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Blockchain Technology Applications in the Business Processes of Logistics Enterprises

A study to explore improvements in Logistics Services Quality (LSQ) with blockchain technology

PATRICIA ALVINA

KTH ROYAL INSTITUTE OF TECHNOLOGY
SCHOOL OF INDUSTRIAL ENGINEERING AND MANAGEMENT

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A study to explore improvements of Logistics Services Quality (LSQ)

by

Patricia Alvina

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Abstract

Blockchain technology is an emerging technology that has attracted many enterprises' interest in recent years. Enterprises are interested in improving business processes using blockchain technology. Blockchain technology creates an immutable record and eliminates intermediaries in the many transaction processes. Logistics services are one of the business processes that could benefit from blockchain technology. However, as an emerging technology, there is a lack of tools to analyse blockchain technology applications in enterprises. This research paper explores how can blockchain technology be utilised to improve enterprises' business process, what will be the model of blockchain technology application, and how enterprise could utilise these models. There are three research methods elaborated in three parts of this report. The next paragraphs explain each part.

The first part explores literature articles to research blockchain technology and logistics services quality parameters. It will identify the components of blockchain technology that create immutable records and eliminates intermediaries. Furthermore, it expounds on the scope and quality of logistics services today. Finally, it identifies the advantages of blockchain technology to improve the quality of logistics service.

The second part of this report researches on the current use cases utilising blockchain technology that improve logistics services. A three-step prioritisation process is applied to define models of blockchain applications from the long list of use cases. The first step is to create a long list of use cases from the unstructured information on the worldwide web. In the second step, the findings from part one are utilised to cluster the long list of use cases into three models of blockchain use case in logistics services: trackability, traceability and direct transaction. Finally, the maturity of each cluster is analysed. Three readiness level are investigated: technological, consumer and regulation readiness. The combinations define the most matured to the least matured use case cluster.

The last part of this report analyses the implementation of models uses cases in various scenarios for application in information technology enterprises. Research on a scenario analysis method and on the relevancy to the enterprises' strategic decision-making process are explained. A simplified method is proposed to analyse the three models of blockchain technology from part two. The use case clusters are evaluated in various scenarios. The scenario analysis of the models of blockchain applications in logistics services will provide limited insight into how enterprises could implement the blockchain technology.

Sammanfattning

Blockchain-tekniken är en ny teknik som har fångat uppmärksamheten och intresset hos många företag de senaste åren. Företag är intresserade av att utveckla affärsprocesser med hjälp av blockchain-teknik. Blockchain-teknik skapar en oföränerlig post och eliminerar mellanhänder i de många transaktionsprocesserna. Logistik tjänster ä ren av de affärsprocesser som skulle kunna ha en fördel av blockchain-tekniken. Som en helt ny teknik är det och andra sidan brist på metoder att analysera blockchain-teknikens tillämpningar för företag. Denna uppsats efterforskar en metod för att analysera blockchain-tekniken i syfte att förbättra företags affärsprocesser. Tre forskningsmetoder är utvecklade i tre delar av denna rapport. Nästa paragraf beskriver de olika delarna.

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Första delen kommer belysa litteraturartiklar för att efterforska kvalitetsparametrar i blockchain-tekniken och logistiska tjänsters. Den identifierar komponenter av Blockchain-tekniken som oföränderliga poster och eliminerar mellanhänder. Fortsättningsvis, kommer den att belysa omfattningen och kvalitén av logistiktjänster idag. Slutligen kommer den att identifiera fördelar med blockchain-tekniken för förbättring av logistiktjänster.

Den andra delen av denna uppsats belyser aktuella användningsfall av blockchain-tekniken vid förbättring av logistiktjänster. En tre-stegs prioritetsprocess appliseras för att identifiera tillämpningar av blockchain modeller från en lång lista av användningsfall. Första steget är att skapa en lång lista av användningsfall från all ostrukturerad information på internet. Andra steget är att hitta, från steg ett, användningsfall och dela upp dem i tre modeller av blockchain användningsfall i logistiktjänster: lokaliseringgrad, spårbarhet och direkt transaktion. Slutligen, mognaden av varje kluster är analyserat där tre olika mognadsgrader har undersökts: Teknologi, beställaren och regleringsberedskap. Kombinationen definerar klustren från den mest mogna till den minst mogna.

Sista delen av rapporten analyserar genomförande-modeller av användningsfall i olika scenarier för tillämpning i företagstjänster för informationsteknologi. Efterforskning av metoder för scenario-analyser och relevans för förtagens strategiska beslutfattningsprocess förklaras. En förenklad metod förslås för att analysera de tre modellerna av blockchain-teknologin från del två. Mognadsgraden av varje kluster av användningsfall utvärderas i olika scenarios. Scenario-analysen av modellerna för blockchain-applikationer inom logistiktjänster kommer att ge begränsad insikt i hur företag kan implementera blockchain-tekniken.

Acknowledgement

Writing a thesis is harder than I thought and more rewarding than I could have ever imagined. None of this would have been possible without the help of some very special people, who i can not begin to thank enough.

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This accomplishment would not have been possible without them. From the bottom of my heart, thank you.

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Abbreviation and Glossary

Encryption is a process to convert information into a code that permits only the intended recipient with assigned authorisation understands the message.

Bill of Landing (sometimes abbreviated as B/L or BoL) is a document issued by a carrier (or their agent) to acknowledge receipt of cargo for shipment.

Bit string (in blockchain technology context) is a sequence of zero and one, typically use to manipulate a set of data.

Block (in blockchain technology context) is a virtual placeholder in a network whereby a set of transactions are kept.

Blockchain technology is a system which records transactions and maintain across several computers within a network.

Crypto currency is a digital currency which use encryption technique to maintain, regulate volume and verify transaction, off the central bank.

Custom is an authority or a country's agency responsible for controlling the flow of goods in and out of a country.

Decryption is a process to unveil encrypted message. The

Hash function is a function utilises to create any data of arbitrary size to fixed-size values. The results can be called hash

Immutable is inability to be change

Keys (in network security) are an instruction to encode or decode a (set) of data

Ledger is a principle book/file recording all transactions with monetary values.

Metadata is a set of data that describes and gives information about other data.

Nodes (in computer networking context) are a device that connects between points, device that redistributes between point or communication last point.

Nonce is an arbitrary number use once in a cryptographic communication to ensure old data can not be repeated.

Peer to Peer (In computer network) is a network of computer, whereby all computers are in the same level. Peer computer shared resources with the network without approval from a central server.

Pellet is a portable platform whereby good can be staked on top of it normally to be move from one place to another.

Trust (in business transaction) is a basis for two parties reaches an agreement. It is a belief that each party is reliable and capable of performing or delivering the product/services as stated in the contract.

Turing complete is a machine that capable to solve beyond one purpose of calculation by using loop function.

Value chain is a process of activities whereby a person or companies add value to a product

Warehouse is a building whereby products are stored before distribution

1. Introduction

1.1 Background

The reliability, availability and safekeeping of information are challenges of every database system today (Tari, et al., 2015). Increased information stored in a digital form in recent time made the role of database systems crucial. As explained by Jeff Garzik (2018) and Tiana Laurence (2017), blockchain technology is a system to store information in a network of decentralised databases (Laurence, 2017; Jeff Garzik, 2018). A verification system and an encryption process are integral components of blockchain technology. The information stored in a blockchain technology network is immutable. It offers to improve the transparency of transactions' processes, to bring trust in the information shared to the unknown party and to secure information with ease (Jeff Garzik, 2018; Laurence, 2017). The interest in blockchain technology has been gaining momentum in recent years; the first blockchain technology in a commercial form is a management tool for a cryptocurrency platform, named bitcoin (Verhelst, 2017). It has successfully managed the cryptocurrency in automatic authentication access and lower administrative cost (Verhelst, 2017). The proven value of blockchain technology has motivated more applications in more industries. Implementation of blockchain technology in logistics promises to bring significant change to the industry (Abeyratne, n.d.; O'Marah, 2017; Casey & Wong, 2017; Hackius & Petersen, 2017). Therefore in this paper, the focus is on logistics services.

DHL Corporation and Accenture Consulting (2018) wrote the blockchain technology has the potential to improve the product flow from the origin to the point of consumption (DHL Corporation and Accenture Consulting, 2018). They have further elaborated that the capability to create an immutable and a single trusted database system could potentially improve, for instance, the time and precision of product delivery. Logistics service is defined traditionally as a service to move products from one place to another. However, today, the definition of logistics services has expanded. Lars Huemer wrote that logistics services, including the product flow improvements, are under the umbrella of logistics services (Huemer, 2012). Hence, logistics services today are a multi-party process, meaning: information transfers between multiple parties, and the authenticity of that information remains a challenge as it is being duplicated manually during transfers. As written by DHL Corporation, Accenture Consulting and Salman A. Baset, digitising this information in logistics services is a challenging and costly exercise (Baset, 2019; DHL Corporation and Accenture Consulting, 2018). The multi-party collaboration process of logistics services requires the data to be stored by an unbiased third-party system. The third-party ensure equal access to the authentic information and high availability of information for all parties. Logistics services are serving multiple industries and require complex management. Improvements in logistics services could influence many industries' efficiencies. Blockchain technology has the potential to change the traditional practice of logistics services (DHL Corporation and Accenture Consulting, 2018).

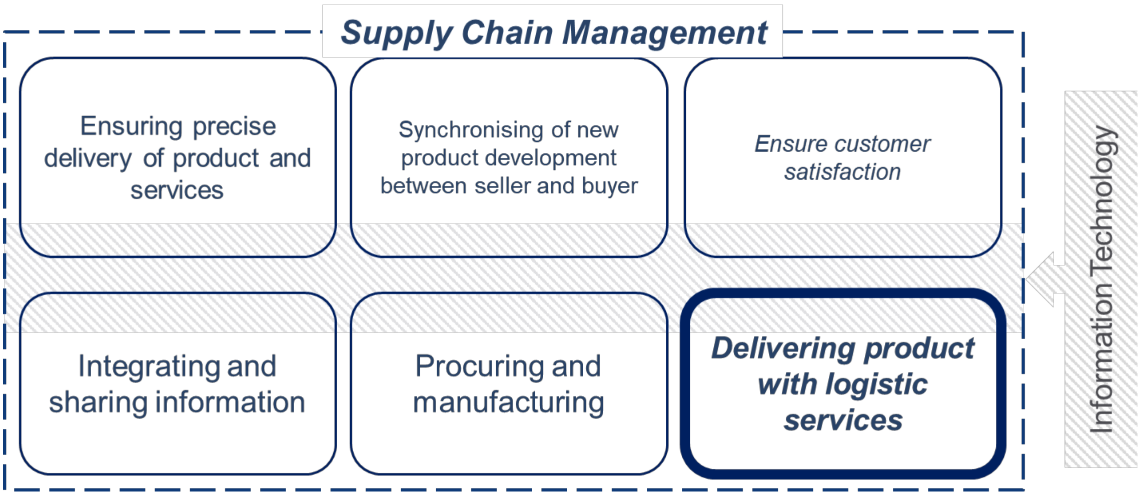

Figure 1-1: Relationship between supply chain management, logistics services and information technology (Dansomboon, et al., 2016).

Logistics services today are a combination of several activities: from managing a fleet of vehicles, transportation of products, strategising delivery alignment between sourcing and procurements, managing information flow and supply network (Zijm, et al. 2019). The activities in logistics services are coordinated to support supply chain management (Huemer, 2012). Figure 1-1 illustrates the relationship between logistics, supply chain management and information technology layers. As described by Henk Zijm in his book, supply chain management is a broad range of activities. The activities of supply chain management comprise of measurement of performance, product development, customer services, integration and information sharing, procurement and manufacturing and logistics services. The activities are meant to optimise the flow of material, information and cost from the point of origin to destination (Dansomboon, et al., 2016). Dansomboon et al. (2016) mentioned that a well operated logistics services enhances competitiveness of sellers. Information technology has become an underlying essential tool to integrate all activities. Improvement in information technology is crucial for logistics services and supply chain management (Gil-Saura & Ruiz-Molina, 2011; Zijm, et al., 2019). Emerging information technologies such as artificial intelligence, internet of things, machine learning and blockchain were identified as a potential disruptor for these industries (Zijm, et al., 2019). However, implementations of these technologies in an enterprise are minimal (Baset, 2019; Zijm, et al., 2019).

Factors causing the limited implementation of emerging technologies are complex (Baset, 2019; Evans, 2013). On the one hand, enterprises are hesitant to implement new technology without comprehensive tests, as reliability is essential. Conducting a comprehensive reliability test need significant resources. On the other hand, the functionality of mature technologies is tested and proven over the years. An enterprise must be sure of the values that the emerging technologies could bring to the existing process before implementation. Salman A. Baset argues that the adoption of new technology in the enterprise should improve efficiency but as with minimal downtime as possible to the existing business process (Baset, 2019). The limited implementation of emerging technologies provides the possibility for information technology enterprise to fill the gap and bring the blockchain technology to maturity and commercialisation. However, developing new technology to maturity comes with risks. This paper explores three challenges as it has potential to improve product flow from origin to destination. They are 1) the functionality of blockchain technology influencing the logistics services, 2) the maturity of blockchain technology for logistics services and 3) scenarios whereby models use cases can be implemented by an enterprise. The next section explains the research structure to address these challenges.

1.2 Research Structure, Questions and Objectives

With the given challenges, the report is subdivided into three parts. This section begins with the research structure. Subsequently, each part's research questions and objectives, and the methodology employed in this research, and its limitations, are elaborated.

Blockchain technology has the potential to improve business processes (DHL Corporation and Accenture Consulting, 2018). However, without complete information, the challenges of implementing emerging technologies remain unresolved. Selected challenges in implementing blockchain technology in an enterprise are going to be elaborated. Figure 1-2 illustrates the research structure. The challenges are explained in a three-part report, and each part of this report is independent. It contains research questions, the objective and the methodology. Each part response to various challenges in implementing blockchain technology in an enterprise. The results of part one are carried over to part two. Subsequently, the result of part two is employed in part three. The topic gets more in-depth as we get to the next part.

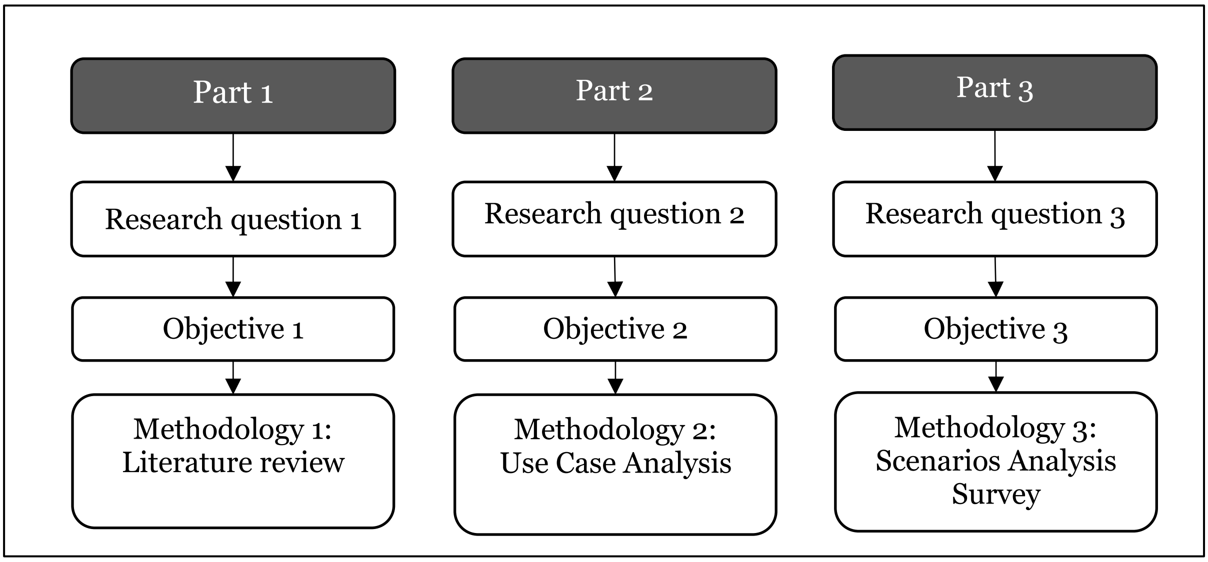

Figure 1-2: Structure of this research

1.2.1 Research Questions and Objectives

As mentioned in the research structure, the research process is subdivided into three parts. The goal of each part is to address a challenge in implementing blockchain technology at various levels. From the high-level perspective to a specific area of application. The main research question is how could blockchain technology be implemented to improved enterprise' logistics services processes. In order to address this central research question, three sub-research questions for each part are developed:

1. Part 1: How can the blockchain technology improve logistics services? (employing literature review)
2. Part 2: What will be the model of blockchain technology suitable for logistic services based on use cases analysis?
3. Part 3: How does the digital enterprise optimise itself to implement blockchain technology within the industry?

1.3 Types of Methodologies Employed in This Report and Limitation

The research structure described that this report is subdivided into three parts. This section explores the methodologies used in each part of the research. It begins with the reasoning behind the used methodology, followed by the limitations of the methodology.

As described in the research question, each part is addressing a challenge in implementing blockchain technology. The outcome of the first part use as a foundation for the subsequent part.

1.3.1 Methodology and Limitation for Part One: Characteristics of Blockchain Technology Influencing Improvements for Logistics Services

The research question mentioned that part one explains the blockchain technology components that could improve key performance parameters of logistics services as part of the supply chain management. The sub-topics to be elaborated explores the different components of blockchain technology as an emerging technology and critical performance parameters of logistics services as part of supply chain management. A literature review is a primary method in part one.

As this topic is a new area of research, there are a few academic publications. The academic publications mostly address the issue of technical performances in blockchain technology. However, there is an information gap to address the main research question. Non-academic sources are utilised to fill this gap. The non-academic source of literature is also known as grey literature (Orlov, 2017; Edeland & Mörk, 2018).

The types of grey literature utilised in this report are:

- White papers produced by commercial and government organisations
- Government institutions' reports
- Online posts on blockchain community platforms
- Consultants' reports

The grey literature has limitations. Although it could contribute to a high-level commercial perspective on the blockchain technology, a verification layer is needed to support the grey literature (Edeland & Mörk, 2018). Research publish on academic paper can support the finding from grey literature. The literature review was consolidated using online search engines such as Google Scholar and KTH Library search engine. Next, the methodology and limitation of part two are explained.

1.3.2 Methodology and Limitation for Part Two: Models of Blockchain Technology-Based Application for Logistics Services

As part one explains the components of a blockchain technology that influence logistics services, part two will examine use cases that have been developed using blockchain technology in a broad spectrum of logistics services. In particular, the type of blockchain use cases that could be the model for logistics services. As the nature of the research question is explorative and qualitative, use case analysis is the most suitable method to address it. A vast number of blockchain use cases were needed to address this question.

