the T-shirt. The vegetables purchased are unsure if they are gardened, took care in a right way and gained Food and Drug Administration approval. The transparency benefit that Blockchain can bring to companies can solve this problem. Typically, the important characteristics of Blockchain technology are immutability and decentralization. It means that the data can be viewed by any parties involved in the supply chain from suppliers to end-consumers; moreover, data cannot be destructive or counterfeit as it is kept in a public ledger. As a world’s leading retailer, Walmart saw such potentials of this technology that it teamed up with IBM to investigate in giving the technology into its supply chain system.

Food safety has always been one of the global top concerns. According to the World Health Organization, about 420,000 people die each year resulted from food poisoning. A decade ago in the United States, a deadly E. coli virus strain in spinach which spread to 26 states, killing three and causing 199 persons infected (Center for Disease Control and Prevention, 2006). The Chinese melamine scandal in 2008, melamine was found in milk for infants. This incident killed six children, causing thousands of others to be hospitalized, and causing hundreds of thousands of others to suffer a decline in health in China (World Health Organization, 2008). The need of transparency in supply chain in the food industry was raised due to unoriginality and bad quality of food supplies. However, the fast moving consumer good (FMCG) industry like Walmart is complicated since there are many stakeholders involved in the production and distribution of the product including farmers, processors, and distributors. There are plenty of steps in the process of making raw materials into final, consumable products. Therefore, the origin can be easily distorted. It takes a lot of time to identify the reason of contamination and the point where food gets contaminated. As a result, the true value of a product and the investigation on negative occurrences due to food contamination, counterfeiting can be difficult to determine. When the spinach case became the red alert at that time, the U.S Food & Drug Administration made all the retailers and food service companies pull

spinach nationwide. It took about 2 weeks until they found out that one supplier, one farm, one lot, one day production that was the reason for the breakdown of the entire spinach industry. Another situation recently is a salmonella outbreak in Mexican papayas which took two months to track down the source of the issue and cancel the production (U.S. Food & Drug Administration, 2017). What if there is an unexpected negative incurrence happened, instead of spending days or weeks to obtain data and isolate food-borne illness, it is now shortened to a few minutes, seconds? The consequences could have been less severe if the retailers were able to track the originality and ingredients of the food to find out the roots of the problem and solve it.

Walmart's Vice President of food Safety, Frank Yiannas said that: "The food is guilty, until it is proved innocent." Customers place pressure and reliance on Walmart's safe products. The reputation of Walmart can be strongly influenced even if the issues started from somewhere out of Walmart's control. That's why Walmart implemented trial of Blockchain to tackle food safety. According to Frank Yiannas, traceability answers the questions of who, where, when; but transparency allows us to know how. For example, traceability includes farm location, lot number, and harvest date, while transparency indicates how food was produced, was it grown organically, were pesticides used? Walmart believes Blockchain can increase the level of these two factors in the retail industry. That's why Walmart collaborate with IBM, JD.com and Tsinghua University to develop and create standards and solutions for food safety in China (Gillio Prisco, 2017). These four partners are teaming up to apply Blockchain and Internet of things sensors to trace 2 pilots: first one is Chinese pork and second one is Mexican mangoes shipped to the United States. The first pilot, Blockchain records where the meat originally comes from, how it is stored and its shelf life. Walmart has successfully traced the port products from a farm owned by Chinese meat producer Jinluo to a Walmart distribution centre in Beijing (Katrina, 2017). For the second pilot, Blockchain platform allows Walmart to record the data of the following (Alec, 2017):

- Farm origin data
- Batch number
- Factory and processing data
- Expiration dates
- Storage temperatures
- Shipping details

This information is recorded and put into the system through each step during the whole process. In the tests, shipments are tagged with numeric identifiers at the beginning of their journey, and signed and logged at each checkpoint. Whenever, wherever the shipments reached a destinations or whatever happened to the shipments, all of the information is recorded to the ledger. Walmart is allowed to track back this information by entering a shipment's six-digit "lot" number in a web portal (Alec, 2017). The mangos process from farm to on the shelf is summarized as below (David, 2017):

