Implementation of Blockchain in the Modern Supply Chain

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The way international companies operate in the 21st century is everchanging with a shift of reliance and importance placed onto the supply chain network. With this shift comes new challenges. One exciting solution is a technology called Blockchain which has demonstrated potential in other industries already. Blockchain is an example of an emerging industry 4.0 technology which has grown rapidly past being a mere trend and materialised into something quantifiable.

The author conducted this research to investigate the feasibility of using blockchain technology as a solution to the common challenges faced by the modern supply chain. The author has opted to use secondary research, in the form of desktop, to answer each respective investigative question. The investigative questions were used to answer the research question of 'what are the recommendations for a logistics company implementing Blockchain technology?'. The author has only included fundamental a review of both supply chain and blockchain qualities and theories due to the extensive nature of the topics.

The objective was to cater to the broader audience through the introduction of what the technology is, it's essential characteristics and a comprehensive review of currently available applications. This has been presented through the theoretical framework, accompanied with figures. The author believes the results found in section 3 have offered legitimacy to this research as it entails real-life examples of blockchain based applications and their respective industry utilisation presenting credibility to potential implementation.

Whilst the results encompassed a large amount of theory regarding blockchain, it's uses and applications, the author acknowledges the limitations created by the lack of different research methods. The results display the true potential found whilst also acknowledging the drawbacks offering an unbiased review of the subject at hand.

Keywords
Blockchain technology. Supply chain management. Logistics.

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1 Introduction

This is a research-orientated bachelor's thesis for my international business degree programme in Supply chain management at Haaga-Helia University of Applied Sciences. In this chapter you will find my introduction to my thesis topic, research question, project scope, benefiting parties, risk management and key concepts.

1.1 Background to the topic

In recent years, businesses have changed shape and forms to accommodate the everchanging market. These everchanging markets have translated to businesses becoming more heavily reliant on their supply chains. The shift has acted as a catalyst to wide-scale changes in the way supply chains operate.

The change in supply chains can be accounted for through interesting technological advancements such as data analytics, artificial intelligence, automation, cloud computing, IoT (internet of things) and now Blockchain technology. Such technologies have revolutionized the function of traditional supply chains; however, common issues continue to plague logistics. Issues like transparency, collaboration, communication, multiple suppliers, order delays, late payments, damaged or lost goods, cargo tracking are just a few.

On top of the issues, the modern consumer maintains ever high standards and expectations, adding to the concoction of difficulty for viable logistic solutions. The desire for viable solutions is at an all-time high with little to no room for error.

Blockchain technology is an exciting technology that acts as the foundation for huge cryptocurrencies like Bitcoin and Ethereum. The cryptic nature of this technology has created excitement in other industries already such as the financial sector but utilisations elsewhere, like logistics and supply chain, are still in its infancy. Consequently, Blockchain adoption has its limitations in implementation, scalability, and regulatory considerations.

Blockchain technology boasts interesting possibilities such as improved transparency through a general ledger, better security through encryption and overall, promises of a better future in efficiency and effectiveness for logistic processes.

Is it even possible for the logistics of a supply chain to accommodate expectations of the modern market?

1.2 Research Question

The goal of this thesis is to develop awareness on the needs of a modern supply chain and how Blockchain can accommodate them. The outcome of this thesis is to offer logistic companies an insight on the feasibility, utility, and efficacy of this technology, through comparisons, detailing the plus and negative, and listing the different Blockchain applications in a supply chain.

The international aspect required by the degree programme at Haaga-helia is illustrated throughout this thesis due to the nature of my research question and topic choice.

My research question is as follows.

RQ: What are the recommendations for a logistics company implementing Blockchain technology?

To answer this research question, I have broken it down into five investigative questions.

IQ 1. What are the needs of a modern supply chain?

IQ 2. What are the fundamentals of Blockchain technology?

IQ 3. What Blockchain applications can be implemented into a business's supply chain?

IQ 4. What are some examples of Blockchain implementation improving the logistics industry, if any?

Table 1 – Overlay matrix.

Investigative questions	Theoretical Framework	Research methods	Outcomes
IQ. 1: What are the needs of a modern supply chain?	Logistics and Supply chain theory, Porter's value chain, IoT industry 4.0 and typical challenges with logistics.	Desktop research.	(Chapter 2.1, 2.2).

Investigative questions	Theoretical Framework	Research methods	Outcomes
IQ. 2: What are the fundamentals of Blockchain technology?	Basics of Blockchain technology, smart contracts, monetary flow and Blockchain	Desktop research.	(Chapter 2.3).
IQ. 3: What Blockchain applications can be implemented into a business's supply chain?	Theory of different suitable applications, distributed ledgers technology.	Desktop research for relevant theories.	(Chapter 2.3, 3).
IQ. 4: What are the typical blockchain applications in supply chain management.	Investigate and explore current examples of Blockchain applications utilised in logistics and its benefits.	Desktop research	(Chapter 3).

1.3 Delimitation or Project scope

In this thesis I will be covering the fundamentals of Blockchain technology and role it can play in a modern supply chain. The focus will be on companies conducting business in the logistics sector. I will be introducing Blockchain, consensus mechanism and the role of distributed ledgers. A selection of universally desired traits and needed characteristics of a modern supply chain will also

be investigated. I will include different types of Blockchain applications viable for logistic implementation. This will be a comprehensive analysis of the applications and its core elements. Cases of multi-national logistics company's already implementing blockchain technology will be presented and discussed through reports and articles.

This research hopes to discover, investigate, and identify the feasibility of Blockchain for companies operating as logistic service providers, including prevalent advantages and disadvantages of such technology. The thesis will also include a conclusion and considerations with an emphasis on allowing the reader to draw upon their own thoughts and opinions. I am aware of the possible issues that may arise from my thesis not focusing on a specific company, with the focus being instead on a selection of logistic companies.

1.4 Anticipated Benefits

My research will benefit a commissioning company or anyone reading by explaining the fundamentals of Blockchain. The theory will include supply chain relevant Blockchain features and applications including an investigation into how and why numerous businesses have already transitioned. I will include examples of Blockchain technology applications and how it can be implemented e.g. smart contracts and Blockchain based cryptocurrencies. As the focus of this thesis is Blockchain in relation to modern supply chains management, the benefits will be universal for businesses with supply chains which have not already utilised the technology. However, companies operating as logistic service providers will gain the most due to the nature and focus of the thesis. Some potential benefits from understanding and utilising this technology can range communication to efficiency, as well as the common advantages and disadvantages of implementing. As the author, I will gain an overview of this technology and its offerings through my research whilst also offering individuals in a similar position a competitive insight into an exciting and trending technology.

1.5 Risks and risk management

Access is one of the biggest reasons why I might not be able to complete my thesis. Access to business information can and will often be confidential. Legislative issues could arise from the thesis as Blockchain's in businesses operate on private or closed networks and therefore any information or data is likely inaccessible to the public. Trying to access such data is often protected and would require special authorisation.