Internet search engines and grey literature are the primary sources to scan for existing blockchain use cases. The result is a wide range of use cases. Subsequently, a method to identify strategic blockchain use cases relevant to logistics and supply chain management was needed.

The methodology to evaluate the gathered use cases is a three-step process: inventory, assessment and prioritisation. Edeland & Mörk (2018) use a similar method. However, this method has been modified to address the logistics services industry. It is elaborated in section 8. The result subjected to researcher's selection bias. At the end of this section, a selected number of use cases were investigated further and presented in part three.

1.3.3 Methodology and Limitation for Part Three: Information Technology Enteprises Implementation of Blockchain Technology for Logistics Services

As part two provide an overview of use cases models that have the potential to improve logistics services, part three investigate the scenarios of implementation and deployment model of these use cases in a logistics enterprise. The research divided into a two-step research process. Firstly, possible future scenarios are elaborated. Secondly, a survey was conducted to observe opinion on the blockchain deployment in an enterprise. The secondary data source is used as the primary source of scenarios development, and grey literature supplements the research.

A survey technique was employed to reach out to a broader audience. The limitations of a survey are the perceptions of respondents and investigators to the survey questions. The perceptions are due to social contexts such as group affiliation and social consciousness (Gostkowski, 1974; O'Leary, 2004)

At the end of part three, a perspective on implementing blockchain technology as an emerging technology to be expounded. In combination with part one and part two, this report answers two challenges in implementing blockchain technology. Although it is incomprehensive, this study provides an early explorative research method and a foundation for further research.

Part One: Characteristics of Blockchain Technology Influencing Improvements for Logistics Services

As mentioned in the research structure, part one elaborates on blockchain technology and logistics services based on a literature review. Specifically, how can blockchain technology improve logistics services? This paper proposes to address the questions in three chapters (chapter 2, 3, 4). Chapter 2 explains blockchain technology platforms' categorisations and characteristics, while in chapter 3 explores logistics services as part of supply chain management and its quality services parameters. Lastly, chapter 4 elaborates on the components and principles of blockchain technology that can influence the logistics services.

2. Blockchain Technology Platforms’ Categorisations and Characteristics

This chapter is the first out of two literature reviews in part one. It explains about blockchain technology platform categorisations. Four types of categorisations are proposed. It commences with a high-level categorisation of the accessibility of blockchain networks to a more specific component of blockchain technology, methods to reach an agreement (consensus) and automation in the process (smart contract).

As mentioned in the introduction, blockchain technology is a decentralised data storage system. Blockchain technology’s first commercial application in Bitcoin (2009) provides characteristics such as leaving traces for any desired and undesired changes, resist undesired changes, digital and distributed data storage systems without a central repository (Nakamoto, 2008; Yaga, et al., 2018). More platforms have been released over the years, and the functionalities of blockchain technology have improved.

The number of platforms inspired by the functionality of blockchain technology has grown in the past years. Examples of platforms launched after the first blockchain technology concepts are Hyperledger, Ethereum, Corda R3 and IOTA (Brown, et al., 2016; Behlendorf, 2016; Blazevic, 2008). However, it remains challenging to know whether these platforms have similar characteristics of blockchain technology. The main challenges for identifying blockchain-based technology platforms are the inconsistency in the grey literature, the rapid growth of these platforms and the open-source nature of the first blockchain technologies. In an open-source platform, controls of the versioning system and production versions are not as comprehensive as a commercial system (Edeland & Mörk, 2018).

According to the National Institute of Science and Technology, United States Department of Commerce, there are several methods to categorise blockchain technology (Yaga, et al., 2018). This paper proposes categorisations based on the accessibility of the network where the blockchain technology is deployed, the components of blockchain technology, the method to get consensus when keeping data and applications of a smart contract. The categorisation methods align with the method proposed by (Yaga, et al., 2018).

As an emerging technology, blockchain platforms are improving at a fast pace (Banker, 2017). Categorisation should not define the quality of blockchain technology or technical challenges — instead, this paper focuses on how blockchains platforms addressing various business challenges. Therefore, answering the research question of blockchain technology’s capabilities to assist logistics services. The technical challenges of each blockchain technology are excluded in this research, because it affects all blockchain technology (Edeland & Mörk, 2018). The categories mentioned in this section identify a variety of blockchain technology platforms.

2.1 Categorisations of Blockchain Technology Platforms

This section elaborates on four categorisations methods of blockchain technology platforms. The categorisations are based on the accessibility of the network where the blockchain technology is being deployed, the components of blockchain technology, the method to get a consensus of data and the application of smart contracts. The categorisation provides a method to identify similarities in blockchain technology platforms.

2.1.1 Categorisations Based on Accessibility of the Network Environment

As mentioned in section 1.1, blockchain technology is a system to store information in a network of decentralised databases (Laurence, 2017). Blockchain is a distributed, immutable database that brings trust to the system, instead of to a third party (Yaga, et al., 2018). One of the components that made this possible is the type of network environment of blockchain. Two popular access types of blockchain technology networks are permissionless networks and permissioned networks. The permissionless network was first deployed by Bitcoin allow a large number of participation from the public, who are strangers and did not trust each other (Jeff Garzik, 2018; Yaga, et al., 2018; Nakamoto, 2008). However, many blockchain technology platforms today employ permissioned network. Both networks are explained in the next paragraphs.

Permissionless Networks: In the permissionless blockchain technology networks, anyone in the network can participate regardless of the past relationship, or invitation. Blockchain technology does not determine the results, nor another person in the network. An agreement can be reached with decentralised consensus without trusted third parties.

“Permissionless blockchains reach decentralized consensus without requiring pre-established identities or trusted third parties, thus enabling applications such as cryptocurrencies and smart contracts. A consensus is agreed on data that is generated by the application and transmitted by the system's (peer-to-peer) network layer.” (Neudecker & Hartenstein, 2018)

The bitcoin platform was the first blockchain technology that utilised the concept of the permissionless network in blockchain technology (Verhelst, 2017; Nakamoto, 2008). It allows anyone to set up a network node, read and write to the network and contribute to the decision-making process. As there is no limitation on participants, there is no boundary on the size of the network (Yaga, et al., 2018; Jeff Garzik, 2018).

The permissionless network is synonymous with unregulated environment, favourable for innovative nature of emerging technologies (Buterin & Mougayar, 2016). However, they explained that permissionless network is not well accepted for businesses' regulated and structured processes.

Permissioned Networks: These networks are created to leverage on the need of blockchain technology for application in the business environment (Behlendorf, 2016; Baset, 2019; Buterin & Mougayar, 2016). Buterin & Mougayar (2016) wrote that businesses need regulated and structured processes. Therefore a permissioned blockchain network's limit this participation. The networks operate in a private setting with a form of identity or authorisation. Hence, the capability to access or participate in the networks is limited to a selected user (Buterin & Mougayar, 2016; Yaga, et al., 2018). Yaga et al. (2018) explain that permissioned blockchain networks offer the same benefits as permissionless blockchain networks. Both networks are capable to store information in the network of a decentralised database, distributed and immutable.

The benefit of a permissioned blockchain network is an increased level of trust between users (Yaga, et al., 2018). The higher level of trust is formed due to limited participation and punishment for misbehaviour (Buterin & Mougayar, 2016; Yaga, et al., 2018). A network administrator could be assigned to limit participation with authorisation and to create rules for participation. Misbehaviour of a participant could result in the access being revoked. Consequently, as the participation is limited, the network size and hardware resources are reduced.

Yaga, et. al. (2018) explain that as the permissioned network is meant to comply with the regulatory environment, the participant's access to data could also be controlled (Yaga, et al., 2018). Figure 2-1 describes examples of data accessibility in the permissionless and permissioned networks. Buterin & Maugayar (2016), in The Business Blockchain book, explains that the permissionless network is the starting position for innovation (Buterin & Mougayar, 2016). As innovation, unregulated and permissionless environments are relevant to each other, permissioned network has muted innovation potential.

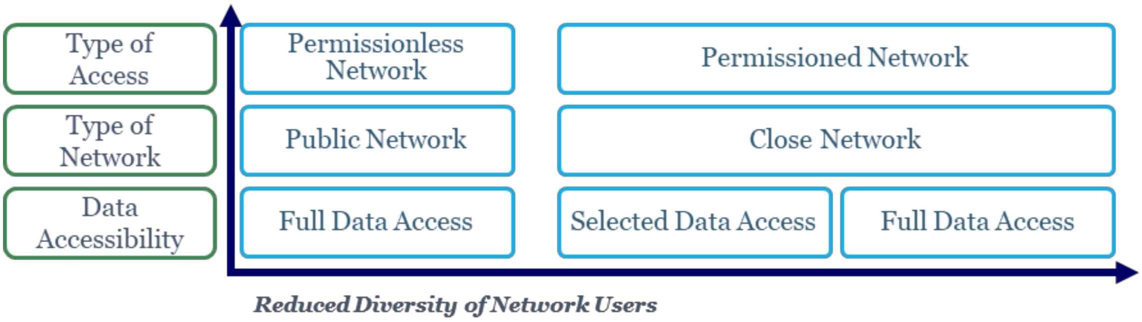

Figure 2-1: Types of access, network and data accessibility (Yaga, et al., 2018)

Network access types are a categorisation from a high-level perspective. This categorisation indicates the types of environments a blockchain could be deployed in. Blockchain components could provide another layer of blockchain technology categorisation.

2.1.2 Categorisation Based on Application of Blockchain component

In the first level of categorisation, blockchain technology is differentiated based on the network types. In the second level of categorisation, it differentiates the components of the blockchain. A blockchain is comprised of several supporting components that create a unique Distributed Ledger Technologies (DLT) functionality. These components are Cryptographic Hash Function, Asymmetric Key Cryptography, Block, Chain and Nodes (Yaga, et al., 2018; Laurence, 2017).

Figure 2-2: Components of Blockchain Technology (non-comprehensive) (Inspired by Yaga, et al., 2018; Laurence, 2017; Zheng, et al., 2017)

The components are grouped and elaborated based on the function they serve in the blockchain technology. This paper proposes two categories. Firstly, components that allow private communication in public networks. They are grouped into cryptography. These are cryptography hash function and asymmetric key cryptography (Yaga, et al., 2018). Secondly, components that allow data to be kept in the blockchain technology. These components are blocks, ledgers and chaining blocks (Laurence, 2017).

2.1.2.1 Components for secure communication in public: Cryptography

The components that allow private communications in the public domain computer networks (i.e. the internet) fall into this category. They are grouped under the cryptography function. Delfs and Knebl in their book wrote cryptography allows the sender to conceal a message and prevent it from being read or modified by an unintended recipient (Delfs & Knebl, 2015). Only the intended recipient can retrieve the original message. These processes are also known as encryption and decryption. Cryptography uses an algorithm and a key for the encryption and decryption process (Yaga, et al., 2018). Two parties can communicate in a public domain without letting another party understand the message by using an algorithm and a key (Esl, 2012). An algorithm and a key allow messages to be encrypted and decrypted by the intended recipient. A message authentication process could be added to ensure an additional layer of security (Yaga, et al., 2018).

In order to ensure messages receives by the intended party and have never been altered, blockchain technology combines cryptography with an asymmetric key and a message authentication process (Nakamoto, 2008; Yaga, et al., 2018). It resulted in two cryptography methods: asymmetric key cryptography and cryptography with a hash function as a message authentication process (Yaga, et al., 2018).

Asymmetric Key Cryptography

As mentioned, keys are needed to encrypt and decrypt messages in cryptography. The same key or a different key could be used for encryption and decryption processes. Blockchain technology uses a different key to allow a public audience to send a message. Asymmetric key cryptography is an improved version of symmetric key cryptography (Laurence, 2017). The challenge in symmetric key cryptography is on the distribution of keys without giving access to an unintended recipient (Yaga, et al., 2018; Laurence, 2017). Asymmetric key cryptography resolves this issue by using two keys. These keys are a public and a private key. The public key is available for everyone, while the private is only belong to the owner. The public key is used when encrypting a message, while the private key is used during a decryption process (Esl, 2012; Yaga, et al., 2018; Nakamoto, 2008). Refer to Figure 2-3, for the difference between asymmetric and symmetric key encryption (Esl, 2012; Delfs & Knebl, 2015). Messages can be transferred securely from A to B because only B knows the key to unveil the encrypted message sent by A.

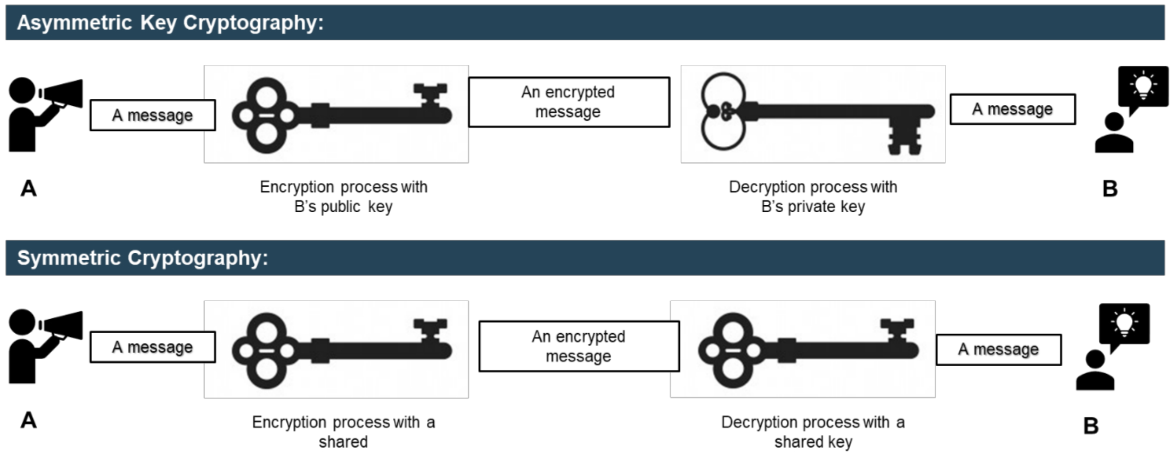

Figure 2-3: Illustration of asymmetric and symmetric keys (Inspired by (Esl, 2012; Yaga, et al., 2018))

Cryptographic Hash Function

As the first cryptography function ensure only the intended recipient can unveil the message, this second cryptography component of the blockchain technology ensure the message is authentic (Esl, 2012). In a public computer network, a message is considered as an authentic message when it is originated from the intended sender and never been altered during transmission (Esl, 2012; Delfs & Knebl, 2015). An authentication function can be applied to ensure the authenticity of the message.

Yaga et.al. explain that the blockchain technology uses a hash-authentication function to ensure a genuine message has been transmitted to the intended recipient. In the book "The introduction of cryptography" by Delfs & Knebl (2015) elaborate that the hash function created a fixed-length output when applied to a variable-length message (Delfs & Knebl, 2015). Figure 2-4 illustrates the concept of cryptography hash function (Yaga, et al., 2018). Regardless of the input length, the output is always the same length. This fixed-length output serves as the message authenticator. The cryptographic hash function has several key improvements over other authentication functions:

1. Preimage Resistant. The message is not reversible or invertible, as it is only for decryption at the recipient's end.
2. Second preimage resistant: It is computationally infeasible to find the same second output from the same input
3. Collision resistant: It is computationally infeasible to produce the same hash output.

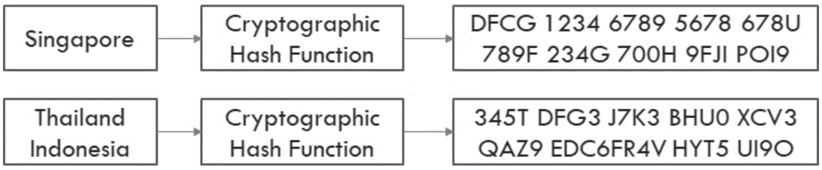

Figure 2-4: Example of cryptography hash function used in Bitcoin (Inspired by (Yaga, et al., 2018))

The application of cryptography hash functions resulted in infeasibility to calculate the input using the output and the certainty that each output is unique (Esl, 2012; Yaga, et al., 2018). Cryptography is applied to many other components of blockchain to ensure only the intended recipient receives the message. These components are elaborated in the next paragraphs.

2.1.2.2 Components that allow data to be kept in the blockchain technology: Data Storage

This section elaborates on the way blockchain technology stores information. The list of components that make up blockchain technology varies from literature to literature. However, as the objective of part one of this report is to understand blockchain functionality that could assist logistics and supply chain management, this report focuses on the common blockchain technology components to provide a basic understanding of the technology. These components are blocks, chains and nodes in a blockchain technology network.

Blocks

Blocks are a collection of transaction data that have been grouped together over-time (Laurence, 2017). Laurence (2017) explains that the number of transactions per block and triggering events for each block is different and pre-defined for each blockchain technology platform.

Chain

The chain in blockchain technology is a concept of linking one block to another block (Laurence, 2017; Yaga, et al., 2018). Laurence (2017) and Yaga, et al. (2018) further elaborates the block is linked mathematically with a function named hash. Figure 2-5 illustrates the concept of chaining blocks. As seen in the figure, the hash in the new block is a result of converting values from the previous blocks, a one-time use set of number, a timestamp and a hash of the data inside a block. When the hash function is repeated from one block to another block, the result is a sequence of blocks of which the order cannot be changed. Any change in the transaction data, transaction number or sequence of blocks change the hash value, which is not a matched with the previous or the next block hash value (Laurence, 2017; Yaga, et al., 2018).

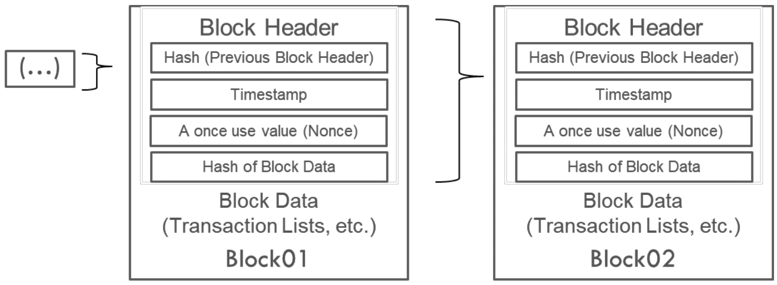

Figure 2-5: Generic concept of blocks and chain (Inspired by (Yaga, et al., 2018) (Laurence, 2017))

Nodes

Nodes in the blockchain network could be seen as representing participants. The naming convention of the nodes varies from one blockchain technology platform to another platform. However, the common type of node across platforms is a node that carries the complete records of all transactions or all blocks. These nodes are named full nodes in the first generation blockchain network and Ethereum. Blockchain network constitutes of full nodes (Laurence, 2017).