- A mango tree takes 5 – 8 years to grow and bear fruits
- Mangoes are grown by small farmers in Central or South America
- Mangoes are shipped to a packing house to get washed and boxed
- Mangoes are shipped to the US by air, sea or land (custom border)
- Mangoes are washed, peeled, sliced and put into containers in a facility center
- Mangoes are shipped to Walmart distribution center for refrigeration
- Mangoes are delivered to store and put on shelves

The result of the process is very encouraging. Before Blockchain, the traditional tracking of one step at a time process took six days, 18 hours, and 26 minutes to trace mangoes back to its

original farm (Sylvain, 2017). By using Blockchain, the information is available to customers in 2.2 seconds (Carlo, 2017). For the future of Blockchain, smartphone applications can aggregate and display information to not only companies but also to end-consumers in a real-time manner (Project Provenance Ltd, 2015). When customers walk into a store, they can just use their phones to scan the barcodes, digits on the products to obtain all information of them.

If there is no intervention of Blockchain, each party in the supply chain will have their own Enterprise Resource Planning System or any internal systems that used to maintain their own records and the single system does not interact with another. When data move across the chain, each party has different visions of what current state is and they use different tools to assess and analyze the data. This creates friction and disagreement in information exchanging between parties. Moreover, each party can change the information, fake it on purpose for internal sakes or unintentionally record the wrong data during the process even in paper documents or computer files. With Blockchain, every party involved (from farmer, manufacturer, and distributors to retailers) is at the same level, they are all provided with the same information and if there is anyone tampering with the system, the other participants will be notified before the change is permitted.

Blockchain application in supply chain analyzed in this case is to demonstrate its benefits to enhance food safety in the society. Imagine how Blockchain can bring positive affects to other industries that have complex supply chain process and high risk of facing counterfeit such as pharmaceutical supply chain or diamond supply chain. For that reason, not only traceability but the ultimate goal of Blockchain is the transparency (Frank, 2017).

### **Smart Contracts – A Revolution for International Trade and Logistics**

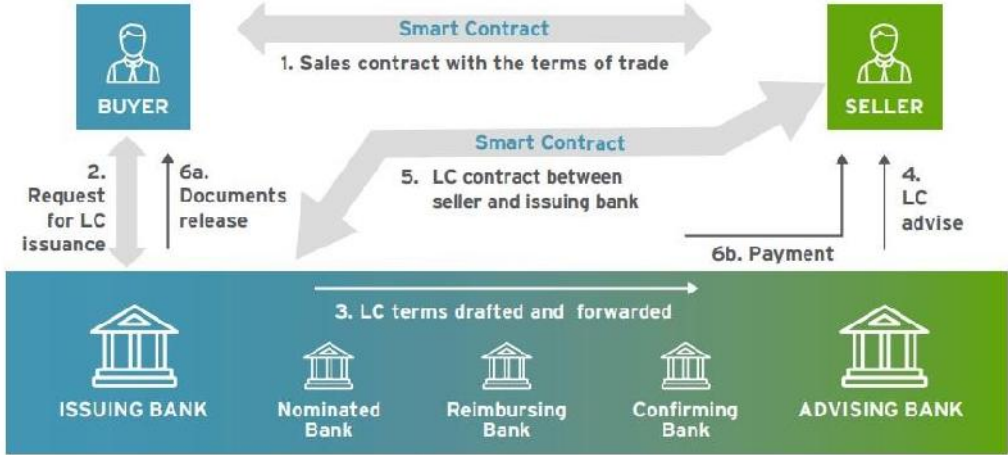
Trade finance by banks and other financial institutions is considered an important function in international commerce since it offers delivery and payment guarantee to buyers and sellers, and it assists them with the trade cycle funding gap (Cognizant, 2017). According to Trade Finance Analytics, the function of trade finance is “to act as a third-party to remove the payment risk and the supply risk, whilst providing the exporter with accelerated receivables and the importer with extended credit”. Trade finance includes activities such as issuing letters of credit, lending, factoring, export credit and financing. Users of trade finance are producers, manufacturers, importers, traders, and exporters. However, there are some pain points of today’s traditional trade financing processes. Trade participants often take higher risks due to reasons such as “manual process inefficiencies, operational and logistical complexities when a large number of entities interact” (Cognizant, 2017). The shipment of goods and payment is sometimes delayed due to multiple checks with the counterparty and verification of funds delivered to the importer. There is a lack of transparency in the movement of goods. Duplicative bills of lading issued by freight forwarders and shipping lines makes the process become more complicated. A bill of lading is a document issued by a carrier (or a shipping agent) works as a receipt of freight service.