The inability to find a commissioning company can also be an issue for me as my ability to gather primary research is inhibited. Thus, meaning I would not be able to draw up from information/ data

from their company which can help map out the approach I am taking in my thesis. No commissioning company could also mean I am unable to find a willing individual part of an international business using Blockchain technology to grant me an insight into their supply chain. This can then overlap with other risks like legislation and access. The risk of lack of information from case companies can also occur.

Multinational companies use complex supply chains which can lead to the results being hard to draw understanding and conclusions from. However, I believe this risk can be prevented through adequate research methodology.

1.6 Key concepts

The purpose of this subchapter is to outline the key concepts in which the reader can gain an understanding on the key concepts which relate to my thesis topic. These key concepts are mentioned throughout my thesis.

Supply chain management can be defined as “a network of facilities that produce raw materials, transform them into intermediate goods and then final products, and deliver the products to customers through a distribution system. The management of the supply chain and the roles of various actors involved differ from industry to industry and company to company.”. (Shukla et al 2011, 2059)

Supply chain management and logistics are not interchangeable words, however, are very much interrelated as “Logistics is a fundamental part of supply chain management”. (European Commission 2024)

Logistics is encompassing a broad range of activities that involves the movement of goods. One source which defines it simply as ‘the processes and networks used to move and store materials within supply chains and move products to their final destination”. (Adzija & Kukhta 2022). The activities of international logistic service providers can be further refined into inbound and outbound. Both inbound and outbound logistics not only share a common goal but are considered primary activities and key to an organization. (Ndubi et al 2016, 181.)

Blockchain is a technology that enables the secure sharing of information. A Blockchain itself is composed of three main components, cryptography, a digital log of transactions and a database that can be shared across a public or private network. These components have created a wave of excitement for numerous companies operating in financial and fintech industries. (McKinsey 2022.)

Industry 4.0 is the current, ever-evolving, phase of industrial development that is best summarised as a “collection of technologies”. The vision of Industry 4.0 emphasizes “the global networks of machines, often in a smart factory setting, capable of autonomously exchanging information and controlling each other”. (Tjahjono 2017, 1175). Blockchain technology is just one example of a wide list of enticing Industry 4.0 innovations. The mission of these technological innovations is to improve entire business operations, naturally encompassing logistics. Innovations continue to enhance qualities such as productivity, efficiency and flexibility is key to creating good opportunities for businesses to make better, well-devised decisions. (SAP 2024.)

Cryptocurrencies are a newly emerging technology which was originally and is commonly created using Blockchain technology. The first to emerge was Bitcoin, published in 2009. (Rue 2024) Since then, numerous new cryptocurrencies have emerged garnering both positive and negative attention. Defined by one source as “a medium of exchange that is digital, encrypted and decentralized”. The same source also states that “Unlike the U.S. Dollar or the Euro, there is no central authority that manages and maintains the value of a cryptocurrency”. Consequently, cryptocurrencies have often found scrutiny due to the very fact of its decentralised nature and lack of regulation. Despite the mixed response, the benefits that include the likes of more cost-effective transactions, reduced payment time and potential for decentralised systems have made it a worthy opponent to the traditional payment methods. (Ashford 2020)

Network Topologies is the “physical and logical arrangement of nodes and connections in a network” and “are often represented as a graph”. Well devised network topologies can help organizations identify any “faults and fix issues, improving its data transfer efficiency” (TechTarget 2021).

Hyperledger is an open-sourced platform that offers different Blockchain frameworks for international companies. The term ‘Hyperledger’ is often described as an ‘umbrella term’ for several frameworks with Hyperledger Sawtooth and Hyperledger Fabric being most relevant in this research. Hyperledger frameworks offers tools and a foundation for building a Blockchain based application.

2 Theoretical Framework

My theoretical framework consists of two chapters identifying the fundamental theories of both Blockchain and Supply chain. The inclusion of figures accompanies parts of my theoretical framework to help visualise theories and concepts.

2.1 Logistics

As aforementioned briefly in the previous section, it is worth reinstating that the term ‘supply chain’ includes a plethora of different processes and activities that are involved in the planning, oversight, and coordination of the supply chain. A subset of the larger more complex supply chain, logistics is defined further as the “planning framework that enables businesses to store and transport their goods to their customers”. The areas include “procurement, inventory management, distribution, warehousing, transportation, packaging and risk management” (DHL 2024). For this project, the approach is investigating logistics. The similarities between logistics and supply chain are everlasting and often leads to the components and functions to be interrelated and intertwined. The commonly shared perspectives include:

- Both focus on the optimisation of costs and good flow throughout the supply chain.

- Encompass key activities like the warehousing, inventory management and order fulfilment.

- Require collaboration and communication amongst various involved stakeholders like manufacturers, suppliers, distributors, and retailers.

- SCM and logistics heavy rely on the industry 4.0 technology to enhance operations, overall efficiency and decision making,

(Mangan & Lalwani 2016, 3-19)

2.2 Fundamental Supply chain theory

Comprehensively, supply chain management can be defined as the “handling of the entire production flow of a good or service”. This encompasses the origin stages of dealing with raw components to delivering finalised products. Operating companies build suppliers networks which not only add value but move the product along to other organizations incorporated in the supply chain (IBM 2024a).

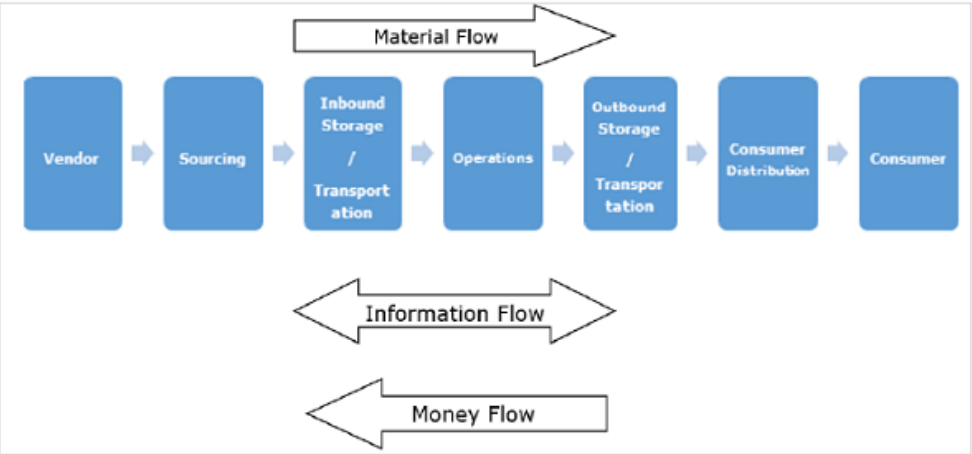

Figure 1. Supply chain process flow. (Tutorialspoint 2023)

In figure 1, the model illustrates two of three flows in a typical supply chain. Both physical and informational flows are considered sequential which means it follows logically order. As a product is produced it flows from upstream to downstream along the chain until it reaches the consumer. Subsequently, the flow of information flows both up and downstream as parties in the chain communicate. In addition to the two flows depicted in Figure 1, there is an additional flow titled ‘cash flow’. Cash flow is the third and final flow which is present in any supply chain and represents payments, for example the retailer paying the distributor. Despite the linear nature of this graph, modern supply chains for global companies will often take form as a large network with multiple buyers and suppliers. From this large network, various issues can manifest themselves in the supply chain. (Khalid et al 2005, 79-82.) (Drane & Faramarzi 2023)

The focus of this thesis is to identify universal issues or challenges that currently plague the modern logistics opposed to company specific issues. By addressing a larger scope of issues, companies will have a greater insight into the feasibility of Blockchain solutions. This, in theory, will benefit a wider audience. Below, through desktop research, are several examples.