The naming convention and functionality varies in other types of blockchain platforms (Buterin, 2014; Behlendorf, 2016; Brown, et al., 2016; Nakamoto, 2008). However, nodes still represent participants in blockchain technology. A collection of nodes creates a blockchain technology network. There are differences in the nodes' naming convention and functionality for each blockchain technology. However, it is not be investigated further in this report.

2.1.3 Categorisation Based on Application of Consensus Algorithm

Until now, the types of network environment and components of blockchain have been described. At this point, the methodology for blockchain to reach an agreement is discussed. Blockchain technology reaches an agreement to produce a block with a consensus algorithm. The consensus algorithm varies depending on the purpose of the platform (Baset, 2019; Buterin & Mougayar, 2016). As blockchain technology's main function is to bring trust into the system, the consensus algorithm becomes an essential mechanism in the blockchain technology platform (Yaga, et al., 2018; Jeff Garzik, 2018; Behlendorf, 2016; Laurence, 2017).

"Blockchains are powerful tools because they create honest systems that self-correct without the need for a third party to enforce the rules. They accomplish the enforcement of rules through their consensus algorithm." (Laurence, 2017).

This section is elaborated in the following structure. Firstly, a typical transaction process to reach a consensus will be elaborated. Secondly, the consensus algorithm used in permissionless and permissioned network is elaborated. Lastly, each consensus model is explained.

Blockchain Processes to Reach a Consensus

As it has been pointed out, blockchain is a database system keeping records of various transactions in the network. Laurence (2017) explains the processes of the creation of a new block in the blockchain technology. The process begins with a participant requesting for a transaction to be recorded in the blockchain network. The request is broadcast to all nodes. The nodes validate the transactions. The validated transaction is added to the nodes' block. As mentioned before, a block has a predefined number of transactions. When the maximal number of transactions per block is reached, it triggers a process to decide which node's block will be added into the older chain of blocks (Yaga, et al., 2018). Ethereum (2019) explained that the processes in the ethereum platform are similar. Subsequently, nodes have to decide which block will be the block to be chained with the existing chain of blocks. Due to delay in transmission, the block created in each node may carry a different sequence of transactions. Nodes must follow a set of rules and regulation to decide which block should be added into the older chained of blocks (Laurence, 2017; Yaga, et al., 2018). The rules and regulations are defined in the consensus algorithm. When the nodes reach an agreement, the new block is added into the older chain of blocks. The transaction is then confirmed. Changes can be no longer be made to the transactions (Laurence, 2017; Yaga, et al., 2018).

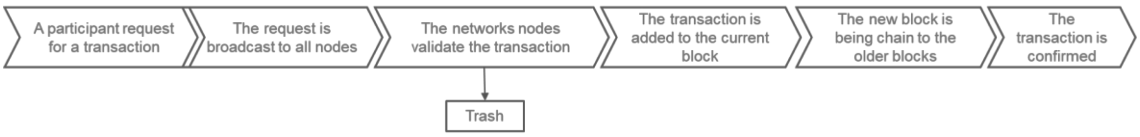

Figure 2-6: Conceptualization of processes in the Blockchain Technology (Inspired by: (Laurence, 2017))

Blockchain technology today employs various consensus models (Yaga, et al., 2018; Behlendorf, 2016). The selection of rules and regulations of reaching a consensus are relevant to the network environment where the blockchain platform operates (Buterin & Mougayar, 2016; Buterin, 2014; Hyperledger, 2018; Intel Corp., n.d.). In the permissionless network whereby the participants could be anyone, the level of trust between participants is very low. Hence, a comprehensive consensus algorithm should be employed to bring trust to the system (Laurence, 2017; Yaga, et al., 2018). An example of this consensus algorithm is Proof of Work. However, in the permissioned network, a form of authentication is implemented to participate in the blockchain platform. The level of trust between participants is higher, as each participant has gone through a form of reliability screening process (Baset, 2019). In this case, a comprehensive consensus algorithm is not necessary. A simplified consensus algorithm suffices to bring trust to the system (Yaga, et al., 2018; Laurence, 2017). Proof of Stake (PoS) and Proof of Elapsed Time (PoET) are examples of simplified consensus algorithms (Hyperledger, 2018; Ethereum, 2019).

Consensus Model: Proof of Work

Proof of Work (PoW) is a type of consensus algorithm for a permissionless network, whereby anyone could participate and the level of trust between participants is the lowest. PoW is seen as the most secure consensus algorithm when solving the byzantine general's problem (Laurence, 2017).

"It solves the byzantine general's problem, which is the ultimate human problem, especially online: How do you trust the information you are given and the people who are giving you that information, when self-interest, malicious third parties, and the like can deceive you." (Laurence, 2017)

PoW is a complex cryptographic hash function and computationally intensive puzzle (Yaga, et al., 2018; Buterin & Mougayar, 2016; Behlendorf, 2016). When the node is the first to solve this computationally intensive puzzle, it will become the new block and will be chained to the old blocks.

Bitcoin and Ethereum 1.0 are currently using the PoW consensus model. Although PoW is a highly secure consensus model, it has its challenge (Laurence, 2017; Ethereum, 2019). Due to the complexity of the puzzle in PoW, it takes more resources and a longer time to solve a puzzle, to reach a consensus and to create a new block. This challenge increases as the number of blocks grow. Blockchain applications that need an immediate transaction's finality and fewer resources, PoW consensus algorithm may not suffice (Yaga, et al., 2018; Buterin & Mougayar, 2016).

Consensus Model: Proof of Stake

Proof-of-Stake (PoS) is currently deployed for a permissionless network with less time to reach consensus in comparison to PoW (Ethereum, 2019; Buterin, 2014; Buterin & Mougayar, 2016). The PoS consensus algorithm opens the possibility for all participants to create a block by submitting an asset as collateral. Once the deposit has been submitted, these participants are invited to solve an algorithm. PoS relies on the idea that the more collateral a participant invested in the system, the higher the amount this participant has to lose if the system fails (Buterin & Mougayar, 2016). Hence, the participants will work to make it a success and less complex algorithm may suffice.

Consensus Model: Proof of Elapsed Time

Proof of Elapsed Time (PoET) is one of the consensus algorithms deployed in permissioned and permissionless network. It works in a similar way as PoW. However, it uses fewer resources in comparison to PoW (Intel Corp., n.d.; Hyperledger, 2018). As there is very limited literature on PoET, this section discusses only PoET 1.0. It is also known as PoET SGX (Intel Corp., n.d.). It works in a similar way as PoW and offers a solution for the byzantine general problem. However, the PoET consensus algorithm works by selecting random participants to solve a puzzle at a given target rate. So, it uses significantly fewer resources (Yaga, et al., 2018; Hyperledger, 2018; Intel Corp., n.d.). The trust to the system is created due to blockchain technology's deployment in a trusted environment, identity verification and blacklisting based on asymmetric key cryptography and a set of election policies (Intel Corp., n.d.).

In summary, there are many consensus algorithms today. These consensus algorithms offer solutions to a byzantine general problem in various degrees of complexity and security. PoW is perceived as the most secure consensus algorithm (Laurence, 2017). However, it takes a longer time for a transaction to reach finality and require more resources. On the contrary, PoET uses less time to create a block and reach transaction finality in comparison to PoW (Laurence, 2017). The trust in the system is created by implementing a set of rules and regulation to be a participant. As the process of reaching an agreement to create a block is known, the challenge is how to make a binding blockchain transaction.

2.1.4 Categorisation Based on Application of Smart Contract

Until now, components that secure the blockchain platform when a transaction enters the system have been explained. Blockchain technology brings trust to the system. Here, the components that could bring two participants from the general public to trust and agree on entering into a transaction are elaborated. The smart contract provides an assurance to both parties by connecting assets to the digital platform (Buterin, 2014; Yaga, et al., 2018; Buterin & Mougayar, 2016). An example of an asset is digital currency or cryptocurrency. The connection of digital assets into a transaction makes it possible to enforce a consequence when a clause in a contract is breached. As a smart contract is issued within a blockchain technology platform, it carries the security component mentioned above. It results in immutability and traceability if any changes are made in the transaction (Buterin & Mougayar, 2016; Yaga, et al., 2018).

In enterprise blockchains, a smart contract is unique for each process (Buterin, 2014). Hence, the improvement made in a smart contract by ethereum platform and hyperledger has made blockchain technology become useful for enterprises. The difference between these platforms are discussed in the next section.

2.2 Summary: Comparison of Blockchain Technologies

In this section, three types of blockchain technologies are elaborated and discussed. They are bitcoin, ethereum and hyperledger.

Bitcoin

Bitcoin was the first implementation of the blockchain platform (Verhelst, 2017). The idea was written by Satoshi Nakamoto in 2008. The intent of the platform was to solve a double-spending problem in a peer-to-peer electronic cash transaction without a third party. Double spending means the same resource is used twice. The blockchain technology platform in bitcoin resolved this issue by using proof of work consensus model in a permissionless network available for the public (Nakamoto, 2008). As more participants join in the network, the network becomes more decentralised and secure. However, bitcoin technology also comes with challenges. Firstly, more resources needed to resolved the PoW consensus model and create a new block as the chain of blocks gets longer (Buterin, 2014). Furthermore, bitcoin was intended only for one application, a peer-to-peer electronic cash transaction, in one blockchain technology platform (Buterin, 2014). The smart contract in the bitcoin platform is non-programmable. These concerns were addressed in the subsequent versions of the blockchain technology platform.

Ethereum

In the ethereum's website, the first of ethereum project (2015) was proposed by Vitalik Buterin (Ethereum, n.d.). He proposed a blockchain technology capable of hosting multiple smart contracts created by participants (Buterin, 2014). The result is the ethereum platform, a decentralised database technology that hosts multiple applications and data in multiple nodes. Any participants can write a program and execute in decentralised nodes, without any central server to execute the program. This results in high redundancy and a reliable system, as multiple nodes are capable of running the application independently. Ethereum is capable to run multiple applications at the same time by making the ethereum platform use a turing complete language (Mukhopadhyay, 2018). The concept of turing complete is briefly described in the paragraph below.

"Vitalik Buterin usually explains Turing complete language as a programming language which can construct a loop, while the scripting language of bitcoin can only construct a simple transaction logic and cannot construct a loop. So, if you want to do something a hundred times in the bitcoin scripting language, you would have to copy and paste the code a hundred times, while in ethereum you could just write it once and tell the computer to execute it a hundred times." (Mukhopadhyay, 2018)

As ethereum becomes a decentralised application platform, it becomes possible to write a variety of business processes in blockchain technology (Buterin & Mougayar, 2016; Hyperledger, 2018). However, as the ethereum 1.0 platform is using PoW consensus model, the concern of high resources consumption remains. Ethereum 2.0 will be addressing this issue by using Proof-of-Stake consensus model. It is currently under development. At the point of writing, it is scheduled to be released in the year 2020. The tentative specification of Ethereum 2.0 is summarised in Table 2-1. Nevertheless, the programmable smart contract has further inspired many industries to explore business processes using blockchain technology. A consortium of industries has gathered and produce hyperledger.

Hyperledger

Hyperledger was formed by a consortium of enterprises, hosted by the Linux Foundation (Hyperledger, 2018). The vision of hyperledger is to provide a single home for blockchain technologies. Therefore, users can access most blockchain technology development with ease. Brian Behlendorf (Hyperledger CEO) mentioned that the focus of hyperledger should address blockchain technology use cases that will improve business processes (Behlendorf, 2016). Business processes usually are a highly centralised and regulated environment. As with many other technologies, blockchain technology applications for enterprises come with advantages and disadvantages.

As the bitcoin platform removed intermediary parties with its direct electronics' transactions, blockchain technology for enterprises also aims to bring more trust between businesses (Hyperledger, 2018). The trust that blockchain technology brings, remove the third party, reduce friction, save time and expenses. The decentralisation structure and high reliability of blockchain technology made it possible to increase the efficiency of the business process which involves multiple parties. However, a business is also a highly regulated and centralised process. The implementation of blockchain technology, like with any other new technology, in an enterprise comes with challenges.

The decentralised decision-making process in blockchain technology is a contradiction with the competitive nature of the commercial environment in businesses (Baset, 2019; Hyperledger, 2018). The resulting challenges are to define which information is to be shared, at which point of the business process collaboration should start and end, who should be involved, when the process should be expanded, how the technology should be implemented for better business performance (Baset, 2019). Hyperledger addresses the challenges with a permissioned network and modular design (O'Dowd, et al., 2018; Buterin & Mougayar, 2016). Below are examples of Hyperledger blockchain technologies and their components that could address industry blockchain technology needs.

There are many types of blockchain technologies under Hyperledger umbrella. Here, the first two blockchain technologies of Hyperledger are discussed. They are Hyperledger Fabric and Hyperledger Sawtooth.

Hyperledger Fabric is a permissioned network blockchain with flexible components (Hyperledger, 2018). The participants can select suitable consensus models for business services, membership services, and the location and type of smart contracts to be deployed. The aim is to provide a modular, easy-to-deploy system for industrial processes.

Hyperledger Sawtooth is a permissionless blockchain network with the possibility of creating a permissioned network (Blummer, et al., 2018; Hyperledger, 2018; O'Dowd, et al., 2018). The permissioned network is made by particular clustering nodes for a private transaction (Hyperledger, 2018). Hyperledger Sawtooth started with the PoET consensus algorithm. It has moved forward to a flexible consensus model (Hyperledger, 2018).

Table 2-1: Blockchain technologies comparison (Inspired by Ethereum, 2019; Hyperledger, 2018; Nakamoto, 2008)

	Bitcoin	**Ethereum 1.0**	**Ethereum 2.0**	**Hyperledger Fabric**	**Hyperledger Sawtooth**
First release date	2008	2015	To be release 2020	2017	2018
Network types	Permissionless	Permissionless	Permissionless	Permissioned	Permissioned and Permissionless
Accessibility	Public	Public	Public	By membership	Public, but private nodes can be configured
Consensus model	Proof of Work	Proof of Work	Proof of Stake	Flexible	Flexible and Proof of Elapsed Time
Smart Contract	Non-Programmable	Programmable	Programmable	Programmable	Programmable

The comparison of various blockchain technology components is compiled in Table 2-1.

In summary, blockchain technology is a distributed database system that keeps transactions data in a block of a pre-defined size. It uses cryptography algorithms to secure the system. The transaction inside blockchain technology is immutable. Blockchain technology’s decentralised decision-making process by means of consensus models. The consensus models are algorithms for nodes to reach an agreement. The nodes have to agree on which new block will be chained to the existing chain of blocks. These functionalities support the enterprise to streamline the process and increase efficiency. Blockchain technology under hyperledger umbrella has provided access limitation to create blockchain technology application in business. The access limitation is possible with permissioned networks and the flexibility to join and leave the network with a membership system. The existing blockchain technology structure and flexible consensus model address the challenges of businesses when adopting blockchain technology mentioned above. Logistics services as part of Supply Chain Management are identified as one of the industries that could benefit from Hyperledger development (Baset, 2019). Figure 2-7 illustrates the concept of blockchain technology. The next section elaborates on logistics services as part of supply chain management.

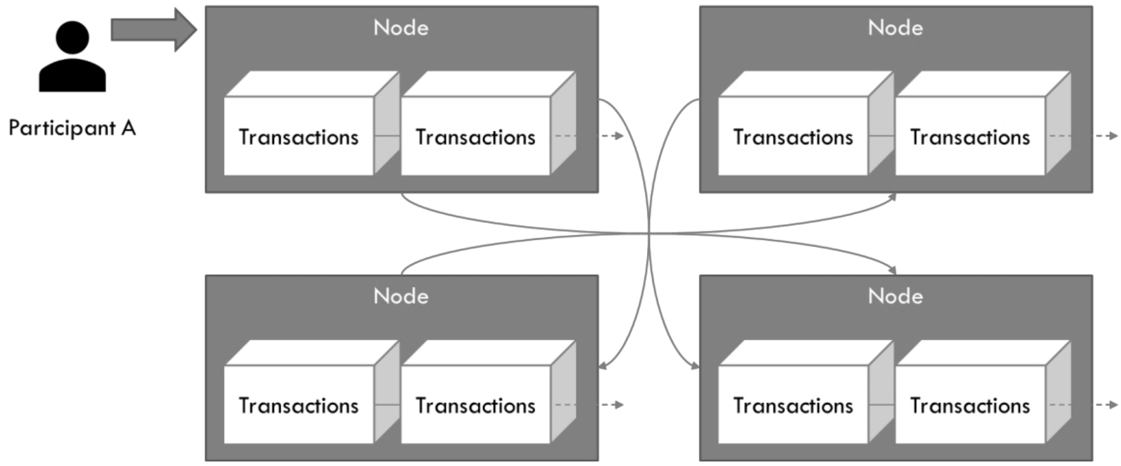

Figure 2-7: Blockchain technology as a system

3. Logistics Services – Quality in the Consumers' Perspective

This chapter is the second literature review of part one. First, section 3.1 elaborates the evolution of logistic services and involvement of information technology. Second, section 3.2 elaborates parameters of logistic service quality (LSQ).

Logistics service is defined traditionally as a service to move products from one place to another with a single transportation mode (Petersen, et al., 2018). However, logistics enterprises today have increasingly offered a comprehensive range of services in one place. These services range from the movement of material from source, storage, assembly, transportation to consumer and return flow. Hence, the scope of logistics services has evolved tremendously and provides more value in supply chain management. This definition of logistics service is acknowledged by Huemer, 2012; Melkonyan & Krumme, 2019; Petersen, et al., 2018. They reasoned that the scope of services provided by the logistics enterprise has expanded due to the possibility to earn a higher income to respond to the consumers' demand. Hence, it is challenging to define a clear boundary of logistics services today. This paper proposes to elaborate logistics services from the type of logistics services enterprise. This perspective seems suitable for this research because of the growing trend to engage external logistics services enterprise (Alagheband & Alireza, 2011). The scope of logistics service explains in section 3.1. As logistics services expand and more parties become involved in the process, a guideline on desired quality of logistics services is relevant. The next section discusses the desired parameters of logistics services.

Regardless of the expansion in the range of logistics services due to the change in the business nature of the logistics enterprise, service quality defines a client's satisfaction. Therefore, maintaining a steady income from return client and enterprise financial performance and consumer shares. This logistics services' business objective is acknowledged by Bowersox, et al., 1995; Bowersox, 1991; Thai, 2013. They recognise that the parameter of logistics services quality is an indicator of client satisfaction. Section 3.2 of this chapter elaborates on the Logistic Service Quality (LSQ). There are several perspectives on the classification of LSQ. Extensive research has been conducted by Thai (2013). The most comprehensive is LSQ categorisation was proposed by Mentzer, et al. (1999) and Thai (2013). Mentzer et al. (1999) propose LSQ specifically for logistics. The categorisations are comprehensive because it includes desire of customer services from the customer's perspective (Thai, 2013).