Smart contracts can benefit the trade finance by offering payment assurance to sellers through automating payment methods. Cognizant stated in their research paper on “How Blockchain Can Revitalize Trade Finance” in 2017:

“While payment methods like letters of credit (LC) provide an effective way to mitigate business risks through bank facilitation of the trade flow and settlement process, their value can be seriously limited by high costs, contractual delays and process complexities. To reduce the risk of delayed or denied payments, the LC can be modeled as self-executing contracts on Blockchain (see

Figure 1). This would automate compliance verification with contract terms and ensure faster payment to sellers by preventing disputes from arising due to ambiguities in the payment contracts. Automating the payment method on Blockchain also expedites payments through early discovery of discrepancies and increases the efficiency of the amendment process."

The process begins when both the importer and exporter agree on sales of goods and the information is shared with the import bank using smart contract. The import bank can review the agreement and submit draft terms to pay to export bank. The export bank then reviews the provided payment obligation and advises the exporter about the terms. Once approval is made, a smart contract between the exporter and the import bank is generated on the Blockchain to cover terms and conditions. After receiving the obligations, the exporter will digitally sign letter of credit within the smart contract to begin shipment. Upon delivery, importer will digitally acknowledge receipt of goods and trigger payment. Blockchain will automate payment from importer to exporter via a smart contract (Deloitte, 2016).



Source: Cognizant

**Figure 1** Letter of Credit Process Flow

Thailand has also adopted Blockchain technology in the project of Blockchain-based letters of guarantee (LGs). With the expectation of upgrading the business efficiency and competitiveness, the Thailand Blockchain Community Initiative was established and its first project of Blockchain-based LGs was expected to cut the operating costs by half using electronic documentation. 14 commercial banks have teamed up with seven partners (Metropolitan Electricity Authority, Provincial Electricity Authority, and Electricity Generating Authority of Thailand, PTT Global Chemical Plc, PTT Polymer Marketing, IRPC Plc and Siam Cement Group) to push forward the idea of implementing cutting-edge technologies such as Blockchain to boost the overall Thai economy. Mr. Predee Daochai, Thai Bankers’ Association Chairman, pointed out that “Blockchain would enable LG service to be more efficient, reliable and secure, with a unified information standard”. It was a new era of paperless processes for banking and business sectors which is “highly secure, easy to examine and difficult to forge” (Kasikorn Bank News, 2018).



Applying Blockchain technology to international trade will allow parties to make use of more effective and transparent technological infrastructure than the current paper-based system. With Blockchain, an accurate record of all transactions and change in titles can be kept securely without the need of a centralized intermediary. The transformation of bills of lading system is an evidence of the impact of smart contracts on international trade. A paper bill of lading takes long time to be transferred from the exporter to the importer via express courier service. There is more chance that the bill of lading can be lost or stolen during the long travel time. The transportation cost for bills of lading is quite high depending on exporter charges, courier used, and distance travelled. In a Blockchain-based bill of lading system, a bill of lading is established through the carrier's digital signing of a digital bill of lading through a private key upon receipt of the goods. The shipper also retains a private key in order to make decisions regarding the cargo during the carriage, including the endorsement of the bill of lading to another third party. That third party can also further endorse the bill of lading to another party and the process continues until the party that holds the most recent private key claims the cargo at the port of discharge. Every time there is a new transfer, the existing private key can no longer be used and a new key is issued to the transferee. Maersk, the largest shipping line in the world, has partnered with IBM to come up with a Blockchain-based bill of lading system and it is predicted to save billions of dollars with the elimination of the traditional paper-based system (IBM News Room, 2017). A Blockchain-based bill of lading would be decentralized and automated, storing transaction information between involved parties so only permitted participants can gain access to the system. The transactions can only be validated with the collective approval of all the parties involved. This negates the chances of fraud or double spending since the encrypted data would be impossible to be modified by an individual (Rajamanickam, 2017).

Smart contracts will become the future of international trade documents and trade finance. Its real-time review, transparent factoring, disintermediation, reduced counterparty risk, proof of ownership, and reduced transaction fees make smart contracts a revolution in today's supply chain and logistics.