Managing Data is an issue which can arise from lagging behind technology implementations. As competitors implement the latest technologies, companies may be reluctant to take the financial risk, struggle to identify solutions or just, bluntly, lack of awareness. Furthermore, as supplier networks continue the trend of becoming larger, keeping track of data from several different software’s can become a challenge in tracking shipments, payment.

In conjunction, another data issues can arise from **Lack of data visibility.** This is another example of a challenge faced in modern logistics and supply chains.

Disjointed communication can also play havoc on logistics as the industry lacks universal, integrated communication channels. Fragmented communication leads to misinformation, delays, and errors. In logistics, coordinating shipments and tracking shipments can become a challenge without appropriate solutions.

Digital transformation for companies is a huge challenge faced by countless supply chains across all industries. Recent developments in suitable technology such as IoT and AI have arisen challenges in implementation.

Lack of traceability is another challenge which has detrimental effects on the supply chain and overall efficiency. Products can be subjected to delays and even being completely lost without adequate traceability systems incorporated.

In addition to the problems mentioned above, the logistics service providers face several other challenges.

Visibility: Becomes a challenge when there is a lack of understanding in how shipments are progressing without a real-time update. Consequently, this can cause issues in centralizing information and data.

Costs: Another prevalent challenge which is arises from the current market and economy. Issues from the unexpected costs, poor inventory management and dispute resolution can also create problems for logistic companies as they operate on razor thin margins. Cost control is hugely important in this domain, as logistic service providers are constantly trying to balance costs.

Customer value: Can be difficult in the modern age as well as customers specific demands and needs, desire personalised solutions and efficient service whilst all being environmentally friendly. **(**Blume 2019)

The importance of finding the right solutions is vital for streamlining operational costs, improving efficiency, and meeting the modern consumer demands. The vitalness is apparent as “Logistics firms that capitalize on the promise of logistics software, cloud services, and smart technologies are better positioned to predict customer demand, manage logistics operations, and effectively solve any supply chain crisis”. (Inbound Logistics 2023)

2.3 Fundamentals of Blockchain technology

Blockchain technology, is best defined as a form of distributed ledger which holds utility and potential through it’s based applications. As a distributed ledger, blockchain records all entries.

Each entry is created through consensus mechanism which validates and authenticates e.g. monetary transactions.

Consensus mechanism is the foundation of Blockchain. It correlates to the sharing between all Blockchain networks and applications and is described as the ‘protocol that bounds trust and agreement between all users. I have included a figure below, see figure 2, to help understand and visualise what the mechanism process is.

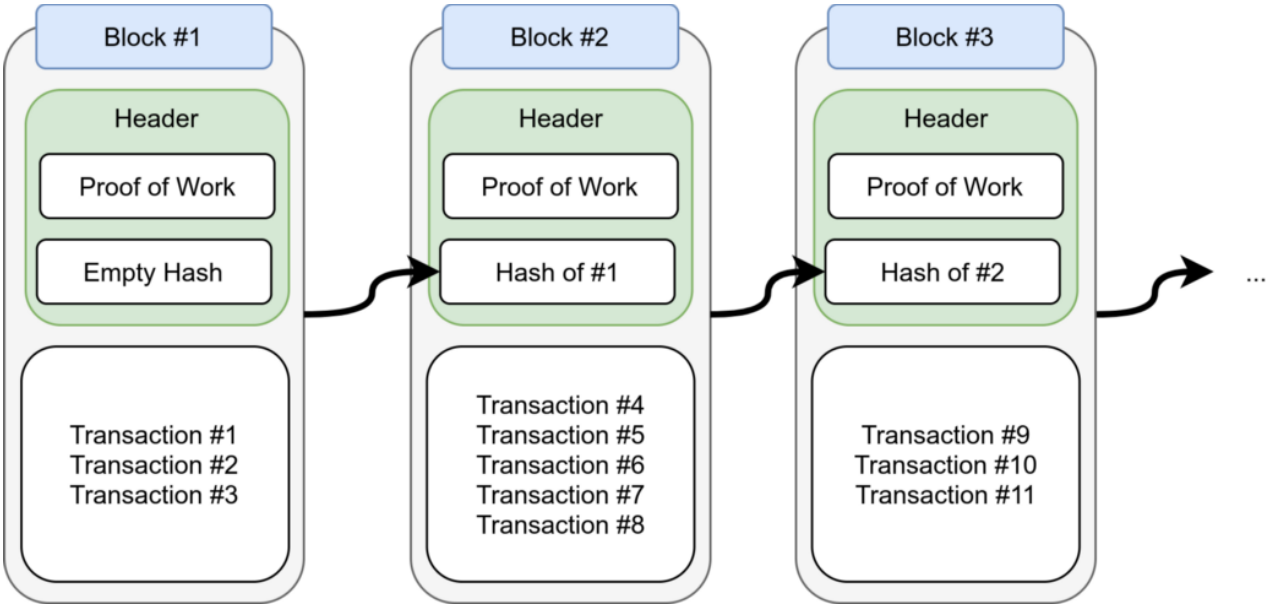

Figure 2 - An example of a blockchain. (Thoma 2021)

The process of each transaction appears as singular block on the chain, and can be broken down into 3 key components, a timestamp, data, and hash. At the start the hash is empty and will only be created after the first Block in the sequence is completed. Once all the data about the transaction is added, the Block becomes visible to everyone on the network. However, the first Block is special as it does not contain a hash value of the previous block as it is the first in sequence. This first block is often considered as the ‘genesis block’. The next data added will then appear as Block 2, as seen in the figure above. This process is repeated to create a blockchain. The hash holds importance regarding safety and security as it uses cryptography. Cryptography consists of random code which is essentially impossible to change. This makes the so called ‘block’ unique and any changes to the hash will result in the entire blockchain being altered. In a supply chain, this technology can offer a range of benefits. Through correct calibration of blockchain, automation can be created leading an array of pluses. The nature of this technology offers businesses and supply chains more traceability and transparency through each block which holds information. (Thoma 2021)

Distributed ledgers are a fundamental component of Blockchain technology. The distributed ledger can be defined as a “database that is consensually shared and synchronized across multiple sites, institutions, or geographies, accessible by multiple people” (Majaski 2021). Currently, a distributed ledger is one of the key features of Blockchain technology and holds potential to offer a new solution to several modern supply chain issues. The idea has revolutionized the way people see a ledger. To understand such a statement, it is important to define the differences to the traditional/centralised ledger. The traditional ledger works with one centralised authority who maintains a record hence the synonym. In the figure below demonstrates the difference.