Furthermore, several other authors agreed with this categorisation and have repeated the process for various areas (Thai, 2013; Rafiq & Jaafar, 2007). Hence, this categorisation is found most suitable and is explored in this paper. At the end of this chapter explains the coverage and parameter of logistics service quality.

3.1 The Evolution of Logistic Services

This section describes the evolution of logistics services from the logistics enterprise perspective. Four models of logistics companies elaborated are: one-party logistics to four-party logistics. It ends with a brief summary of the impact of logistics parties on the logistics services.

Traditional logistics services offer transportation, storage, inventory, material management to achieve customer satisfaction (Alagheband & Alireza, 2011; Stock, et al., 1998). However, this definition has evolved due to consumer demand and more complex buyer and seller scenarios. The evolution of services in logistics is aligned with the view of Alagheband & Alireza, 2011; Gil-Saura & Ruiz-Molina, 2011; Hackius & Petersen, 2017; Thai, 2013; Zijm, et al., 2019. They explain that; one of the causes of complexity is the increasing geographical distance between retailers, suppliers, manufacturers and buyers. Thus, resulting in a need for various modes of transports, storages and management of products during the transition process from one mode of transport to the other until it reaches the consumer (Matthieu, 2018). This challenge has created opportunities for logistics enterprise to expand the scope of logistics services.

There are many studies done on the scope of logistics services today. The growing trend of logistics outsourcing and the buyer-oriented market have further push logistics enterprise to evolved and broaden the scope of logistics services offered. Several authors, Alagheband & Alireza, 2011; Gil-Saura & Ruiz-Molina, 2011; Hackius & Petersen, 2017; Huemer, 2012; Melkonyan & Krumme, 2019; Zijm, et al., 2019, agree with this perspective. They have explained their ideas on how logistics services should evolve. Melkonyan & Krumme (2019) propose logistics services should be expanded to address sustainability concerns. However, Zijm et al. (2019) elaborate that globalisation has given access for both buyer and seller access to buy/sell products beyond geographical boundaries. Therefore, it is an essential factor should be taken into consideration for the future of logistics enterprise. As the purpose of this paper is to find ways for companies to improve the logistics services with new technology, the definition of logistic services from the enterprise perspective is elaborated.

Logistics services change as the logistics companies have to evolve to respond to consumer demand (Zijm, et al., 2019; Alagheband & Alireza, 2011). The evolution of companies models, along with its services offered, elaborates next. The first model begins with the simplified logistics services (first-party logistics), to a more complex model commonly found today (second-party and third-party logistics), and possible future models taking into consideration the sustainability, globalisation and change in buyer demand (fourth-party logistics) (Alagheband & Alireza, 2011; Zijm, et al., 2019). Zijm, et al. (2019) and Köylüoglu & Krumme. (2015) mentioned that first-party logistics (1PL) to fourth-party logistics (4PL) is a simplified classification based on enterprise business model and range of services offered. There is no uniform definition of first to fourth parties logistics across the publications. The elaborations below is based on studies by Alagheband & Alireza, 2011; Kawa & Maryniak, 2019; Matthieu, 2018; Melkonyan & Krumme, 2019; Zijm, et al., 2019.

First Party Logistic (1PL)

First-party logistics is a classical concept of logistics services (Zijm, et al., 2019). These companies are the manufacturer or retailers who provide delivery services (Alagheband & Alireza, 2011; Matthieu, 2018). Matthieu (2018) explained that in the 1PL concept, the manufacturer manages the workforce, schedule, transportation and optimises the processes internally. Hence, an enterprise is considered as a first-party logistics service provider when it provides one type of services to move product from one place to another. This perspective is aligned with study by Zijm, et al. (2019) and Matthieu (2018). This process is challenging and costly for manufacturers who could have focused their resources on improving their main product, especially with increasing distance to consumers (Alagheband & Alireza, 2011; Zijm, et al., 2019). Second-party logistics processes aim to addresses these challenges.

Second Party Logistics (2PL)

Globalisation has increased the distances a product has to travel from seller to buyer (Zijm, et al., 2019). This pushes the manufacturers and retailers to engage multiple modes of transportation and other relevant services needed during transportation. The enterprises that are considered as 2PL provides transportation services by land, air and sea. A simplified explanation is explained by Zijm, et al. (2019). They mentioned that an enterprise classified as 2PL when it has the capabilities to offer all services by the 1PL companies and management of product along the route. These services are various modes of transportation, handling and storage of products. Finally, 2PL addresses the issue of transportations in multiple modes of transport. However, the increased types of transportation modes require coordination and synchronisation between each transportation modes. It becomes challenging to provides precision and efficiency of the product delivery, as demanded by the buyer (Zijm, et al., 2019; Melkonyan & Krumme, 2019).

Third-Party Logistics (3PL)

The buyer's demand for a more efficient, economic and precise delivery system has created opportunities for logistics enterprises to offer more synchronised logistics services (Marasco, 2008; Melkonyan & Krumme, 2019; Boschian & Paganelli, 2016). Briefly, 3PL companies provide services offered by 2PL companies and other services to ensure precision delivery for customer satisfaction (Alagheband & Alireza, 2011).

There is extensive research on the 3PL model. Literature studies conducted on 152 articles by Marasco (2008) shows that there are many ways to describe 3PL concepts. Berglund et al. 1999 (cited in Marasco, 2008) proposed a comprehensive definition of 3PL (Marasco, 2008; Berglund, et al., 1999).

"Third-party logistics are activities carried out by a logistics service provider on behalf of a shipper and consisting of at least management and execution of transportation and warehousing. In addition, other activities can be included, for example, inventory management, information-related activities, such as tracking and tracing, value-added activities, such as secondary assembly and installation of products. Also, the contract is required to contain some management, analytical or design activities, and the length of the co-operation between shipper and provider to be at least one year, to distinguish third-party logistics from traditional "arm's length" sourcing of transportation and/or warehousing" (Berglund, et al., 1999).

However, logistics services can be further improved. As described by Skender, et al. (2017), 3PL companies address the issue of transportation cost reduction with synchronisation and optimisation of logistics services. However, a further evolution of logistics services can improve product value. Improvement in product value can be achieved when logistics services extend to the entire supply chain, from the beginning to the end of product life (Skender, et al., 2017). Hence, 4PL logistics companies aim to address these challenges.

Fourth Party Logistics (4PL)

Sellers are challenged to offer a more personalised product in a high degree to satisfy buyer's demands (Skender, et al., 2017; Zijm, et al., 2019). Maintaining a record of a product as it changes hands from the beginning to the end of a product's life is one-way logistics enterprise can address these needs. This results in a growing complexity of logistics services and pushes companies to leverage new technologies and collaborate with experts to appeal to consumer.

Anderson Consulting (later Accenture) was the first to define the concept of 4PL (Sahay, et al., 2006). 4PL is services of gathering and managing resources, capabilities and technology of its own organization and complimentary services provide by experts to optimised product delivery to a consumer for the utmost customer satisfaction (Skender, et al., 2017)

Skender et al. (2017) conducted reviews on 21 articles related to 4PL, in an attempt to research the benefits of implementing a 4PL model for an enterprise. They conclude that the majority of articles identifies 4PL services as a combination of management of traditional logistics services offered by 3PL, enhanced with information technology and seamless integration of experts. This definition of 4PL aligns with Zijm, et al. (2019). Additionally, Sahay, et al. (2006) and Zijm, et al. (2019) explains that 4PL holds a critical role in the growing return product services. Figure 3-1 provides a summary of the various types of logistics parties by the range of services provided. The range of services provided increases from 1PL to 4PL.

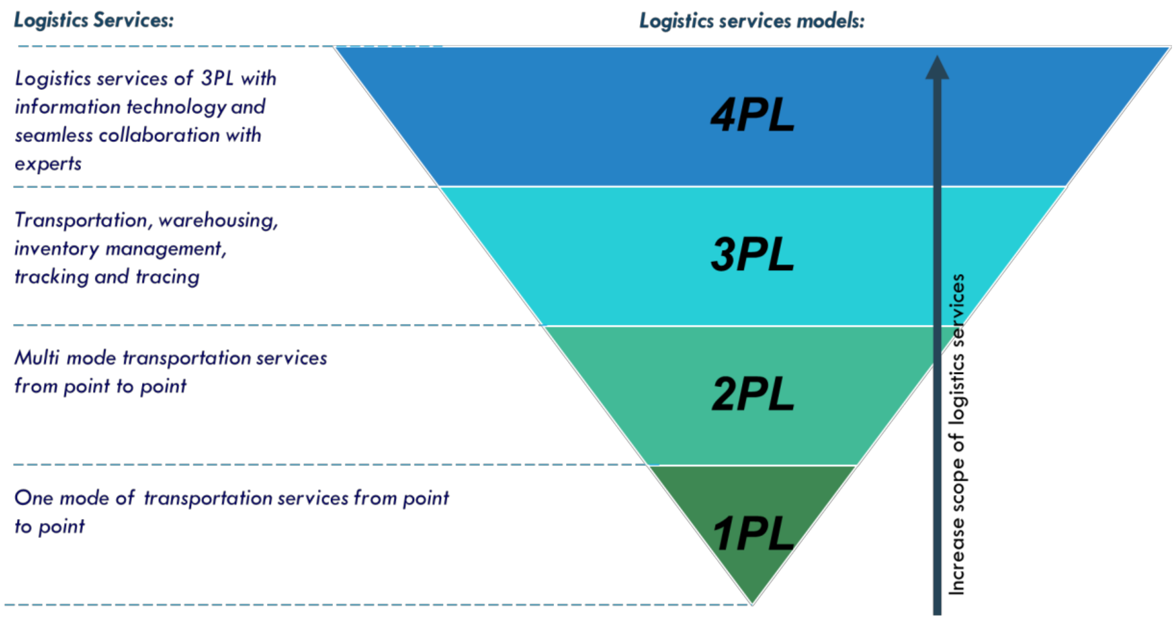

Figure 3-1: Comparison of various logistics services

In summary, the extent of logistics services has evolved and expanded to respond to consumer demand today. Figure 3-2 describes the logistics services' range by various logistics parties model. The traditional logistics services (1PL) of delivering the product directly by the manufacturer and retailer no longer suffice (Zijm, et al., 2019). 2PL companies provide multi-mode of transportation services and associate services during the process, such as warehousing. This logistics service can reach out to more manufacturers or retailers, to more consumers across geographical boundaries. As consumers' demand becomes increasingly more complex, the 3PL logistics services model provides 2PL services with inventory management and tracking and tracing (Berglund, et al., 1999). The 4PL logistics services model addresses the demand for a more personalised product as needed by buyer, including product return services. It integrates industry experts and information technology in the process, in addition to the services offered by 3PL (Skender, et al., 2017).

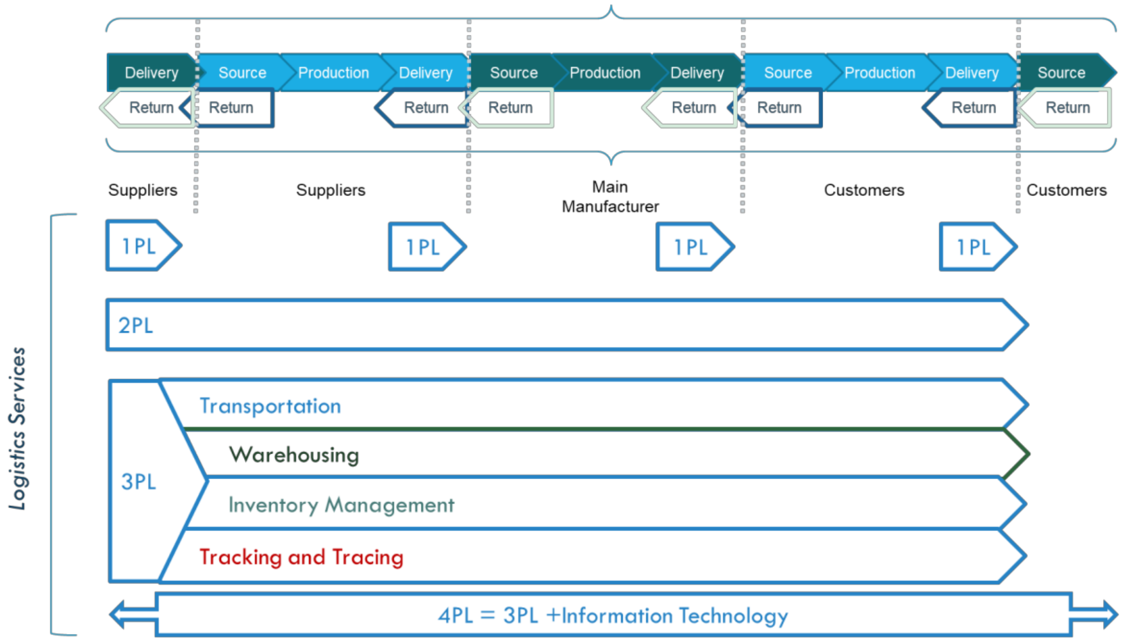

Figure 3-2: Various logistics services in the delivery, source, production and return flow (Inspired by Melkonyan & Krumme, 2019; Zijm, et al., 2019; Marasco, 2008).

The explanation on logistics services above provides a boundary to differentiate logistics services from supply chain management. Next, parameters to obtain customers' satisfaction serves as indicators of logistics service quality is described. There are many articles on this topic proposing various perspective of logistics services quality. Thai (2013) has conducted an extensive literature review. Thai (2013) concludes the method proposed by Mentzer, et al., (1999) is the most comprehensive parameters. Furthermore, the study was replicated and tested by several authors. The following section elaborates the logistics service quality based on parameter proposed by Mentzer et al. 1999 (cited in Mentzer et al., 2001).

3.2 Defining Logistics Services Quality (LSQ): Parameters for customers satisfactions

This section begins by elaborating on the reasons for LSQ as a parameter for logistics services, followed by an explanation on the parameters.

Enterprises are incentivised to expand the logistics services to obtain a competitive advantage for responding to the demand of buyers. However, the expansion of assets or capabilities requires resources. The management of logistics services enterprises requires an indicator of the buyers' perspective of quality services. This opinion aligns with Mentzer, et al., 1999; Mentzer, et al., 2001; Meng Zhao, 2001. Mentzer, et al. (1999) proposed a Logistics Services Quality (LSQ) as a scale of quality customer services for logistics services and its management. LSQ was developed following a logistics research methodology proposed by Mentzer & Kahn (1995), enhanced with quality of product during arrival parameter by Bienstock, et al. (1997)

and tested against multiple buyer segments (Mentzer, et al., 1999). Furthermore, Thai (2013) conducted a literature study which indicates that Mentzer et al. 1999 (cited in Mentzer et al., 2001) LSQ parameters are the most comprehensive. Table 3-1 indicate articles reviewed by Thai (2013). Thai (2013) compares studies of various logistics service quality in academic publications.

Table 3-1: Logistic Services Quality comparison (Thai, 2013)

No. LSQ	**Authors**
1	Bienstock, et al. (1997)
2	Gronroos, 1982; Rinehart, Cooper and Wagenheim, 1989; Lehtine and Lehtine, 1991; Collier, 1991; Mentzer, Rutner and Marsumo, 1997; Maltz and Maltz, 1998; McDougall and Levesque, 2000
3	Lalonde and Zinszer, 1976; Mentzer, Gomes and Krapfel, 1989; Novack, Langley and Rinehart, 1995;
6	Feng, Zheng and Tan, 2007; Jian and Zhenpeng, 2008
9	Mentzer, Flint and Kent, 1999; Mentzer, Flint and Hult, 2001; Rafiq and Jaafar, 2001

Furthermore, buyers' satisfaction influences repeat purchases and recurring income desire by enterprises (Gil-Saura & Ruiz-Molina, 2011). Hence, LSQ integrates the logistics theory with the practical application in businesses which is relevant for this paper. Nine parameters were considered as necessary by Mentzer, et al. (1999). Below explains these parameters.

1. *Personnel contact quality* is the buyers' perception on product and services, knowledge and the extent of assistance provided by the relationship staff (DeCarlo & Thomas W, 1996; Mentzer, et al., 1999; Mentzer, et al., 2001).
2. *Order release quantity* is the supplier and logistics services enterprise capabilities to deliver the quantity requested by the customer, with minimum loss due to unsold product (Novack, et al., 1995; Keehler, et al., 1999; Mentzer, et al., 1999).
3. *Information quality* is the logistics services enterprises' capabilities to provide information on product and services. The reliability of information increases the consumer's trust in the company and services. Therefore, the buyer becomes confident of their purchased (Mentzer, et al., 1999; Mentzer, et al., 1997)
4. *Ordering procedure* is the suppliers and logistics services enterprises' capability to create an easy to use, efficient and effective procedures for buyer (Mentzer, et al., 1999; Bienstock, et al., 1997)
5. *Order accuracy* is the logistics services enterprises' ability to deliver a product in precise type and quantity (Mentzer, et al., 1997; Mentzer, et al., 1999)
6. *Order condition* is the logistics service enterprise capability to deliver product undamaged (Mentzer, et al., 1999; Mentzer, et al., 2001).

7. *Order quality* is the sellers and logistics service enterprises can deliver products as promised. The product should conform with the specification provided to the buyers (Mentzer, et al., 1999; Mentzer, et al., 2001).
8. *Order discrepancy handling* is the logistics service enterprises' capability to manage disputes between product specification and claim of inaccuracy from the buyer (Mentzer, et al., 1999; Mentzer, et al., 2001).
9. *Timeliness* is the capability of logistics services providers to deliver the product to the buyer within the time frame promised to the buyer (Mentzer, et al., 1999; Mentzer, et al., 2001).

Mentzer et. al. (2001) proposed how LSQ parameter related to buyers' satisfaction. Figure 3-3 describes this relationship. Research indicates that the importance of each parameter varied. However, the degree of importance of one parameter to another outside this scope of study.