### **Blockchain in Air Travel**

Blockchain is believed to be promising to air travel industry; due to the fact that there are many parties involved in air travel including immigration officers, airlines, airports, agencies and customers. The flow of information about passengers, flights is enormous. Therefore, SITA, a multinational information technology company who provides IT services to the air transport industry, has teamed up with airlines and airports applying Blockchain in their operations. The purpose is to test whether Blockchain would be an effective way to sync flight data between different silos of air transport process. The project is called "Flight Chain". It was carried out by SITA, British Airlines and Heathrow Airport with the support from Geneva and Miami International Airports. (O'Sullivan, 2018). Flight data case was conducted to test Blockchain's possibilities and performance. A white paper by SITA has been published and it reveals the results of the test. Flight data was selected because there is no sensitive information related to a person's identity or commercial aspect to be publicly shared between partners. In addition to that, there are difficulties in sharing data across networks while making sure the data is integrated (FlightChain white paper, 2017). Flight data usually exist in multiple copies and not all partners can have easy access to view these data. Not to mention the data is sometimes conflicting between data sources. It happens often that the appearing information is different and changing from gates, airport monitors or customers'

application. The current state of a flight is difficult to determine, there is no “single source of truth for information of a flight”.

The problem of flight data as said by Kevin O’Sullivan, a lead engineer of SITA Labs:

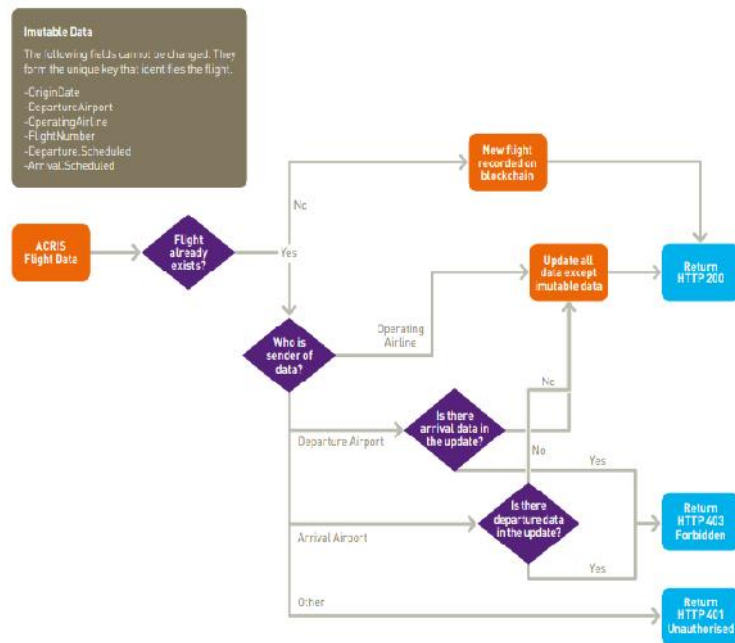
“When a passenger turns up in an airport, their app will say one thing, the display in the airport says another, and then the crew on the ground says something else. Then the ground handlers have different information as well.”

Especially when there is a flight delay, the displayed information is varied between separate control and storage systems.

The root of this problem is that everyone has their own database that stores data, and these databases do not interact or share information. O’Sullivan also stated that airlines and airports have been exchanging information, but only between two or a few partners. Each of the involved parties updates and stores information in their own timetables.

With a distributed database like Blockchain, all the transitions can be immutably recorded and shared to every partner and each of them can visualize the data in real time. Departure airport, arrival airport, ground service employees, airline employees and customers will be able to work from the exactly same data set.