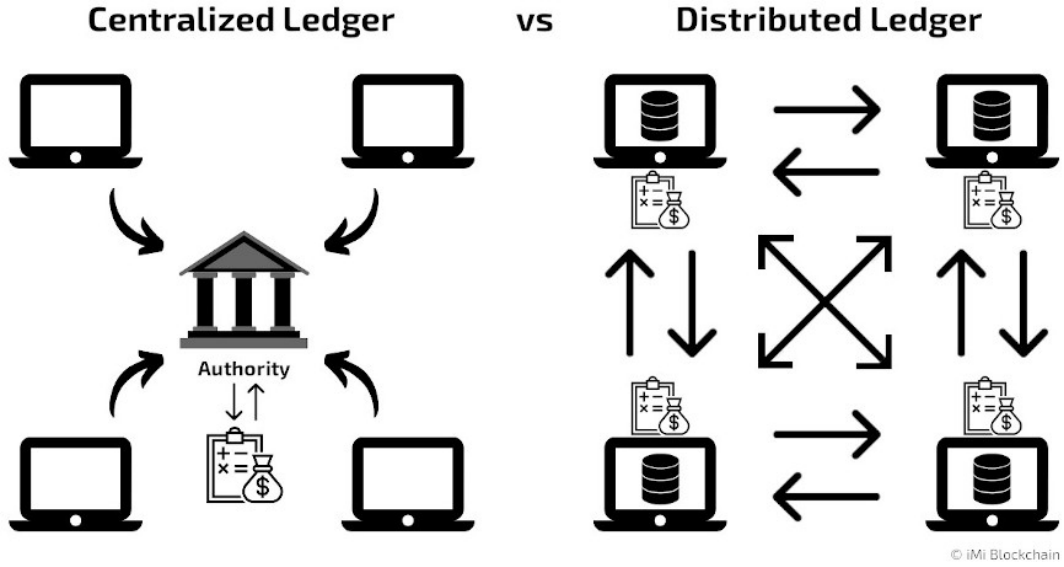

Figure 3 – Centralized Ledger vs. Distributed Ledger (iMi Blockchain 2024)

As seen in the figure, the distributed ledger uses a de-centralised approach allowing all parties to access the ledger. The fundamentals of distributed ledgers are a point of interest for logistics due to the nature of it. Having an unmuted, distributed record of each transaction would greatly benefit logistics companies as fallbacks through an improvement in transparency, security, and collaboration to be fixed. Furthermore, all stakeholders involved will have undisputable record stored forever on the Blockchains database. Due to the cryptographic nature of Blockchain, the ledger cannot be altered thus any unsolicited changes is extremely unlikely, bordering on impossible.

Access to the Blockchain database is dependent on the rules and protocols of the network. These rules and protocols can determine the boundaries for four different forms which, in no order, are public, private, federated and hybrid networks.

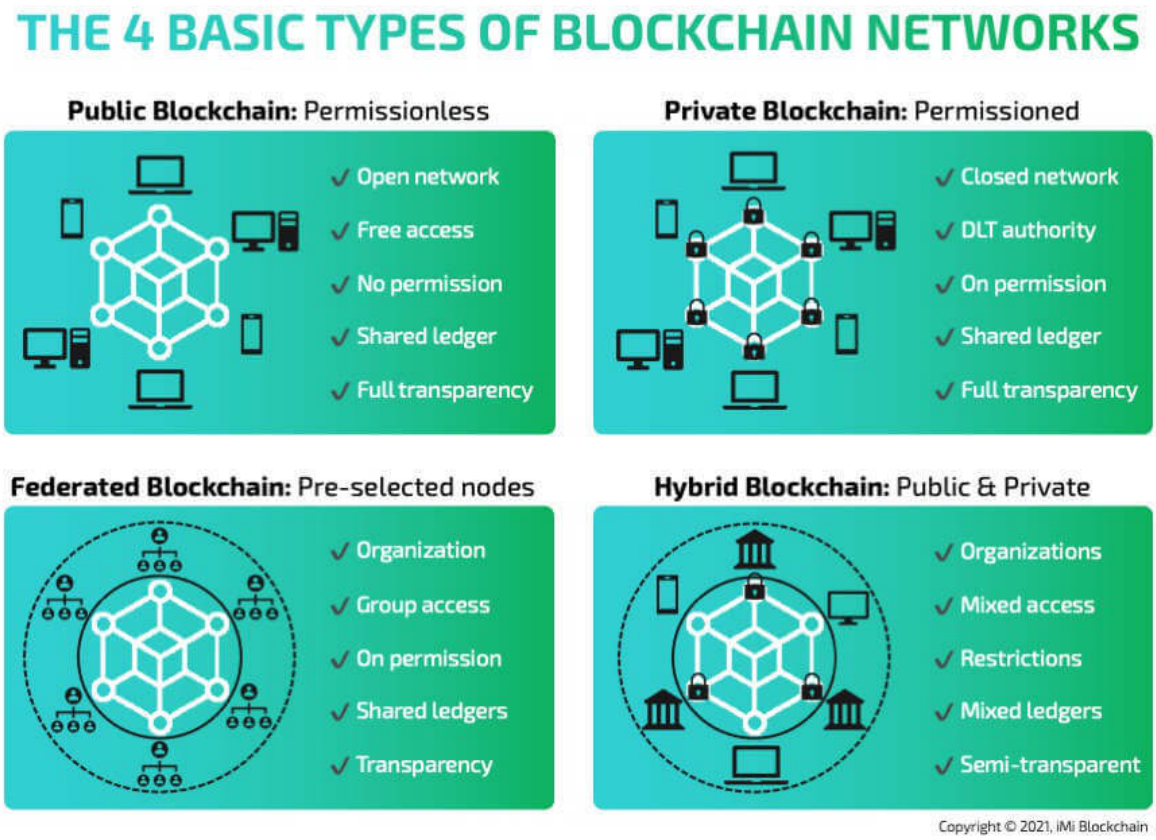

Figure 4 – 4 Basic types of Blockchain networks (iMi Blockchain 2024)

Public blockchain networks are “a permissionless, non-restrictive, distributed ledger system, which means anyone who is connected to the internet can join a blockchain network and become a part of it”. (Sharma 2023). This option is popular with cryptocurrencies due to the non-restrictive accessibility. In addition, the network topology is designed in a way that all parties or ‘nodes’ has the data distributed to them.

The next is **private blockchain networks** which is best defined as a “restrictive blockchain that operates in a closed network” (Sharma 2023). Private blockchain networks are permissioned, and inaccessible to the public and utilise a hierarchical design which connotes to different stakeholders having different levels of power. Some can only access whereas some can access and validate. The use of this network offers more control and privacy for wide range of industries. Private blockchains can used in internal supply chains.

Federated/Consortium blockchain networks is a permissioned network “best suited for organizations where there is a need for both types of blockchains, i.e., public and private”. (Sharma 2023). In my opinion, logistic service providers could benefit the most from this implementation due to the nature of its internal and external friendly design. This type of blockchain network offers the

ability for multiple businesses to collaborate and form a ‘federation’. Inside of an agreed federation, elements of both public and private blockchains networks are utilised. it differs because it involves various organizational members working together on a decentralized network.