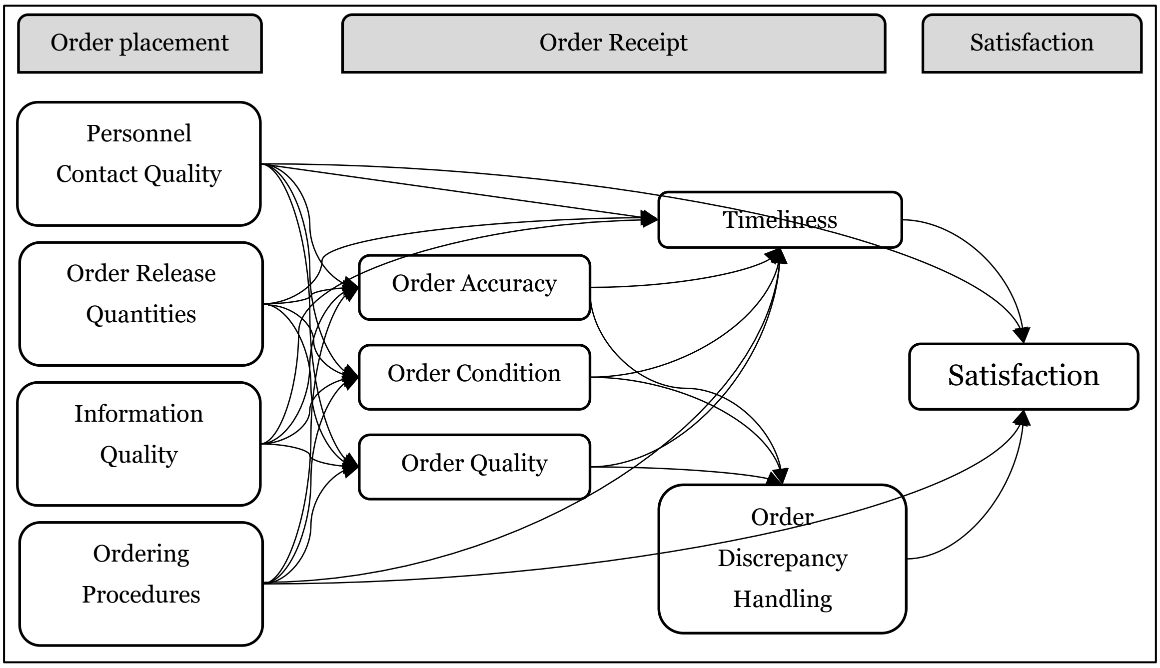

Figure 3-3: The assumed relationship between LSQ parameters (Mentzer, et al., 2001)

In summary, logistics services enterprise are commercially driven entities. Managers need a set of parameters to improve service quality for the consumer. Consumer satisfaction results in customer loyalty and repeats income (Meng Zhao, 2001; Mentzer, et al., 1999). Naturally, improvement in LSQ using new technology justifies the spending of resources for the enterprise. The next chapter (chapter 4) explains the analysis of blockchain technology influence in LSQ.

4. Analysis and Discussion Part One: Improving LSQ with Blockchain Technology

This section analyses the finding from the literature review of blockchain technology in chapter 2 with logistics services in chapter 3. Firstly, It explains the summary of benefits when using blockchain technology. It is then followed by a discussion on relevancy to logistics services. Lastly, the impact on the logistics service quality (LSQ) parameter is discussed.

Section 2 elaborates the components of blockchain technology. These components bring value such as making sure that the information kept in blockchain technology is secure and verified. It cannot be changed once it is stored within the blockchain technology network. Therefore, any changes to the information are traceable. Hence, the information within the blockchain technology network can be trusted. Blockchain technology is formed through deployment in decentralised nodes. Selected nodes carry the full set of information. Hence, it provides easier access in comparison to the centralised database system. The growing collection of consensus models made that the information stored in blockchain technology can be accessible in near to real-time. In addition, smart contract makes the execution of contract clauses binding and time-efficient. This system and value of blockchain technology have been explained in detail in these books: Brown, et al., 2016; Jeff Garzik, 2018; Laurence, 2017; Yaga, et al., 2018. These values is simplified in the next paragraph.

This paper classified the values of blockchain technology mentioned above into two categories, to simplify the analysis with logistics services. They are information storage and exchange and contract automation. Table 4-1 tabulates the value of blockchain technology into two proposed categories. Firstly, information stored in blockchain technology is secured, verified, trusted. Secondly, the participant's assets are verified. Therefore, executing a contract can be done automatically. These blockchain technology values and classifications align with Kawa & Maryniak (2019). Blockchain technology is capable of improving logistics services (Abeyratne, n.d.; Baset, 2019; DHL Corporation and Accenture Consulting, 2018; O'Marah, 2017; Zijm, et al., 2019). The value that blockchain technology can bring for logistics services is explained below.

Table 4-1: Blockchain technology benefits

Information Storage and Exchange	Contract Automation
• Secured • Verified • Trusted • Near to real-time • Easier to access	• Verify the assets of participants • Execute transactions automatically

There are minimal academic publications on blockchain technology applications in logistics services. Kawa & Maryniak (2019) shares the same opinion in their book. This paper elaborates three advantages that blockchain could bring to logistics services. This research proposes a simplified model, inspired by the work of Baset, 2019; Melkonyan & Krumme, 2019; Hackius & Petersen, 2017; Kawa & Maryniak (2019).

1. Track-ability is the capability to identify the location and condition of a product at any time, during delivery. Therefore, increasing customer satisfaction.
2. Trace-ability is the capability to provide the history of a product with information that can be trusted. Therefore, providing the consumer with confidence in the product origin, quality, etc.
3. Direct transaction capable is the ability to execute a binding transaction directly between buyer and seller without an intermediary.

As the advantages are briefly mentioned above, the following paragraph describes the relationship between these advantages of blockchain in logistics with LSQ. Specifically, which LSQ parameters can be addressed with blockchain technology. Mentzer et al., 1999 (cited in Mentzer et al., 2001) elaborates that LSQ was developed to provide logistics services enterprises with a competitive advantage. Hence aligning with LSQ parameters is critical for logistics services enterprises.

Blockchain technology track-ability and relevancy with LSQ

Blockchain technology could capture and share the environmental condition of a product as it transfers from origin to destination. The environmental condition information captures in blockchain system result in faster and more accurate problem identification from the origin of a problem as it arises (Kawa & Maryniak, 2019). Furthermore, in the shipment of perishable goods, this informs buyers about the product quality they are going to receive. If there is a problem during the journey, suppliers and logistics services providers can be informed simultaneously. Hence, a new set of products can be prepared for shipment to reduce delayed delivery time to consumers. The advantages of blockchain technology in providing tracking mentioned above, were acknowledged by Baset, 2019; Melkonyan & Krumme, 2019; Kawa & Maryniak, 2019.

The information relevant for tracking purposes are:

- Origin of product
- Timestamps
- Time constraint during each activity
- Temperature during transportation

- The responsible parties for each part of the journey
- Mode of production
- Places and routes
- Types of transportation used to move products

Hackius & Petersen (2017) and Baset (2019) have agreed that blockchain technology can provide authentic, verifiable and secure information, as it is being exchanged from party to party. Kawa & Maryniak (2019) also mentioned that as the information is shared in a secured, decentralised system, it reduces the need for direct communication and increases time-efficiency in the process.

"...by creating digitized document workflow they managed to ensure all documents and activities in the supply chain to be available and visible to every partner, supported with information about who, where and when issued them or move the goods. This decreases the need for domestic and international direct communication, avoids mistakes, waiting, and other forms of waste, and ensure significantly faster information transactions and indirectly faster material flows..." (Kawa & Maryniak, 2019).

Although, Kawa & Maryniak (2019) and Yaga, et al. (2018) also explained that integration with another technology to capture data into digital format is necessary to make this advantage. However, this paper limits the discussion to blockchain technology advantages and the relation with LSQ.

Mentzer, et al. (1999) and Mentzer, et al. (2001) elaborated the definition of order quality and timeliness as an LSQ parameter. The order quality is achieved when the product is delivered as specified to the consumer during purchase. Timeliness is defined as the time needed for a product to arrive at the consumer.

"Order quality refers to how well products work (Novack. Rinehart. and Langley 1994). This includes how well they conform to product specifications and customers' needs." (Mentzer, et al., 2001)

Blockchain technology could provide verifiable facts during transportation, which is essential to justify the product specification. For example, the ambient temperature of perishable products could prove the quality of the product as promised during purchase. Furthermore, as all tracking related data are kept in a shared secured, decentralised system, the need for administrative process and improves delivery time reduce. Hence, track-ability is a relevant parameter to provide quality logistics services.

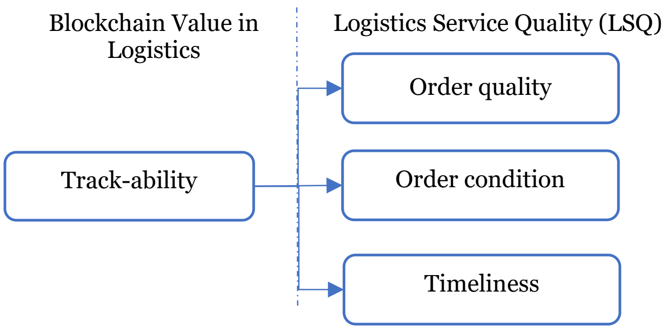

Figure 4-1: Value of Track-ability in LSQ

Figure 4-1 illustrates the value of trackability and relation with LSQ parameters. Blockchain capability to track product information in higher granularity is relevant to improve LSQ parameters. The LSQ parameters influence order quality, order condition and timeliness. The process of moving a product from the point of origin to the point of destination is a multi-party process (Refer to section 3.1). Cost reduction can be achieved with the direct transaction. This benefit of blockchain technology is discussed in the next paragraph.

Blockchain trace-ability and relevancy with LSQ parameters

As described in chapter 2, blockchain technology is a shared database technology. The network becomes more secure with more people participating in the network. As logistics services have evolved and expanded, more parties are involved in the process of product delivery from origin to the destination. Blockchain technology makes possible for anyone to participate in the blockchain network. The participants contribute information on the product from the origin to destinations in high granularity and frequency. Therefore, creating a history of the product. The information below is essential for the buyers and can be provided by blockchain technology's participants:

- Where was it truthfully made?
- How and by who was it made?
- Where, how and by who was it transported?
- Where is its location at the moment?

Melkonyan & Krumme (2019) and Hackius & Petersen (2017) agree that blockchain technology ensures the information provided comes with a higher degree of accuracy and immutable. Also, Kawa & Maryniak (2019) argue that a verifiable source of product origin is a necessary tool to prevent fraud and counterfeit products from spreading. The aspect of buyers' satisfaction in logistics services discusses in the paragraph below.

The high granularity data (e.g. the precise origin, the methods of transportation, and the location of products) improves buyers' perception of information provided by the seller and ease in managing the claim in product quality discrepancy. The buyer will be confident about the information provided. This argument aligns with Mentzer, et al. (1999) and Mentzer, et al. (2001) who explain about information quality parameters and discrepancy handling.

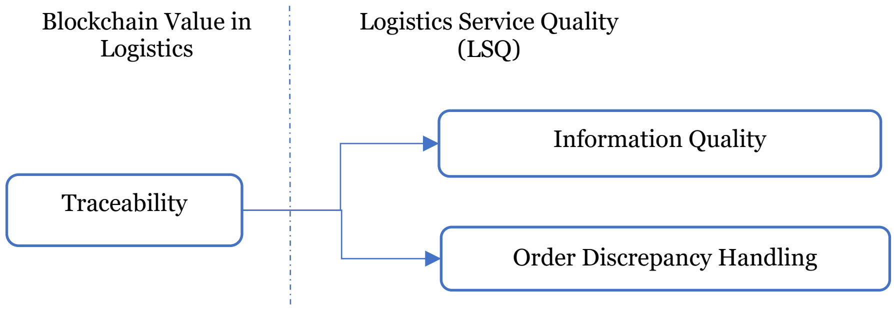

Figure 4-2: Trace-ability value for LSQ

Figure 4-2 illustrates this relationship. Naturally, traceability parameters are essential parameters for logistics services. Blockchain technology is capable of sharing information on the location of the product as it moves from origin to destination, with equal access to the relevant parties. The relevancy of this capability with LSQ discusses in the next paragraph.

Blockchain technology's capability to create a direct transaction and LSQ parameter

The smart contract is capable of executing transactions automatically and directly. The connected digital asset with a smart contract makes transactions binding for buyers and sellers. Smart contract components of blockchain technology have become programmable in ethereum and hyperledger platform. This improvement has made it possible for various types of transactions in industries to leverage a smart contract. Section 2.1.4 and 2.2 elaborate smart contracts and their applications within blockchain technology. The main application of smart contract in logistics is their capability to create direct transactions without an intermediary, as described by Kawa & Maryniak (2019). The results of the removal of intermediaries in logistics services are:

- Transactions become more time and cost-efficient.
- Transaction clauses form by digital code.
- Available for relevant parties to review.
- Subjected to approval by all parties before being put into the system

Kawa & Maryniak (2019) agree with the above results. The time and cost-efficient and transparent nature of the smart contract improve the ordering procedure and order discrepancy handling.

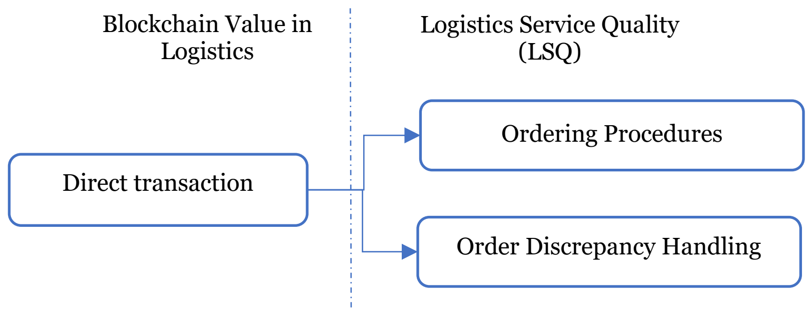

Figure 4-3: Value of direct transaction in LSQ

Figure 4-3 illustrates which LSQ parameters improved because of blockchain technology's ability to create a direct transaction. These parameters are ordering procedure and discrepancy handling. As described by Mentzer, et al. (1999): ordering procedures are a collection of procedures to make an order, while order discrepancy handling is how the system address discrepancies in the product. Therefore, direct transaction is a relevant capability for logistics services. The next paragraph provides a summary of blockchain technology influence to logistics services.

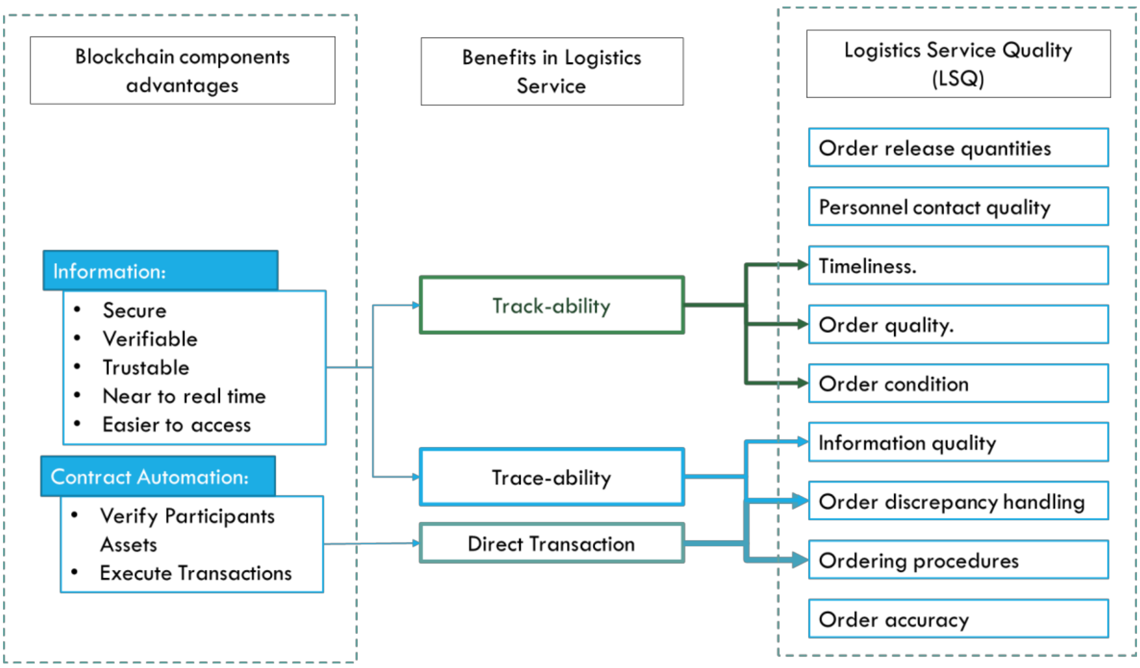

Figure 4-4: Summary of blockchain value in LSQ (Inspired by Kawa & Maryniak, 2019; Hackius & Petersen, 2017)

Figure 4-4 illustrates the influence of blockchain components in logistics services and logistics services quality parameters. The secure, verifiable, trustable, near to real-time, easy access to information nature available in blockchain technology improves the capability of logistics enterprises to track product flow and trace product origin. Separately, the capability to verify participants' assets and execute transactions automatically allows logistics services enterprises to create a direct transaction. Subsequently, track-ability improves timeliness, order quality and conditions of LSQ parameter. While trace-ability and the direct transaction improves information quality, order discrepancy handling and ordering procedures of LSQ parameters. These research results are inspired and aligned with Baset, 2019; Hackius & Petersen, 2017; Mentzer, et al., 1999; Mentzer, et al., 2001; Kawa & Maryniak, 2019; Yaga, et al., 2018; Zijm, et al., 2019. However, due to time limitation, not all factors are being discussed. Furthermore, as the nature of this research is qualitative, the result is subjective to the author's perception and opinion (Refer to section 1.3.1 for more information about the limitation of this research). Due to the limitation of academic literature on this topic, the evaluation of blockchain technology application to be prioritised for implementation in logistics services is incomprehensive. In part two, use cases of blockchain technology are gathered and analysed to provide another perspective on which blockchain applications should be a priority.

5. Summary of Part One

Blockchain technology is a newly proposed method to keep information in a secure, immutable manner on a decentralised location. It was invented by combining several existing components of existing technology. The components are types of networks, cryptography, transaction grouping and consensus models. The variations and combinations of various components created numerous blockchain technologies today. Bitcoin was the first blockchain technology, proving that the technology is capable of bringing trust between public participants. Bitcoin uses blockchain technology to manage cryptocurrency transactions and platform. The transactions in the bitcoin platform stored with blockchain technology become immutable and permanent. Each participant or node carries the full transaction information. Any changes in the transaction require consensus from all participants. All transactions are authorised and stored without manual interference, as nodes reached agreements by means of consensus model. Ethereum version of blockchain technology inspires many other business processes to leverage on blockchain technology. This was made possible as the ethereum made transaction automation customisable for other processes beyond cryptocurrency transactions. Hyperledger created an umbrella for all blockchain technology platforms to share developments and templates of applications. Therefore, provide tools for companies to use blockchain technology in their industrial processes. The tools and shared concept platforms available in hyperledger reduce the need for resources when using blockchain technology in for business processes.