The test was implementing a mutual database (permissioned private Blockchain) where departure airport shares boarding gate, then arrival airport publishes baggage conveyor belt, while an airline shares other important information as well on to the Blockchain. More than two million flight changes were processed with smart contracts and stored on the Blockchain. All of this data are shared and synced so that everyone has a same vision of what’s going on, what the next procedures are. All details were uploaded and processed through a smart contract. If the details passed the in previous set-up rules, they would be accepted, written down on the system and distributed to all the stakeholders. Information discrepancies and confusion were believed to be eliminated and help improve operations to be more effective and smooth. The results from the project were unveiled by SITA in the white paper and Blockchain did function as expected. The project has successfully showed that Blockchain is able to provide “a single source of truth for real time flight data” and increase the integrity of shared information (Peters, 2018). They admitted that Blockchain did really keep data in sync and distribute it to participants. In addition to that, the data stored on Blockchain was absolutely unchangeable, tampering-free and always up-to-date in any individual systems. With smart contract application, it provides controlling access to a specific party based on the consensus of what the rules were. In the test, Ryanair were unable to update flight data that is related to British Airways and Munich Airport were unable to update data of the flights that did not depart from or arrive at the airport itself.



Source: Flight Chain

**Figure 2** Logic Flow for Flight Chain Smart Contract

In summary, “A private Blockchain has the performance, scalability and resilience to be a useful tool for the air transport industry” (O’Sullivan, 2018).

On the other side, there were key lessons withdrawn during the project mentioned in the white paper as following:

1. “Decentralized” is not “self-managed”: Smart contracts deployment, access and permission management to the Blockchain, software upgrades require a middle organization that is not integrated to the process of Blockchain to govern and manage, especially in private Blockchain systems
2. Blockchain is not bulletproof: this type of system is only as strong as its weakest link. The network is only secure only when all of the nodes ensure high security. Because it is a distributed system, one act of attack from outsiders to the weakest node could lead to information leak or control loss of the whole system.

Project team lead, Kevin O’Sullivan said that it required time and many more trials for the technology to become more mainstream. SITA is looking for participation from other airports and airlines to add into the system and add more complicated rules to smart contract so the results of the test can be more complete.

## **Limitations of Blockchain**

Besides the promising potentials Blockchain is providing and is believed to provide to logistics and supply chain management. Blockchain has been detected its own limitations as it is developing and evolving every day. Those limitations include:

### **1. Complexity**

Blockchain is a new, emerging technology at the moment. It can bring a huge change from traditional ways of managing supply chain. To successfully execute the platform, the risks and function of the platform must be deeply understood. There is still lack of knowledge and understanding about the technology. Apparently, it is complicated and difficult for any big or small companies to educate their employees about this new specialized technology and get familiar with the new platform. It is estimated that business process change makes up for 80% while only 20% is technology implementation (William, 2015). The process of learning and adoption of Blockchain will definitely requires quite a long time.

### **2. High computing power – High cost**

The basic characteristic of Blockchain is that it requires each node in the network to have a copy of a ledger. The process of adding new blocks into the chain is very energy-consuming. As Blockchain becomes more worldwide and the network grows bigger, there is a need for bigger storage, computer power and amount of electricity from every participant. The capital and maintenance cost can be extremely high. Bitcoin, the first application of Blockchain technology, is estimated to have the total running cost to be \$600 million per year (O'Reilly, 2015). And this number is expected to increase in the future. It means that small companies which do not have enough resources and capital will eventually get kicked out from the network.

### **3. Political & social issues**

As discussed above, Blockchain is a platform that disrupts the existence of middlemen like banks, brokers, etc. Buyers and sellers can directly contact with each other without the help of the third-party as in traditional business. Some of these middlemen belong to the Government, or run under the governance models, there can be disagreements whether Blockchain should be implemented. The implementation of Blockchain comes along with the fracture in various industries that depend on intermediaries such as banks, insurance, real estate, etc. This will not only transform the industry but also create job losses and increase the unemployment rate of the country, since third parties become unnecessary. Accordingly, some nations have come up with regulations to minimize the threat of Blockchain on the economy.

## **4. Conclusion and Recommendation**

### **4.1 Conclusion**

The objective of this thesis is to introduce Blockchain and analyze the potentials and challenges that it brings to supply chain management of various industries. The research questions have been answered from the analysis and summary of the thesis.