Another example of blockchain networks is **Hybrid networks.** This network is again popular in a business setting due to the varying levels of public and privacy. In a hybrid blockchain, ‘transactions and records are typically not made public, but they can be validated if necessary by granting access via a smart contract.’ Different members hold different levels of authority across the multiple nodes; for example, the ability to authorise transactions. This helps hide potential confidential chains whilst still being able to collaborate on others.

(iMi Blockchain 2024) (Sharma 2023) (Simplilearn 2023)

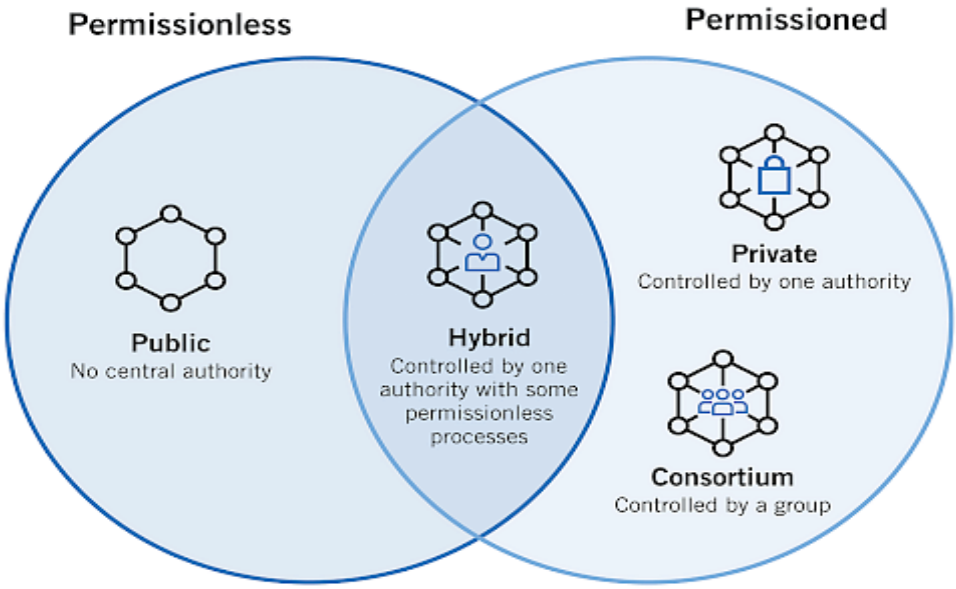

Figure 5 – Permissionless and Permissioned Networks (Simplilearn 2023)

Decisions on selecting the correct network goes down to business needs and wants from their network. These are the deciding factors and are specific to each company. The figure above illustrates the differences in permissions.

Smart contracts act as the all-important bridge, the connection, the link when it comes to finding the correct Blockchain solution for their supply chain. Smart contracts are very logical and often is found as the metaphorical bridge for Blockchain implementation into a supply chain. Essentially an opportunity for all the features of Blockchain in a one stop all place. It is defined by one source as “digital contracts stored on a blockchain that are automatically executed when predetermined terms and conditions are met” (IBM 2024b). Which translates simply into ‘automation’. Amongst all the

features offered, automation stands above the rest as it has the ability to reduce lead time on numerous levels in the supply chain and create fewer overall costs as there is no need for individual/ body to complete the transaction. This increase in efficacy is a valuable quality needed in a modern supply chain. Smart contracts are also versatile as it can be created, for example, between supplier and wholesaler or wholesaler and manufacturer, etc.

The basis of smart contracts offers a plethora of pluses. For example, a reduction of lead time and costs, better security through its transparency of terms and finally vastly reduced error rate compared to humans.

For the sake of this research, I have opted to keep the workings of smart contracts brief and have only touch upon the fundamental elements that make up smart contract.

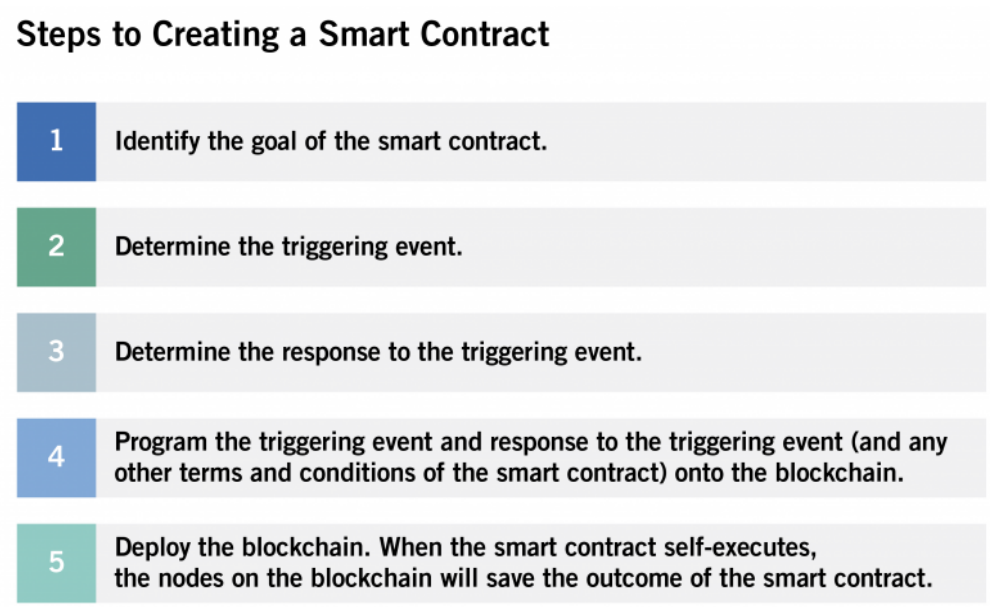

Figure 6 - Steps to Creating a Smart Contract (The National Law Review 2021)

Above is figure 5 which illustrates 5 steps to creating a smart contract. The automation lies in the predetermined conditions stated in the digital contract. Once matched, terms stated in the contract are released. For an international business to create such a contract, all respective stakeholders would need to reach an agreement.

The potential value smart contracts hold is immense, as it can be utilised in many ways from government voting systems, payments, and settlements in the financial sector to modernising supply chains. A common advantage offered is improved efficiency and lead time through automation because once a predetermined condition is met, it is executed removing any contract

processing time. Ultimately, Blockchain Smart contracts are ‘self-executing’ digital contracts will hold advantage over the once traditional contract agreement (Crosby et al 2016, 10.)

In relation to the supply chain, smart contracts can be used to record distributed ledger entries and release payments. This distributed ledger quality is present in all Blockchain. For releasing payments “two parties, such as a manufacturer and a supplier, could set up digital wallets and a smart contract for the manufacturer to pay the supplier for the purchase of goods. After the manufacturer inspects and accepts the goods, the smart contract would automatically move cryptocurrency from the manufacturer’s digital wallet to the supplier’s digital wallet to effect payment” (The National Law Review 2021).