The evolution in logistics services made the differentiation from the supply chain management concept somewhat indistinguishable. Logistics services companies have progressed from providing a simple point to point delivery by the seller to more complex third and fourth-party services providing cross-continent delivery, custom handling, real-time delivery updates with support of information technology. Nevertheless, the logistics services companies are still bound by logistics services quality parameters. This paper proposed nine parameters considered important from a buyer's perspective for a logistics services company. These parameters are personnel contact quality, order release quantities, information quality, ordering procedures, order accuracy, order condition, order quality, order discrepancy handling, timeliness. Research shows each parameter influences the others to a certain degree. Timeliness is the most critical parameters among all others.

The analysis of blockchain components and logistics services' quality parameters indicate that blockchain technology can assist in improving logistics services' quality. The three main areas that blockchain technology can address are the capability to track, trace and create a direct transaction. The application of these functions improves timeliness, order quality, order condition, information quality, order discrepancy handling and ordering procedures.

Part Two: Models of Blockchain Technology-Based Application for Logistic Services

Part two explores the model of blockchain-technology based applications for logistics services. This paper proposes to address the questions in four chapters. Chapter 6 serves as an introduction and explains the reason for this methodology in relevance to part one. Chapter 7 explores the methodology. Chapter 8 elaborates and discusses the results of research based on use cases. Lastly, chapter 8 concludes the research of part two.

6. Introduction: Blockchain Model Selection for Logistics Services Based on Use Case Analysis

This section elaborates the methods to be used to select the model of blockchain technology applications. It begins with a summary of blockchain technology from part one. Followed by the limitations and elaborates a method to improve findings by literature review. The last part elaborates the benefits and limitation of the proposed methods.

Blockchain application to improve enterprises processes gained interest recently. As explained in part one, ethereum and hyperledger made it possible to utilise blockchain technology to improve enterprise processes. The first ethereum launch in 2015, proposed smart contract to become programmable (Ethereum, 2019). Hyperledger made it easier for enterprises to customise various blockchain technology-based processes by providing a single platform for technology companies to access existing development and create use cases (Baset, 2019). Blockchain technology brings participants who do not trust each other to contribute and access the same system without intermediaries (Baset, 2019; Behlendorf, 2016; Brown, et al., 2016; Hyperledger, 2018; Zijm, et al., 2019)

Research shows there is a limited number of scholarly articles on blockchain use cases, and even less in the blockchain application for logistics services. This finding aligns with Kawa & Maryniak (2019). A simple search using KTH Library and Google scholar summarises in table 6-1. Kawa & Maryniak (2019) notice a similar trend in the results. Meanwhile, the World Economic Forum researches on blockchain explorative study in enterprises. The results indicate the blockchain use cases in logistics services as part of supply chain management is most explored by companies based on a survey of corporate executive conducted by Deloitte (Hanebeck, et al., 2019). Therefore, model selection of blockchain technology application based on use cases is not a new technique and similar to study by WEF. Furthermore, academic publications supplement the findings.

Table 6-1: Tabulation of literature searched conducted on 17 September 2019

Keywords:	**KTH Library**	**Google Scholar**
Blockchain	22,411	133,000
Blockchain+logistics	1,416	7,590
Blockchain+logistics+services	1,038	7,030

Oliveira, et al. (2015) describe that use cases are commonly acceptable to elaborate on the functioning of a system that comprises several components. Because use cases describe systems, analysis and evolution of components in a natural language, it is easier to understand

(Oliveira, et al., 2015). Furthermore, research on blockchain use cases in the supply chain from grey literature in the worldwide web resulted in an unstructured long list of use cases. Nevertheless, the literature study in part one shows blockchain technology components, theoretical study of logistics services and its qualities. The results of part one are applied to part two. This additional step is taken to eliminate use cases that are not relevant to blockchain technology and logistics that could potentially create a diversion to the use case analysis. As a list of use cases that are relevant to blockchain technology and logistics services were identified, part two attempts to address the research question: *what will be the model of blockchain technology suitable for logistics services?* However, due to the natural language of use cases, the analysis has its limitation.

Oliveira et al. (2015) explained, due to the natural language employed to describe use cases, it is bound for imprecision, ambiguity and incompleteness. Therefore, the analysis of use cases is subjective to the selection bias. This limitation is elaborated in section 1.3.2. Regardless, use cases analysis is found suitable in this paper due to limited academic publications.

7. Methodology: Use Case Model Selection with Prioritisation Concept

This section elaborates on an approach in analysing blockchain use cases in the worldwide web and grey literature. The result is a model of blockchain applications in logistics services. The three steps of analysis employ in this research are filtering, categorisation and maturity analysis. The explanation follows the same order.

As mentioned above, the result of a web search of use cases is an unstructured long list of information. Furthermore, section 3.1 explains that logistics services are essential components of supply chain management. Improvement in logistics services could assist multiple industries. Hence to select a model of blockchain technology applications for logistics services, a prioritisation model is needed. Figure 7-1 illustrates the three steps to be taken for creating a prioritisation model. Below elaborates on the methodology of this part of the research.

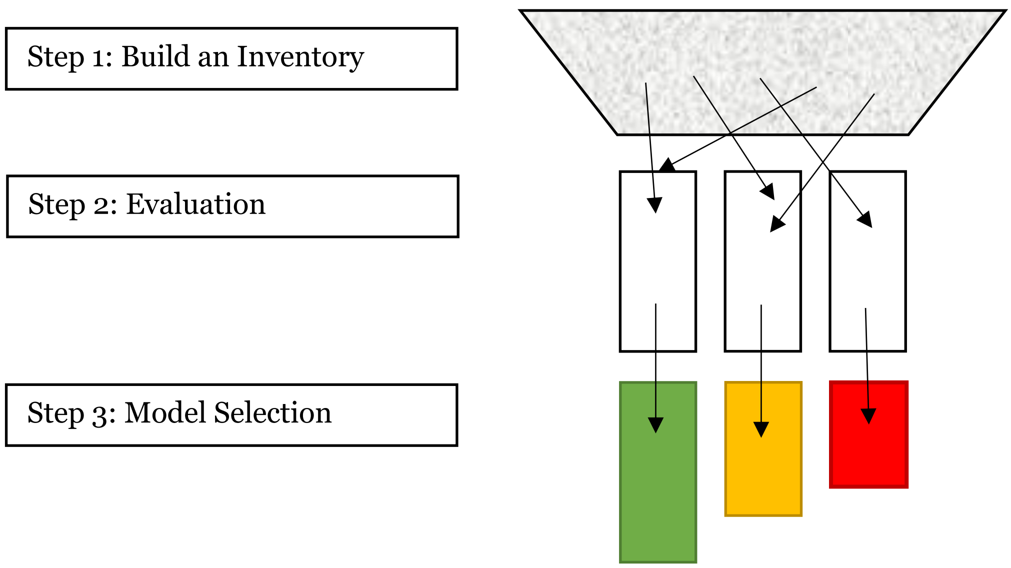

Figure 7-1: Methodology to prioritise and select an application model of blockchain technology for logistics services (Inspired by Edeland & Mörk, 2018)

The methodology begins with creating an inventory of use cases. Research on blockchain use cases has resulted in clusters of industries leveraging on blockchain technology to improve their supply chain management. A selection of use cases relevant in logistics enterprises advances to the next step. Step two of the prioritisation involves assessing the selected use cases on their relevancy to logistics services. The blockchain technology's use cases that are relevant to logistics services advances to the next step of the prioritisation model. Step three of prioritisation analyses the maturity, based on the comprehensiveness on blockchain technology being elaborated in the use case. Finally, the results are analysed and discussed considering the findings in part one. Due to the exploratory study nature of this research, the results are subjective to the author's perception. The limitations of this research have been elaborated in section 1.3.2. However, Edeland & Mörk (2018) utilises a similar method to study blockchain technology applications in the energy sector. This method is proven to be useful to identify blockchain use cases to be prioritised for enterprises, starting from an extensive list of use cases.

7.1 Step One: Building an Inventory of Blockchain Use Cases

This is the first out of a three-step process to select a suitable model of blockchain use cases. This exercise gives a perspective of blockchain technology's applications in enterprises in public. It also studies which industries benefit from improvement of logistics service. The research begins from the higher-level perspective and gets more detailed to identify what is the perceived benefit of blockchain technology for the enterprise process. The steps to create an inventory are building a list of use cases and grouping the use cases. Figure 7-2 illustrates the process applied to create an inventory of use cases.

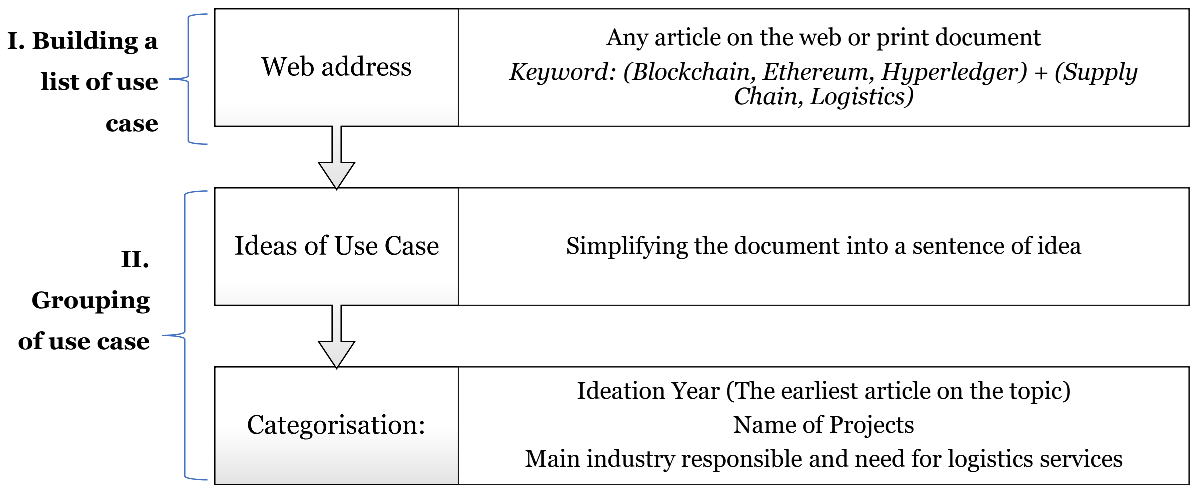

Figure 7-2: Steps to build an inventory of use cases

The process begins with keyword searches in Google and Google scholar. The keywords used are blockchain, hyperledger, ethereum and supply chain and logistics. This results in a long list of unstructured information. The ideas on the blockchain technology-based solution that can improve an enterprises' process are extracted from the articles. This idea becomes an input into the internet search engine to find the earliest article. This result defines the first ideation year. Next, relevant projects are being extracted and the industries that benefit from the projects are identified. Each project becomes one use case. This step is necessary, as grey literature usually is incomprehensive. The next step is to identify the solution relevant to logistics services.

7.2 Step Two: Evaluating the relevancy with Logistics Services.

In the second stage, the use cases relevant to the *logistics industry are* selected from the use cases categorised in step one. These use cases are further analysed, based on their relevancy to *logistics services* and *blockchain technology compatibility*. This assessment stage consists of two steps. Firstly, the use cases are assessed on their need for logistics services. These use cases are the ones who are very likely needed by logistics services or directly relevant to logistics enterprises. Figure 4-4 illustrates these relationships. In particular, the use cases are analysed, based on the advantages of blockchain technology in logistics services. Secondly, the need for blockchain technology to improve the process is evaluated. Figure 7-3 summarises the structure of two steps prioritisation process. The following section evaluates blockchain technology relevance.

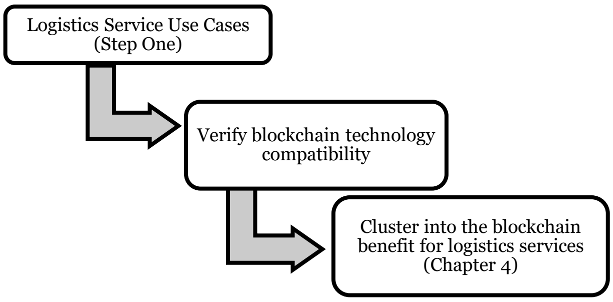

Figure 7-3: Assessing relevancy with logistics services

Blockchain Technology Compatibility

As mentioned in part one, blockchain technology is one of the emerging technologies gaining interest in enterprises recently. Like any other emerging technology, not all functionalities and risks of implementation are thoroughly investigated. Anderson & Felici (2012) have elaborated the risks of an emerging technology.

"Technological risk arises when some technical artefact is deployed in a situation where its operation can result in adverse consequences. Risk is an intensively studied phenomenon across a wide range of disciplines and each discipline brings a particular, distinctive, focus. Academic work on risk is often either retrospective, looking at a particular incident, or abstract, considering general properties of the phenomenon." (Anderson & Felici, 2012).

Knowing there is a risk in deploying an emerging technology, an enterprise may choose another thoroughly tested, existing technology to address this challenge. Yaga et al. (2018) and the United States Department of Homeland Security, Science and Technology Directorate proposed a three-step process (Yaga, et al., 2018). Figure 7-4 summarises this process. Firstly, identify the improvement to be made by blockchain technology. Secondly, verify if existing technologies can be used to address the improvement need. Lastly, verify if there is a challenge with the current system. Next, based on blockchain components and advantages explained in part one, a verification method is recommended below.

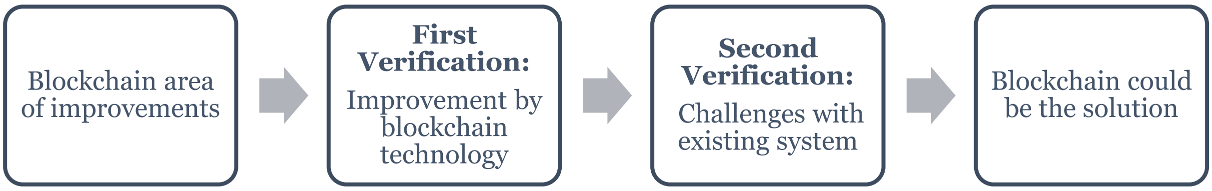

Figure 7-4: Steps to assess blockchain technology compatibility (Inspired by Yaga, et al., 2018)

The advantages of blockchain technology components are: (1) Information stored within blockchain technologies are secure, verifiable, trustable, accessible near to real-time and easier to access due to decentralisation (2) Contracts can be executed automatically as the participants' assets are connected to the system. Based on these advantages, the method proposes to screen each use case into the following categories:

1. Improving the method to store information.
2. Improving interaction between users within the system.

Table 7-1 tabulates the questions developed to assess uses cases. These questions are tabulated based on research on Edeland & Mörk, 2018; Yaga, et al., 2018; Gupta, 2017; Xu, et al., 2019; Wüst & Gervais, 2018. The following paragraph explains the questions.

Table 7-1: Areas and functionality can be addressed and improved with blockchain technology (Inspired by Yaga, et al., 2018; Gupta, 2017; Xu, et al., 2019; Wüst & Gervais, 2018)

Area	Improvements by blockchain technology:
Data storage	1. Does the process require data storage? 2. Does the information need to be regularly updated? 3. Does the type of information stored contain sensitive data and need higher security? 4. Does the process need a high redundancy system?
Interaction between users	1. Does the process need a synchronised interaction between participants? 2. Does the system currently need to be synchronised manually by the participants? 3. Does the system need efficient interaction between the transaction? 4. Does the system need an efficient decision-making process between direct participants without intermediaries?

In the first category, use cases are challenged to use blockchain technology to improve the information storage system. These use cases are questioned with the following statements: (1)

the need to use a database, (2) the need for a regular update, (3) the type of information stored, (4) the need for a high redundancy system.

In the second category, use cases are challenged to consider using blockchain technology to improve the interaction between users in the system. The questions developed to identify this challenge are: (1) the need to have synchronised interaction, the processes are currently being addressed with multiple transactions created in and parallelly stored in separate databases, (2) the transactions are dependent to each other, (3) the need for efficient decision-making process without leaving anyone behind.

Yaga et al. (2018) explained that these questions are critical when implementing blockchain technology, as most of the time an existing technology could address these challenges. Using existing technology means fewer risks and resources needed for the enterprises (Anderson & Felici, 2012). However, the efficiency and effectiveness of existing technology to address these challenges should be questioned.

The following set of questions were proposed by Gupta 2017 (cited in Yaga et al., 2018).

1. Is the current process costly due to intermediary?
2. Is the current system prone to undesirable changes due to cyber-attack or human error?

Blockchain as an emerging technology is a growing technology. Hence, these guidelines are still developing. This aligns with arguments by Baset (2019) and Yaga et al. (2018). Nevertheless, this guideline identifies use cases that are relevant for logistics services and can be improved with blockchain technology. In the next step, the selection of use cases arises in step 2 are analysed on the maturity level. Anderson & Felici (2012) mentioned that emerging technology comes with risks. Understanding the maturity level of use cases provides a better understanding of the risks to be taken by enterprises when implementing blockchain technology.

7.3 Step Three: Selecting Blockchain Model

This is the last step out of the three steps process to select a model of blockchain application in logistics. In this stage, the selected use cases in step two are analysed on the level of maturity. Research indicates that a standard maturity level analysis applicable worldwide is not available. This exercise identifies the gap between the current state of use cases to the state whereby the technological functionality is thoroughly known; the participants/consumer are aware of the product functionality and regulation has been implemented. Therefore, this paper proposes that these factors contribute to the maturity of the technology. These factors are named: technological readiness, consumer readiness, and regulation readiness. Figure 7-5 illustrates the factors contributing to maturity level of technology. This methodology suggests that with consumer and regulation readiness being considered, it reduces the risks of implementation.

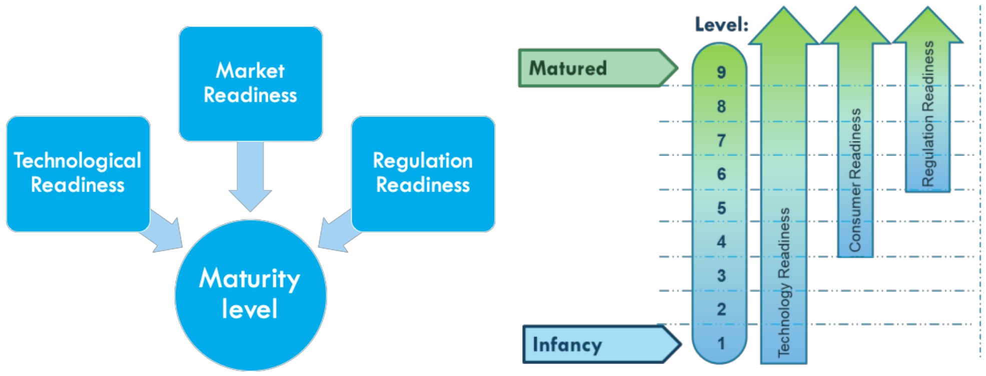

Figure 7-5: (Left) Factors contributing to the maturity level. (Right) Contribution of each factor to the level of maturity.