Examining from a narrow point of view, due to the requirement of extra computing power, Blockchain is not assessed to be more efficient than current centralized data systems. However, the current systems do not allow the customers to know the true value of the products and the ethic and responsibility of companies in sourcing and manufacturing the products. Blockchain is considered to be the transformation of supply chain since its primary aim is to improve supply chain. Today supply chain is a wide ecosystem with various interconnections because business is going to an international or global economy which makes it more complex when cooperating with many different partners from many locations. For example, an automotive manufacturer has to work with many raw materials' suppliers, some of them the company has never had transaction with. The verification of documents for TAX clearance, transfer of ownerships, etc. is difficult and some activities are still error-prone. Therefore, companies face problems in running smoothly and it is understandable that the company does not put 100 percent trust and rely on the suppliers. This problem is believed to be solved by the implementation of Blockchain technology. The most important value of Blockchain is that it provides transparency and efficiency for supply chain processes from warehousing, storage to delivery and payment. First of all, there is no sole authority to control over the technology. The responsibility is equally spread out to all the participating parties in the network. Secondly, every transaction occurred is recorded and informed to all the people related. The transactions cannot be modified or deleted without the approval and consensus of others that share the same ledger. Thirdly, the block is connected to the one before and the one after it so that the chain is secured and incorruptible because if one tries to change one block, the whole chain has to alter.

Blockchain technology is a current new trend in supply chain system. The technology is in its prototype stage and there is a slow progress of Blockchain adoption into supply chain and logistics management. However, it shows the promising solution for supply chain visibility and transparency and will soon earn bigger attraction from many industries. Blockchain for the supply chain will significantly transform the way companies do business in the future. Once transparency is enabled between trading partners, a system of trust can be created that has previously been a challenging issue in the Internet commerce market.

The other term widely mentioned in the Blockchain context is smart contract. Smart contracts are being implemented in many different fields in business such as insurance, election, banking to improve the performance and mitigate risks. In this paper, the main objective is to focus on the application of smart contracts in logistics and supply chain, and its impact on these industries. The supply chain consists of a lot of links and each link has to be connected and confirmed by the previous one in order to make sure the information, product, and money flow is accurate. The problem of the traditional supply chain is that it takes too much time and is unproductive. A smart contract can be the solution for these issues because it can enhance the transparency in the contract terms and protect information from fraud. Decentralized smart contracts improve accuracy, reduce the number of insurance intermediaries and lower the cost. It can also provide shipments tracking with the integration of Internet of Things. As mentioned above, the application of smart contracts in trade finance and logistics documents helps transform the maritime trade industry and replace old

maritime business practices by substituting transaction documents with a more secured mechanism to deliver, buy and sell assets (Nach and Ghilal, 2017). The Blockchain combined with smart contracts offer an opportunity to improve the process in the transport industry and create trust among business partners.

In conclusion, the Blockchain-based smart contract is a promising idea that can enhance the efficiency of current supply chain processes. However, companies should fully understand how this technology works and decide whether to apply or not. There are pros and cons of every system and it is important to look for other alternatives. Keeping the contracts simple at first is an appropriate way to reduce errors. Further development could come later to increase the network size and complexity. Companies should only use Blockchain technology for parts of the system that need decentralization. The mindset of the business partners involved in the transaction must change before smart contracts are successfully implemented. One essential issue related to the Blockchain technology is trust among parties. Everyone must rely on the data provided and the reputation of each individual plays an important role here. The change in mindset could allow organizations to access to a large amount of data. Companies must keep in mind that this is an opportunity not a threat because they all agree to share this information and gain benefits from it.

## **4.2 Recommendation**

The benefits of Blockchain is undeniable, however, not every business should implement this technology into their operations. It is critical for the company to know whether and how to invest in Blockchain. It depends on the vision of the company and its position, role to the market. Companies that are recommended to apply Blockchain technology are:

### **1. Companies with a big circle of suppliers:**

The companies have difficulty managing the complicated network of suppliers. The product requires many different components from different suppliers. The biggest issue is that the company and suppliers have no common platform to share information. It creates extra time, efforts, cost and delays to have the whole view of process and verify the data. Blockchain makes it possible for company to know the information of all parts, track down the source and pinpoint the exact supplier in case there is a faulty component or rotten ingredient (as discussed in Walmart's case). Therefore, the faster and easier the root of problem is recognized, the faster and more efficient solution can be given.

### **2. Companies with short product lifecycles:**

Their supply chain is dynamic and agile to keep up with and satisfy the demand of customers. The suppliers' relationship is shifting and changing in a short space of time. Using Blockchain can improve company's trust on suppliers. Companies are clearly informed where and how raw materials are processed so that they can truly be aware of the real quality of substances that they are purchasing.

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