As the modern supply chains landscape becomes more demanding, I believe smart contracts can really improve the modern supply chains lead times, overall efficiency, and supplier relationships throughout the supply chain.

2.4 Theory about the different Blockchain based applications.

Industry 4.0, as aforementioned briefly in the key concepts chapter, encompasses the development and integration of technology into global industries. The emergence of the latest technology era has opened numerous, enticing opportunities for logistic processes improvement. Certain improvements exist in such forms as partial transfer of intellect, autonomy, and decision-making to technology can be implemented with the use of Blockchain technology.

The first being machine-to-machine communication. This, essentially, is the opportunity for collaboration across different systems. Each system being linked together means information like data can be shared allowing for machines to become smarter, thus, leading to better problem-solving and decision making. By leveraging the technologies of Industry 4.0, such as artificial intelligence and machine learning, the logistics of a company can operate with better efficiency and accuracy with less mistakes. With the addition of a Block-chain incorporation, the transfer of information between machines becomes a real game changer. This is because the core elements of Blockchain allow for improved transparency, trust, and traceability throughout the supply chain. (Eslami et al 2023, 2-11) (Ma et al 2020, 315-329)

Consequently, significant, wide-scale boosts to not only supply chain and logistics alike, but industries have witnessed improvements in their sustainability, adaptability, and productivity. Furthermore, such implementations have improved their ability in establishing new industrial techniques, business models, and other innovations. (Barreto et al 2017, 1250.)

Blockchain technology has huge potential to maintain the integrity and store big data. Big data is another key component of Industry 4.0. Using a big data approach is required to fully utilise the elements of an Industry 4.0 as well as even Logistics 4.0. When I use the term "big data", I am referring to the large amounts of structured and unstructured data that is commonly collected by logistics company. This ‘big data’, once collected, can be data warehoused, thus allowing for analytics to commence. This is a popular trend that currently is rising at an exponential rate and can work concurrently with Blockchain.

One benefit can be translated as better decision making because it allows decisions to be made precisely and quickly through the assistance of data analysis. The blockchain technology makes it possible to trace transactions such as financial, data, and informational.

Correct implementation and execution have the potential to solve many issues that are plaguing the modern supply chain such as significantly lowering human error, reducing costs and time delays.

Logistics using technologies from Industry 4.0 have shown great promise with the incorporation of blockchain technology. Products can be monitored with pinpoint accuracy, as well as each transaction having the ability to be recorded. This can be transaction between several parties, stakeholders or simply put, up and down the supply chain. Blockchain technology preserves this as permanent history, every respective stage of the product's lifecycle recorded, thus allowing for seamless data insight as its moves down the value chain.

(Tijan et al 2019, 1185.) (Mohamed et al 2019, 852-858)

Step by step guide to implementation.

Step 1 – Review

To begin, I must reiterate the importance of reviewing the current logistic systems in play. This means listing out all the companies supply chain processes like inventory management to invoicing/payments and provenance/ Authenticity verification. Once each internal process is identified, a SWOT analysis can be utilised. These further reviews each process by establishing its strengths, weaknesses, opportunities, and threats. Ultimately, enabling you to identify pain points.

Step 2 – Evaluate

Pain points established; we move onto the evaluation stage. This means determining which of these processes can be improved through Blockchain technology. This step requires consideration of aspects including data dependencies, trust and transparency of the network and complexity and

frequency. These aspects show the most potential to being greatly improved through Blockchain. However, merely identifying which processes involves sharing data with multiple stakeholders is a start. A large percentage of all Blockchain implementations requires engaging with stakeholders due to the interoperable nature of Blockchain.

Step 3 – Platform

After the review and evaluation steps are completed, determining the correct Blockchain platform is due. This stage requires considerations like scalability of the platform, the strength of their security and finally a list of features and functionalities the in-question platform supports. It is crucial to align your supply chain needs whilst acknowledging each respective platforms strengths and drawbacks. As mentioned beforehand each Blockchain platform can also take form in public, private and consortium, creating additional considerations due to the nature of each network.

Step 4 – Collaboration and monitoring

Collaboration is often viewed as the foundation of Blockchain due to consensus mechanism employed. When we refer to collaboration, commitment from all stakeholders is necessary. To help sway fellow stakeholders, the key notion that Blockchain technology will be an actual upgrade needs to be reiterated. Once collaboration is secured, monitoring any progress or setbacks is subsequently due. The use of ‘key performance indicators and general feedback from stakeholders, allows for the overall effectiveness and success of Blockchain implementation to be gauged.

(Van Hoek 2019, 829-859) (Baker 2019)

Hyperledger is an initiative first created in 2015. The ideology behind Hyperledger is evident when reading through the whitepaper which is, simply put, to offer a much-needed solution to collaboration not only in the business world but further. One source defines it as an “open-source enterprise blockchain-as-a-service platform that can run customized smart contracts without needing to know the underlying design of the core system”. However, for the sake of this research, the focus will be on what qualities it can offer to the modern supply chain.

(Investopedia 2021)

Hyperledger opens the door to several different options that are continuously adapting. Hyperledger Fabric and Hyperledger Sawtooth are just two examples of frameworks with supply chain potential.

Page 5 of the whitepaper breaks down the decision behind using Blockchain as “Blockchain opens the door to a second generation of the Internet much better-suited for exchanging value, including valuable information. With blockchains, people can establish who they are and then trade items like money, stocks and bonds, intellectual property, deeds, votes, loyalty points, and anything else that has value. Even if the traders don’t know or trust each other, they can trust the technology to record the transaction in a tamper-proof way. And the technology removes the need for any middleman, which saves time and cuts costs.”

As aforementioned, Hyperledger is open sourced which is factor that needs to be considered before implementation. The benefits of this framework are illustrated in the figure below and are described by Hyperledger as ‘philosophy’s’.

Interoperable denotes the ability to communicate and collaborate between all parties, which can translate into supply chains through different stakeholders like suppliers, contractors, etc.

FIGURE 2: THE HYPERLEDGER DESIGN PHILOSOPHY

Figure 7 – Hyperledger Design Philosophy. (Blummer et al 2018)

On the opposite side of the coin, Hyperledger frameworks for supply chain solutions can run into several issues. Below I have included a comprehensive list of these drawbacks:

The whole concept of Hyperledger is open sourced which is also evident in the individual frameworks offered. Subsequently, switching operations onto such a platform will and does require a certain level technical expertise. This technical expertise is responsible for the maintenance and updating of the network, as well as addressing technical issues. This requires additional resources and costs.

In addition, many open-source projects are influenced by the community opposed to strictly the business's needs which is no different to Hyperledger. By having the community decide on the direction of where the framework goes can lead to harmful, uncontrollable decisions and may lead to specific needs of the supply chain not being accommodated too.

To conclude, the decision behind using Hyperledger is again, down to the business. Many issues of logistics are catered for due to the ethos of VeChain. It is often a favourable option as "Hyperledger has more than 230 organizations as members—from Airbus to VMware—as well as 10 projects with 3.6 million lines of code, 10 active working groups, and close to 28,000 participants who have come to 110+ meetups around the world". (Blummer et al 2018, 5).