7.3.1 Technological Readiness

Technological Readiness is a method to gauge the maturity of the blockchain technology towards becoming a new product or solution for the consumer. Blockchain technology is made up of components of technologies and it functions to address various enterprises processes, as explained in part one (Baset, 2019; Behlendorf, 2016). The maturity of technology encompasses the activities taken to develop the technology as an application for a business process or becoming a product ready for the consumer. Development stages involve the conversion of an idea into an innovative concept that can be made available for the public (Yadav, et al., 2007; Blazevic, 2008; Pedrosa, 2012) Table 7-2 describes the stage of technology as it is being developed for each maturity level.

Table 7-2: Technology development level and effect to maturity level

Maturity Level	Technology Readiness
9	The system is fully operational and adjusted to comply with the regulation
8	The system is live and interacting with the consumer
7	Large Scale Project
6	Pilot Project
5	Proof of Concept has been conducted
4	Computer-based simulation conducted
3	Critical functionality of the solution clearly defined.
2	Components have been formed into a solution
1	Components of technology are tested.

This technology readiness assessment is based on the action taken to improve technology development. This process is iterative and not reflected in this method.

7.3.2 Consumer Readiness

Consumer readiness is a measurement of the consumer's perception, as the technology's users, how the technology could improve the intended processes and addressed their needs. This paper proposes consumer readiness as a result of technological readiness. Because enterprises should engage the consumer in co-creation with new technology to create a product desired by the consumer (Kawa & Maryniak, 2019), therefore, to fill the gap in knowledge and perception of a consumer of the technology. This aligns with Pedrosa (2012) in the article "Customer Integration during Innovation Development: An Exploratory Study in the Logistics Service Industry". He argues that integrating the customer affects the technology development process. The majority of articles also support this claim (Atuahene-Gima, et al., 2005; Nordhoff, 2011); Customer integration during technology development assists in creating a product expected by consumer (Atuahene-Gima, et al., 2005). Furthermore, Pedrosa (2012) highlights the utmost importance of engaging the customer at the right time. Engaging customer too early or too late might have adverse effect on technology development (Pedrosa, 2012).

Based on the above arguments, Table 7-3 indicates the consumer's perception of the technology for each level of maturity.

Table 7-3: Consumer readiness effect on the technology maturity

Maturity Level	Consumer Readiness
9	The system is adjusted to comply with the regulation
8	The system is live and interacting with the consumer
7	Large scale project is accepted
6	Pilot project results are accepted
5	Proof of Concept is recognised by the consumer
4	Technology benefits are accepted by the consumer

This method perceives maturity development as a one-directional static process. However, maturity development is a recursive and repetitive process, which was not reflected in this proposed methodology (Pedrosa, 2012). This method meant is meant to provide an indicative relevance between consumer readiness as an impact of technology development and maturity of the technology.

7.3.3 Regulation Readiness

Regulation readiness measures the developments of regulations surrounding the industries and its processes relevant to the use cases, such as regulations surrounding electronic data transfer in shipping industries. There are two types of regulations to be considered. The regulations are “hard” law and “soft” law, which are elaborated further below.

Niforos (2018) explained that there are two ways to regulate the market. In the first method of regulating, actions are taken by the authority or public regulators to govern the usage of the technology and/or its application with a legally binding statute. A legally binding statute is one of the essential regulatory frameworks relevant for the development of blockchain technology also known as “hard law” (Niforos, 2018). In the second method of regulating, actions are taken by a private party in each industry to agree on a set of transaction rules in the industry, also known as “soft law”. Participants may prefer this regulation, due to its flexibility when dealing with the uncertainty of new technology (Niforos, 2018).

“Developing proper governance and regulatory framework for blockchain-based applications will be essential to providing consumer participants the stability they need to fully engage with the technology and allowing innovation to flourish. Given the global, multi-sectoral reach of blockchain, regulators and industry will have to work in a collaborative manner to ensure they can both experiment and learn, and so shape the future of the technology in a way that benefits all parties and society as a whole.” (Niforos, 2018).

Niforos (2018) also argues that regulation development in early stages may hamper technology development.

“Adopting definitive legislation at this early stage may be premature and hamper future innovation.” (Niforos, 2018).

Based on the argument above, technology will be more mature when regulation is ready and becomes a law. Table 7-4 elaborates the state of maturity as a reflection of actions taken by the authority.

Table 7-4: Stages of regulation which will impact the maturity of the technology

Maturity Level	Regulation Readiness
9	The law in-place is consistently applied in the major economic market.
8	A “hard” or “soft” law has been passed, to serve as a form of supervision
7	Public discussion on the technology effect is on-going
6	Authority review the impact of this technology

This method has several limitations. Although it regards regulation as decided by the authority and private party, it does not consider the length that the regulation has been in place. Furthermore, due to time limitations, the laws considered are only in limited countries. Some cases review regulations in United States, Europe and China. In the following paragraph analyses and discusses the results on this prioritisation methods.

8. Analysis and Discussion

This chapter addresses the research question of part two: what is the model of blockchain technology suitable for logistics services. The explanation follows the methodology described in chapter 7. Firstly, the results of each step in the inventory stage are explained. The inventory of the use cases is assessed based on their relevance towards the logistic services using a literature review of logistics services in chapter 3. Secondly, use cases relevant to logistics services are evaluated based on the benefits blockchain technology can bring and cluster based on the benefit of blockchain technology for logistics services, as described in chapter 4. Thirdly, the maturity analysis are applied to the model use cases.

8.1 Step One: Building an Inventory of Blockchain Use Cases

8.1.1 Use Cases Inventory

Using the method presented in section 6.1, the inventory results in an extensive list of use cases. The complete list of use cases can be found in appendix I. Seventy use cases were found to be relevant to logistics and supply chain management.

8.1.2 Grouping

There are several stages of grouping in this category. The exercises provide the indicative activity of the use cases in the industries and relevancy with logistics services.

Firstly, with the pre-defined keywords mentioned in the methodology sections, a list of web addresses was generated related to various use cases proposed or developed by companies or organisations. From each of the web addresses, the ideas of the use cases were extracted. Figure 8-1 illustrates the wide range of words that resulted after extracting ideas from the use cases. It indicates a very broad range of functions and ideas of how blockchain technology could be utilised. However, this exercise did not provide a useful result on how the use cases could be grouped together. Nevertheless, it simplifies the use cases for the next step of grouping.

Figure 8-1: Word mosaic resulted from the ideation of use cases

As the next step, the industry that benefits from the use cases' design idea was allocated and the year the use case was first initiated were searched. The results show blockchain technology could provide benefit to a wide range of industry in high-level supply chain management industries. Fifteen industries that could leverage on blockchain technology on a high-level concept of supply chain management, were identified. Table 8-1 indicates the summary of industries and the first year that the design ideas of blockchain technology use cases for the industry were first found.

Table 8-1: Indicative activities of blockchain development in high-level supply chain management industries.

	2013	2014	2015	2016	2017	2018	2019
Audit and Assurance	0	0	0	0	4	0	0
Automobile	0	0	0	0	2	2	0
Art and Entertainment	0	0	0	0	0	1	0
Communication Service Provider (CSP)	0	0	0	0	0	6	1
E-Commerce and Retail	0	0	1	2	3	3	0
Energy	0	2	6	3	2	2	0
Financial Services	0	0	1	0	1	1	0
Food and Beverages	0	0	0	2	0	1	0
Government	0	0	1	1	0	1	0
Healthcare and Medical	0	0	0	2	3	3	0
Insurance	0	0	0	1	1	0	0
Logistics Services	0	1	0	1	4	2	1
Non Profit	0	0	1	0	0	1	0
Real Estate	0	0	1	0	3	0	0
Waste Management	0	0	0	0	1	0	0
Total	0	3	11	12	24	23	2

This exercise shows the activities in blockchain technology use cases development for various industries. Seventy use cases were added to the inventory list. The strongest activities of blockchain technology were found in the year 2017 and 2018 with a total of forty-four use cases were found during this period. Nevertheless, inconsistencies in the data sources were found during research. Therefore, the results should only be considered as indicative development activities in blockchain technology for supply chain management concept in general. The limitation of this method has been elaborated in section 1.3.2. The challenges encountered during this exercise are elaborated next.

In the last grouping exercise, use cases were classified based on their relevancy with logistics services. Figure 8-2 illustrates the result. Three categories are proposed: high, medium and low relevancy with logistics services. Use cases in e-commerce, retail, healthcare and medical were found to have high relevancy with logistics services provided by logistics enterprises as defined in section 3.1. In the medium relevancy to logistics are services to support logistics services or related to moving product from one place to another. In the low relevancy to logistics are use cases with general relevance to the supply chain management concept. As it has been elaborated, the supply chain management concept is delivering product and services in the right place, time, product/services, which includes activities illustrates in figure 1-1. Next, the limitations and challenges of grouping exercises are elaborated.

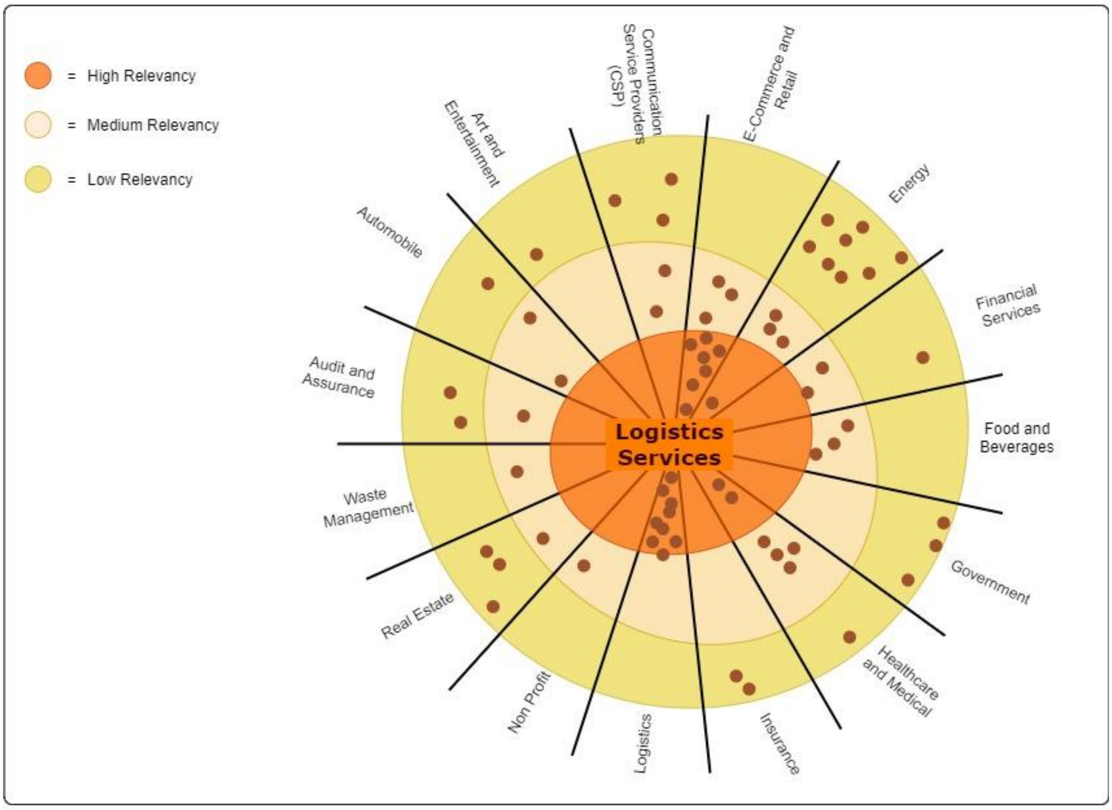

Figure 8-2: Use cases relevant to logistics services

There are two main challenges found during grouping exercise. The first challenge is to find the first year the idea was formed. Projects with rather similar objectives have been initiated across the globe. However, ambiguity and inconsistency of grey literature review made it challenging to classify the idea and identify the first year of development. The second challenge is to differentiate between use cases with high, medium and low relevancy to logistics services. This difficulty is due to the fact that industries needing logistics services are wide spread and due to the evolution in the type of logistics enterprises, as described in section 3.1. Therefore, keyword searches resulted in a very wide list of use cases. These challenges are elaborated further in the next paragraph.

In order to elaborate on the challenges, use case from the waste management industry is taken as an example. In the first challenge, most of these use cases were developed over several years. Field (2013) wrote in Forbes about a social entrepreneur named Plastic Bank who would monetize plastic to help the less fortunate. Plastic Bank announces in the year 2017 that blockchain technology will be utilised. Frankson (2017) wrote the collaboration of Plastic Bank with hyperledger. It shows that ideas have a long development period to identify blockchain technology as a suitable technology. Therefore, the year that the project initiated may not be generalised for all use cases.

In the second challenge, there is a broad interpretation of the idea in the grey literature. Sekhon (2018) proposed to use blockchain in more processes of the waste management industry. The processes he proposed include decentralisation of waste management with the smart contract and waste tracking from waste sources to the processing area. This article has resulted in alignment with logistics services, because it moves products from origin to destination. However, the definition of logistics services by logistics enterprises, as described in section 3.1, excludes this use case as highly relevant to logistics services. Instead it is classified as medium relevancy and related to supply chain management in general. Similar challenges were found in other industries' use cases. As the objective of these exercises is to find a model for blockchain use cases in logistics services, another level of prioritisation model should be applied.

8.2 Step Two: Evaluating the relevancy with Logistics Services.

In this second step of blockchain model selection process, use cases that are relevant to logistics services and that can be improved with blockchain technology, is selected to go to the next step. The evaluation process involves the evaluation of two areas: logistics services and blockchain technology

8.2.1 Use Cases Evaluation on Logistics Services Relevancy

Figure 8-2 illustrates the result of step one in this prioritisation model. Seventeen uses cases were found to be relevant to requiring logistics services of moving product from origin to destination. These use cases were further analysed based on the advantages of blockchain use cases in logistics services as described in section 7.2. Table 8-2 summarises the results.

Table 8-2: Blockchain use cases summary

Blockchain Advantages	Applications	Number of Use cases & industries
Trackability	Location and condition of a product	7 (logistics)
Traceability	History/origin of the product	9 (e-commerce and retail industry, pharmacy
Direct transaction	Automated trackability, traceability and payment system	3 (logistics)

The use cases are elaborated starting from the basic advantages of digital documentation for trackability to more complex product origin and transaction automation. Selective use cases are taken as an example. However, not all use cases are elaborated. The complete long list of use cases is available in appendix I.

8.2.1.1 Use cases relevant to the trackability characteristic of blockchain technology

Trackability is a capability to know the location and condition of a product at any time when the product moves from point of origin to destination. This has been described in section 3.2. Kawa & Maryniak (2019) describe the trackability benefit of blockchain technology is made possible when the information is available in digital format.

"…creating digitized document workflow they managed to ensure all documents and activities in the supply chain to be available and visible to every partner, supported with information about who, where and when issued them or move the goods. This decreases the need for domestic and international direct communication, avoids mistakes, waiting, and other forms of waste, and ensure significantly faster information transactions and indirectly faster material flows in the supply chain." (Kawa & Maryniak, 2019)

Several projects align with the benefits as described above. These projects are TradeLens (n.d.), CargoSmart (2018), CargoX (n.d.), a joint collaboration between AB InBev, Accenture, APL and Kuehne + Nagel (Accenture, n.d.), Blockshipping (2018), PetroBloq (n.d), Logchain (n.d.).

Research shows that the projects are designed to benefit cargo owners and 3PL logistics companies whose main activity is currently entering paper-based documentation into digital format. Subsequently, the data contributed by these two types of companies benefit multiple actors along with the logistics services. The actors are inland transportation, custom/government authority, ports and terminals, ocean carriers, financial services, software developers.

The commonality of the design intent of these projects for logistics services enterprises is to improve customer services, operational efficiency and custom broker clearing process. The logistics enterprises can provide better information to the customer by having more information about the location of shipment, shipment progress, more time to prepare an alternative transportation plan and efficient document management. It is possible because of the blockchain technology components and logistics services quality nature. Kawa & Maryniak (2019) agree on these arguments.

The ability to track a product from origin to destination may result in the future benefit of knowing the source of origin or traceability. The cluster of use case relevant to traceability is described in the next paragraphs.

8.2.1.2 Use cases relevant to traceability characteristic of blockchain technology

Traceability is the ability to inform the consumer, with certainty, about the history of a product. The history of a product is a compilation of events that happened in the past, as the product was being manufactured. The use cases in this category are spread in multiple industries. The industries are retail and e-commerce for food, perishable and high-value assets, waste management, pharmaceutical. Unlike the tracking advantage of blockchain, the capability to trace the origin of a product could benefit multiple sectors. Table 8-3 elaborates on the partnerships or projects developing along this line. The alignment of the partnerships or projects with logistics services is elaborated in the next paragraph.

Table 8-3: Industry partnerships or projects in traceability related in relation to traceability characteristics of logistics services

Industry	Partnerships/Project	Sub-Industry
Retail and E-Commerce	IBM and Wallmart (Hyperledger, n.d.)	Perishable products
	Cargill + Turkeys farmers (Whichita, 2017)	Perishable products
	Te-food (Te-food, n.d.)	Perishable products
	Everledger (Everledger, n.d.)	High-value Assets
	Tracr (TRACR, 2018)	High-value Assets
	Provenance (Provenance, 2019)	Multi industry
Pharmaceutical	Farmatrust (FarmaTrust, n.d.)	Medicine products
	Medildger (MediLedger, n.d.)	Medicine products

Research shows that the use cases mentioned in table 8-3 are addressing the issue of efficiency in supply chain management. Specifically use cases in perishable products, whereby source/origin is of the essence. It can be achieved by providing authorised access for relevant participants to the platform. This reduces the time taken to trace the product's history, creating faster operation, and shorter response time to consumers' enquiries. The result is increased consumer confidence in the product and improvement of consumer satisfaction. This analysis also aligns with the argument by Kawa & Maryniak (2019). However, blockchain technology's capability to create immutable records has created additional value for another industry. Next paragraph explains this value.

The immutable records in blockchain-based technology systems can identify fraud and counterfeit products. Each sub-industry uses various informations to identify the counterfeit product. The difference in each of the three sub-industries are explained next. Firstly, the use cases in perishable products are using production process, material, etc to convince the consumer of the product quality. For instance, the collaboration between Cargill and Turkey farmers use farm certificate and photos to ensure product quality.