The legitimacy behind this option continues to become more and more evident in the whitepaper. To summarise, the whitepaper explains how it was a collective company ambition to find collaborative methods, in true Blockchain fashion, allowing for break throughs in better and overall, more efficient methods to collaborate between different parties.

(Blummer et al 2018, 5-22.)

Blockchain QR codes is another example of a technology that has the potential to be improved using blockchain technology. This method can be implemented by industries that are product orientated. One that can benefit from this technology are international business as they are they restricted by resources.

Firstly, QR codes are a type of barcode which contains a unique pattern and 'hash'. When discussing Blockchain QR codes, the difference lies in the blockchain-based traceability which can be utilised in numerous ways from supply chains to industrial sectors. The similarities of Blockchain QR codes and QR codes are strikingly similar, however, factors like security make the former superior. Traditional QR codes are not as safe as Blockchain based ones as they do not have the same level of encryption. The high levels of safety and data security is accomplishable through hash values. Hash values are the unique string of numbers used in Blockchain. QR codes is an example of Blockchain application can be used throughout the supply chain.

3 Research on Blockchain applications

The final chapter is exploration of transformative Blockchain applications and frameworks currently utilised in supply chain management.

3.1 VeChain

VeChain is an example of a Blockchain based application platform opted for by numerous supply chain networks. It is best defined as a “a blockchain platform designed to streamline commercial logistics and improve supply chain management through the use of distributed ledger technology”. (Aki 2023)

When investigating what platforms can help offer Blockchain based supply chains solutions, VeChain was found to be a popular choice. Currently, VeChain is involved in a large array of industries boasting numerous partnerships. Their primary focus is tracking the manufacturing and quality of the company's products utilising the transparency quality of Blockchain.

Through the use of smart contracts VeChain enables organisations of all sizes to track, verify and authenticate products and materials throughout the supply chain. This is achieved several methods like the aforementioned smart contracts as well as RFID and NFC technology. In the case of my research, logistics companies could really benefit from such technology as it would modernise traditionally methods like manually entering data from tracking and shipping codes which in my opinion is a lot more liable to issues like human error and unnecessary time consumption.

However, it is worth being transparent with the positives and drawbacks found in VeChain. VeChain opts for a centralised blockchain which translates too all data being stored and services being managed by a single supplier. This centralised blockchain, on the one hand, works great as it allows for close monitoring and control of the entire blockchain. In addition, the close control, grants VeChain the ability to quickly identify any potential issues and as well as increase transaction speeds. On the other hand, a centralised approach on a Blockchain is counterintuitive with the nature of Blockchain. This connotes to certain technical problems, such as outages within the VeChain servers which, if were to happen, can cause widescale disruptions to businesses all over the world.

VeChain, itself, is a Chinese enterprise which has links to the Chinese government. This is important to acknowledge as all cryptocurrencies have been banned in China and with VeChain operating on the exact same as technology foundation, it is natural for organisations to exercise concern with the software’s future. Furthermore, VeChain's growth potential may limited by its

inability to provide full consumer information, leaving it redundant when considered a tool for improving a supply chains transparency and collaboration.

(She 2022, 29-30)

3.2 Everledger

The next transformative blockchain based platform is Everledger. Everledger is another application built using the power of Blockchain technology. Which, according to their own website, is “enabling businesses to streamline processes while providing consumers with unprecedented transparency”. (Everledger 2022)

To boast such results, Everledger opts to use other industry 4.0 technologies in conjunction with Blockchain. Such industry 4.0 technologies as smart contracts and distributed ledgers make Everledger an exciting option for improving and accommodating the needs of the modern supply chain. The primary goal of Everledger is to create a secure and transparent solution to products facing a wide range of issues.

One industry which has seen their issues resolved by the blockchain based platform is the diamond. By leveraging blockchain technology again, Everledger can offer a secure and transparent solution for an industry which requires the upmost attention to provenance and sourcing. With Everledger, each diamond is assessed and assigned a unique digital record which profiles the diamond and gives it a history. This is achieved on tamper-proof ledger thus meaning the information is trustworthy and unchangeable. The utilisation of smart contracts is also present in Everledger as they opt to facilitate the verification and transfer of goods. This is in turn enhances efficiency through automation and the overall reliability.

Industries which are heavily reliant on their products and their respective supply chain journey can see the most benefits from utilisation. Through the detailed tracking and history of products, companies can be sure that their materials are obtained in an ethical, fair and safe manner. Manufacturing doesn’t disobey regulations and restrictions and products can be trusted by consumers. Issues regarding authenticity of products are mitigated offering stakeholders a piece of mind. This piece of mind can also be translated to the consumer who can be sure that they are not buying counterfeit or illegitimately sourced goods.

The drawbacks of Everledger for an international company often arises from collaboration. Again, as the platform is blockchain based, the nature of blockchain implementation requires widescale collaboration from stakeholders to reap the most benefits. Lack of involvement can reduce the

efficiency and effectiveness of the platform. In addition, smaller companies may find implementation too resource-intensive and complex to maintain.

(Everledger 2022) (Smits et al 2020, 3-10)

3.3 Provenance

Moving on, Provenance or ProvChain is example of currently available blockchain base cloud provenance that enables transparency and traceability in the industries it is applied to. Provenance is “is purpose-built for financial services” and “Supports the full-digitally native lifecycle of real-world financial assets” (Provenance 2024). Inherently, Provenance blockchain appears to benefit the financial sector mostly, however, the nature of the platform offers far more possibilities for improving and solving supply chains challenges.

ProvChain utilises a distributed ledger which entails each transaction or modification being recorded via their blockchain platform. In addition to blockchain and distributed ledger technology, ProvChain also is heavily reliant on other industry 4.0 technologies. For example, smart contracts and cloud computing which once paired with blockchain can offer more effective solutions to supply chain challenges.

As with the previous examples, ProvChain leverages the blockchain technology to offer an application that provides transparent and trustworthy records of origin, ownership, and any prior or future modifications. ProvChain sets out to accomplish four objectives, real-time cloud data provenance, tamper-proof environment, enhanced privacy preservation and provenance data validation. Each respective objective is accomplished through their Blockchain foundation and industry 4.0 technologies. The data they record uses blockchain technology due to the ability of data handling thus entailing safe data recording and maintenance.

In relation to supply chains, ProvChain shows promise due to its ability to store and maintain the provenance of data. Through utilisation, ProvChain can track and verify the movement of goods ensuring each stakeholder has a full insight into what stage of the supply chain their goods or materials are in, i.e. storage, transport, etc. In addition, the interoperable nature of the blockchain means that documentation and payment of goods process is easier and more streamlined. As each stakeholder can gain access to the data regarding their goods or materials, there is less need for physical paperwork. Consequently, if industries can find a way to involve all concerned parties in the supply chain, a greater efficiency in processes are achieved due to the collaborative and communicative nature of blockchain.

A drawback of this blockchain application is the lack of real-life case examples of supply chains using this platform. Despite the irrefutable secondary evidence that such a platform can work in a supply chain setting, a lack of readily available research online means implementation is unprecedented to some degree.

(Liang et al 2017, 468-477.) (Provenance 2024)

3.4 IBM Foodtrust

The final transformative blockchain based application I have investigated for supply chain implementation is created by the multi-national company IBM. IBM is company which prides itself in utilising the latest technologies to advance industry innovations. Of the industries influenced by these technological innovations, supply chains show great deal of promise. IBM Foodtrust is best summaries by themselves as “a collaborative network of growers, processors, wholesalers, distributors, manufacturers, retailers and others, enhancing visibility and accountability across the food supply chain” which is achieved through “a permissioned, immutable and shared record of food provenance, transaction data, processing details”. (IBM 2024c)

IBM Foodtrust uses the foundation of blockchain technology whilst utilising industry 4.0 technologies such as smart contracts, IoT and distributed ledger technology. The ideology behind using these technologies is to provide the food industry with greater transparency throughout their respective supply chains. When stakeholders involved in the supply chain collaborate, the advantages of blockchain technology materialise. One example is through the tamper-proof nature of blockchain which offers a full record of products history as it naturally travels through the supply chain. A reoccurring trait identifiable in all these examples of blockchain based applications. This full transparency helps limit issues such as fraud, mislabelling and lost goods. The collaborative nature of this application also allows the seamless sharing of data regarding the location of produce is, dwell time, and relevant food industry certificates.

The drawback, which is the common theme in all these blockchain based applications, is the collaboration requirement. Despite the enticing promises, challenges arise from the ability for all involved stakeholders to adopt. Lack of adoptions means lesser benefits from this blockchain platform. In addition, IBM Food trust implementers may endure challenges from costs. This is because industries hoping to improve their supply chain operations need to allocate resources, both time and money, into their existing systems to allow for implementation. (Chen & Long 2021, 3-11.) (IBM 2024c) (Oracle 2020).

Table 2 – Application Comparison

	Specifically for Supply Chains.	Utilisation of Smart Contracts.	Possible automation.	Stakeholder collaboration required.
VeChain	Yes	Yes	Yes	Partial or Full.
Everledger	No	Yes	Yes	Partial or Full.
Provenance	Yes	Yes	Yes	Partial or Full.
IBM FoodTrust	Yes	Yes	Yes	Partial or Full.

4 Summary

In conclusion, this study has illustrated the complexities of the modern supply chain's structure with no solutions considered 'one size fits all'. The complexities and demands such as globalisation, increased customer expectations and ever-evolving market environments continues to pressure supply chain managers to complete the intricate challenge of management.

When considering blockchain implementation, the research aims to compel the reader to further investigate the topic at hand. The author hopes by focusing logistical components of supply chains, companies operating in the logistics industry can formulate an understanding of what the technology is, what it can offer and methods of applications from this research.

After examination of the results, the author has revealed that correct implementation of blockchain in modern supply chains can yield significant benefits. To summarise, benefits such as increased transparency throughout the supply chain, improved traceability of materials and products, better overall efficiency, improved communication and collaboration between stakeholders and a potential long-term benefit of reduced costs can be expected. The author believes with a well devised plan and understanding of the aforementioned theory, Blockchain technology has the potential to not only solve common challenges and issues but revolutionize components of supply chains.

The author's research has answered the research questions regarding 'recommendations for a logistics company implementing Blockchain technology?' through four investigative questions, however, also believes that certain aspects covered in this research require additional research due to the nature of the topic. Research of primary nature would also benefit the reader by offering another perspective to the topic.

5 Research Methods

In this section I will be covering the research methods I have used and why. For my thesis, I felt favourably towards using desktop research as this allows me to identify, analyse and ultimately take the consensus on my topic. This inspired and allowed me to investigate the true potential blockchain holds in the supply chain which extends to even the international business world. Below I have illustrated my research and investigative questions. Each respective part of the research is broken down into a visual below.

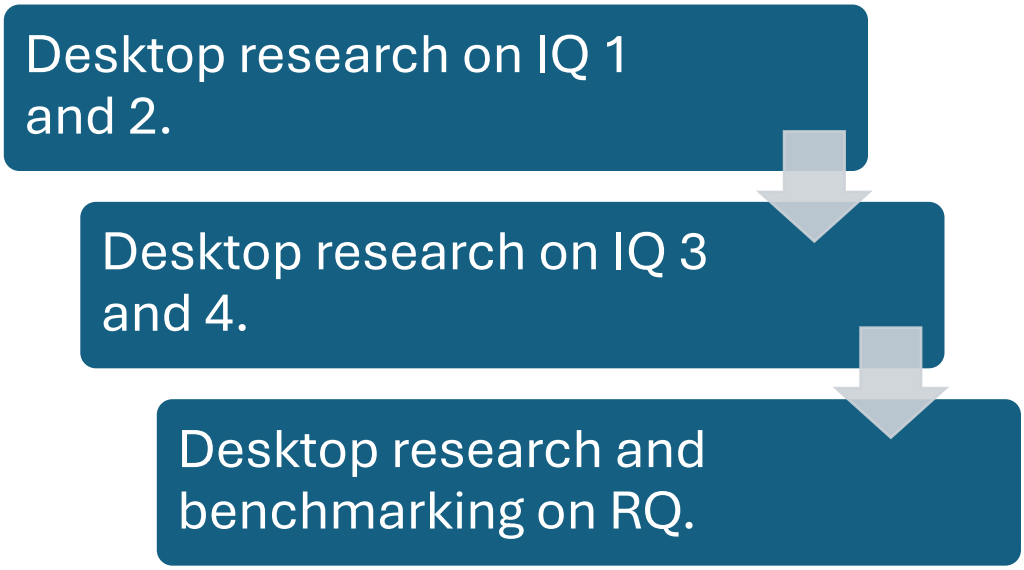

Figure 6 – Research methodology

The entirety of my research will be desktop using secondary data sources for IQ. 1 until IQ. 4.. This will allow me to find relevant reports on any examples of industries using Blockchain technology and ultimately help me answer my research question.

In correlation to that, the rest of my research has been conducted using the same means whilst also implementing benchmarking. I initially planned to use qualitative research through interviews will be used to help answer IQ.2, IQ.3 and IQ. 5 however have since opted for using solely desktop research due to several constraints. Qualitative research can be defined as “research using methods such as participant observation or case studies which result in a narrative, descriptive account of a setting or practice” (Drislane and Parkinson 2002).

Finally, I plan to inspect, analyse, and conclude on my research question through profound data collected throughout my thesis. This is what constitutes as applied research design as the chosen data is collected through several publicly available sources and seeks to solve issues. The

principles for choosing a applied research methods is because using several different information sources offers a more well-rounded understanding of the subject matter as well as removing any potential bias. In conjunction, I will be conducting benchmarking which is defined by one source as “compare the performance of different methods using well-characterized benchmark datasets, to determine the strengths of each method or to provide recommendations regarding suitable choices of methods for an analysis”. (Weber et al 2019, 1)

Consequently, if the desktop research is a success, I hope to be able to conclude my research question.

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