Secondly, in the high-value assets industry, the product's metadata when uploaded in the blockchain network can be used to identify a product with precision and justify the origin. The everledger use case recorded characteristics, serial number, chain of possession, location and condition, along with certificates of authenticity and payment documents (Hanebeck, et al., 2019). Therefore, it is easier to identify counterfeit. (TRACR, 2018) are developing a similar solution (Bender, et al., 2019).

Lastly, use cases in the pharmaceutical industry exploit blockchain technology to trace counterfeit medicine by involving all actors in the supply chain line. Kawa & Maryniak (2019) argues that the value of blockchain technology in pharmaceutical products is due to the long supply chain line. The organisations involved are raw materials suppliers, medical institutions, manufacturing companies, repacking companies, with each an individual system to track the process. Morris (2018) explains blockchain technology could be a solution in a profit-driven pharmaceutical industry. Although trace-ability and track-ability are using smart contract functionality, it is not complete (Kawa & Maryniak, 2019). The next category of use cases are utilising the complete benefits of the smart contract with trackability, traceability and payment automation.

8.2.1.3 Use cases relevant to direct transaction characteristic of blockchain technology

The direct transaction is the advantage of blockchain technology to disregard intermediaries and reducing overall transaction cost. While the use cases in previous sections are digitising paperwork and expediting the process, responding to the need for open access to information in a blockchain platform, this category is addressing issues of intermediary cost beyond open access to the digital document. It is made possible by smart contracts and by connecting assets in digital format in the process. These use cases are elaborated below.

Blockchain in Transport Alliance (BITA) has proposed a use case to engage and address the payment issue of truck drivers by using a blockchain technology platform to standardise data transfer (Salama, 2018; Kawa & Maryniak, 2019). The challenge faced today is 90% of truck companies in the USA are small companies. They own less than six trucks per company. Hence a collaboration model employed by MAERSK and IBM in the shipping industry is not an efficient method to engage truck companies. This challenge is explained by Salama (2018), who explains the reasoning behind BITA use cases to proposed a standardised of data.

Smart Log Project by Kouvala Innovation (Lammi, 2018) and Smart Container Management by IBM, Watson IoT Center and Capgemini (Heinen & Borgers, 2017) are experimenting with providing higher data resolution by the integration of an electronic device in the product or container. This electronic device captures real-time data before, during and after delivery which justifies activation of a smart contract. These data are temperature, travel time on a certain mode of transport, customs clearance time, etc.

"It is imaginable to automate this process with Smart Contracts. A change in temperature which poses a breach of contract can trigger automated processes like an insurance proposal, a contractual penalty for the forwarder and a reorder at the supplier." (Heinen & Borgers, 2017)

However, Kouvala Innovation proposed to integrate data from an electronic device in a shipping palette to be integrated with a smart contract with the condition of shipment integrated into the contract (Lammi, 2018; Banker, 2017). The shipping company could bid for the right to move the product with award and payment can be done with a smart contract. All conditions during shipment are captured by an electronic device, which alerts all relevant parties when a condition in the smart contract is not met.

In brief, selected use cases that can leverage blockchain technology have been elaborated. The use cases were explained from the basic functionality of document digitisation to more complex issues, such as determining product origin and automating transaction with embedded electronics to capture data in real-time. In the next step, the maturity of these use cases is analysed further.

8.3 Step Three: Selecting Blockchain Model

In this step, methods explained in section 7.3 is applied to the selected blockchain use case from step two. The use cases are analysed in the cluster of traceability, trackability and direct transaction. Separately, as a technical issue impact all clusters, it is not part of this maturity analysis (Edeland & Mörk, 2018). Each cluster of use cases is examined on the technology, consumer and regulation readiness. Only use cases that presented a holistic solution will be analysed in this stage. A summary will be provided at the end.

8.3.1 Maturity of Use Cases Providing Trackability

Trackability use cases' make use of blockchain technology to identify the location and condition of the product at all time. The maturity level of these use cases is the highest in comparison to the other clusters with a total score of twenty-one. Figure 8-3 illustrates the scores. The three categories of maturity level are elaborated below.

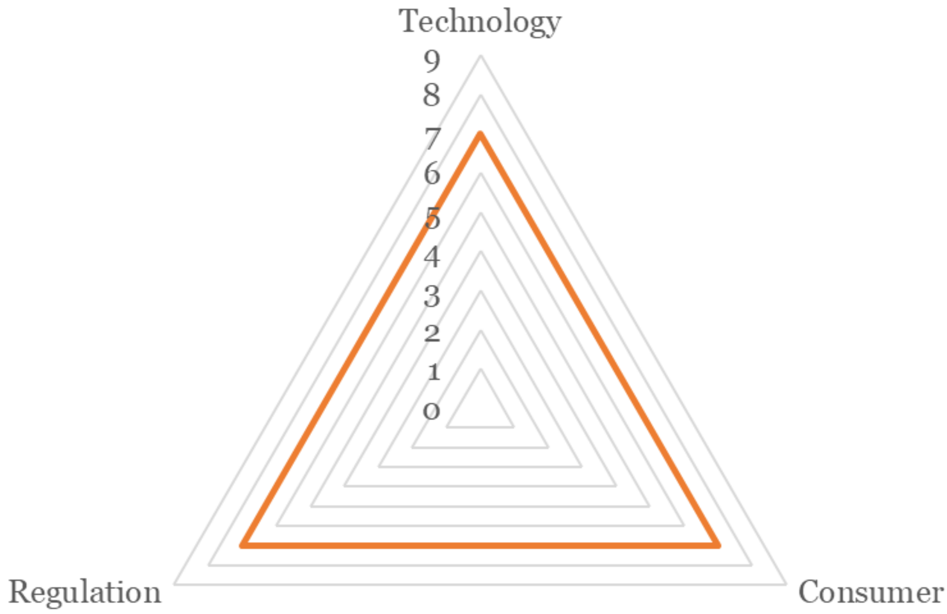

Figure 8-3: Maturity Analysis for Trackability Use Cases

8.3.1.1 The Technology Readiness Level

The technology readiness level is at level seven, the highest among all cluster, because of the clear technology selection in each use cases. The blockchain technology providers were explained in 2.2. Table 8-4 summarises use cases with high technological readiness. Tradelens, CargoSmart, CargoX are using Hyperledger platform with a permissioned network.

BlockShipping and LogChain are using ethereum. The preferred technology partner varies for each company. Although there are several use cases that are still at an early infancy level, the technology environment made it quite feasible to bring them into maturity.

Table 8-4: Use cases with high technological readiness level

	Technology	Technology Provider
Tradelens	Hyperledger	IBM (TradeLens, n.d.)
CargoSmart	Hyperledger	Oracle (Cargo Smart, 2018)
CargoX	Hyperledger	RoadLaunch (Chambers, 2019)
BlockShipping	Ethereum	KeyCore/AWS (Blockshipping, 2018)
LogChain	Ethereum	Microsoft Azure (Maritime Executive, 2019)

8.3.1.2 The Consumer Readiness Level

The consumer readiness level of trackability is similar to the technology readiness level. The reason for this categorisation is because it is addressing an existing problem, a clearly defined value proposition. Almost all use cases are addressing similar challenges in various methods. Tradelens offers digitising documents related to shipping company and 3PL logistics services provider. CargoX offers to address similar challenges of inefficiency in the manual process as a third-party solution. Blockshipping offers the solution for shipping container owner and operator. AB InBev, Accenture, APL and Kuehne + Nagel consortium proves that it is possible to digitise the document and share in blockchain technology. Hatter et al. (2018) argue that it is possible to enable trust and security of blockchain technology by analysing the impact of reallocation of information ownership, accountability and maturity of the emerging technology.

8.3.1.3 The Regulation Readiness Level

The regulation readiness level, at level seven, is lower than the traceability use case. As it has been described in section 7.3, trackability functionality is developed based on document digitisation and open access to information. Research show information exchange standard, “soft” law, for tracking in blockchain technology for logistics services, data storage’s safety requirements are available but siloed within each transport mode or geographical region. These regulations entail how the data is segregated, how access control is being designed, how data is kept private (Hanebeck, et al., 2019; Salama, 2018; Pettersson, 2001).

Salama (2018) agrees that there is a need for standardisation on the data exchange structure across all logistics services worldwide. He elaborated that the logistics industry has been using Electronic Data Interchange (EDI) as a data exchange structure in logistics. However, there is no single standard that applies to all logistic industries worldwide. Nevertheless, as the process of digitising information in logistics is a classic challenge, several organisations have attempted to address this issue.

Organisations, who have attempted to create regulations are INTTRA and BiTA. Firstly, INTTRA, existed to create a united global shipping industry (Pettersson, 2001). Secondly, BITA (Blockchain in Transport Alliance) published a data standard to provide an initial framework for interoperability across a currently fragmented and siloed framework of proprietary blockchain networks (BITA, 2019). In the next paragraph the maturity of traceability use cases is analysed.

8.3.2 Maturity of Use Cases Providing Traceability

Traceability use cases are exploiting the secured system in the blockchain technology to provide a history of the product that the consumer can trust. The overall maturity level of traceability use cases is second after trackability, with total score of twenty. Each maturity category will be explained below.

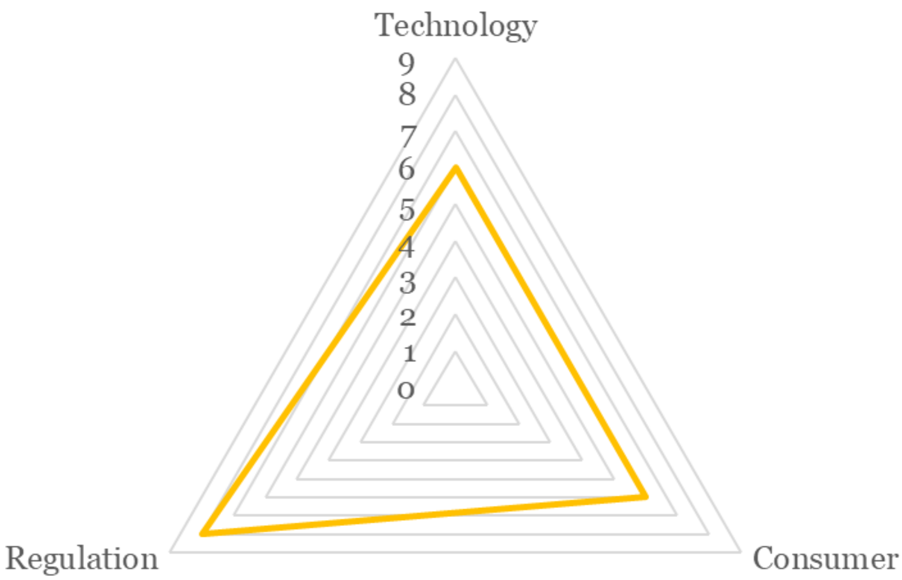

Figure 8-4: Maturity analysis of traceability use cases

8.3.2.1 The Technology Readiness Level

The technology readiness level of the industry is at level six. Table 8-5 summarises the technology preference of the use cases. Most of the use cases have a clearly defined platform preference, such as hyperledger, ethereum and parity ethereum (a deviation of ethereum). However, no information can be found on Tracr blockchain technology preference.

Table 8-5: Use cases with high technological readiness level

Partnerships/Project	Technology	Technology Provider
IBM and Wallmart (Hyperledger, 2018)	Hyperledger	IBM
Cargill + Turkeys farmers (Whichita, 2017)	Hyperledger	IBM
Te-food (Te-food, n.d.)	Hyperledger	In-house
Everledger (Everledger, n.d.)	Hyperledger	Oracle
Provenance (Provenance, 2019)	Ethereum	In-house
Farmatrust (FarmaTrust, n.d.)	Multi platform (Sharif, 2019)	In-house
Mediledger (MediLedger, n.d.)	Variation of the Ethereum	In-house
Tracr	Not available	Not available

8.3.2.2 The Consumer Readiness Level

The consumer readiness level for traceability case is the same as technology readiness level - given the consumer industry requirement for trusted information, especially in the perishable, high-value assets goods and pharmaceutical industry. The use cases have clearly defined challenges for each target industry. Table 8-6 summarises the consumer issue to be addressed from use cases in the traceability. *However, interface to interact with the consumer is not found in most use cases.*

Table 8-6: use cases in traceability with a high maturity level

Partnerships/Project	Sub-Industry	The issue to be address
IBM and Wallmart	Perishable products	Provide the origin of perishable product sold in the wall mart store: - Uploading certificate of origin - Time is taken to trace the product source
Cargill + Turkeys farmers	Perishable products	Provide the complete history of the turkey's farmers sold by Cargill directly from the farmers. Farmers could upload the history of the farms, photos and other information to provide trust to consumer on the product quality.
Te-food	Perishable products	A third party, traceability solution for all perishable products. Using product identifier consumer can be engaged with information on the farm and supply chain company along the delivery process.
Everledger	High-value assets	A third party, traceability solutions for diamond, art, luxury, gemstones, wines. The system provides information such as the location of mine, original product, and the people involved in shaping the diamond.
Tracr	High-value assets	A traceability solution created by a consortium of the diamond companies. It will store product information and participants involve In the supply chain.
Provenance	Multi-industries	A third-party traceability solution created to share the origin of various types of retail products (e.g. fashion, jewellery, processed food, etc.). The information uploaded in the system varied between seller.

Farmatrust	Medicine products	A third-party solution of product verification system to comply for the regulatory standard of medicine.
Medildeger	Medicine products	A third-party solution of product verification system to comply for the regulatory standard of medicine.

8.3.2.3 The Regulation Readiness Level

The regulation readiness of traceability cluster, in level eight, is higher than the trackability cluster. This is due to the availability in “hard” and “soft” law, owing to the highly regulated nature of industries. The next paragraphs explain regulations related to perishable products. As the use cases mostly appear on food-related products, the focus is on food regulation, followed by regulations in the pharmaceutical industry and high-value assets. The industry of high-value assets is widespread. An example of regulation in the diamond industry, relevant to the use case is elaborated.

Regulation on food products varied from country to country. McEntire & Kennedy (2019); Chen et al. (2015) have elaborated food traceability regulations in the United States, Europe and China. There are extensive regulations that have been developed on data standardisation and food traceability by authorities and private institutions. However, they argue that the fast pace in which industries processes advances have outpaced the authority’s speed to create new laws and monitor every step of the process. Hence, better technology to monitor food production and safety requirement is needed.

Field (2008) has elaborated that health care regulation is complex because it concerns the wellbeing of people. Therefore, more oversight is needed in the health care industry. Huang et al. (2018) explain that regulation on drug traceability has become mandatory in the United States, Europe and China. U.S. Food and Drug Administration (n.d.) provided U.S. Drug Supply Chain Security Act (DSCSA), while European regulation is mandated by European Medicine Agency (n.d.) and National Medical Product Administrator has produce regulation on drug identification and traceability (Adents Team, 2019; National Medical Product Administrator, 2019).

Until now the regulation for food and medicine products have been explained. In contrary to “hard law” in food and medicine industry, the high assets industry regulation is an example of industry-based “soft law”. Research shows there are a variety of regulations established by the industry. The Kimberley process certificate is one of the industry regulatory requirement to track rough diamonds and prevent conflict diamonds to enter the legitimate world market. This certificate is also adopted by Everledger and Tracr (Yam, 2019; Moore, 2018). Haufler (2009) elaborates that the Kimberley process is an example of industry-based certification controlling export or import process implemented to domestic legislation of member states.

8.3.3 Maturity of Use Cases Providing Direct Transactions

The use cases providing direct transaction processes are made possible with a smart contract, enhanced with the automation of data entry with electronic devices. The results include automation process and automation in transfer of assets. The overall maturity level of this cluster is seventeen, the lowest among all cluster. The following describes the maturity in each parameter.

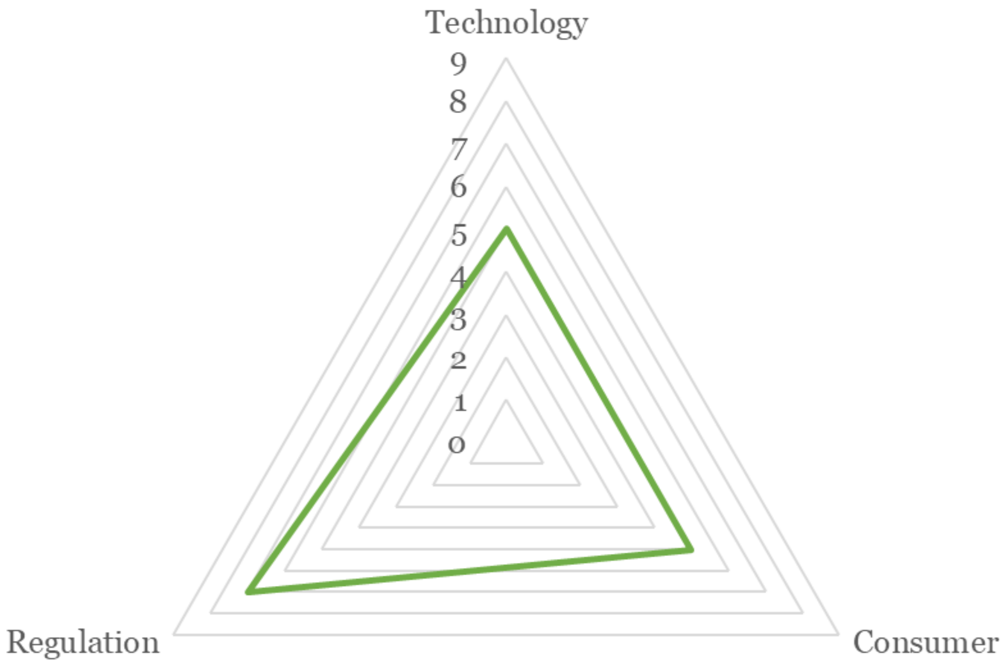

Figure 8-5: Maturity analysis of direct transaction use cases

8.3.3.1 The Technology Readiness Level

The technology readiness level for direct transaction use cases is at level five. This is due to unclarity in the method to address the automation of assets transfer and connection with physical devices. Projects in this cluster did not pass proof-of.concept stage.

8.3.3.2 The Consumer Readiness Level

The consumer readiness level for direct transaction use cases is also at level 5. Table 8-7 summarises the use cases in this category. The low level is due to the unclear elaboration on how the use cases address the issue of automatic payment and smart contract.

Table 8-7: Use cases of indirect transactions

Use case	Challenge to be addressed
BiTA	Addressing the payment issue of truck driver
SmartLog **Smart Container Management**	Using electronic data to automate smart contract

8.3.3.3 The Regulation Readiness Level

The regulation readiness for these use cases is at level seven, the lowest among all clusters. This is due to the unclear regulation involving payment systems and smart contracts. World Economic Forum (2019) describes that the future blockchain technology applications in the supply chain require linkage with digital assets. A uniform legal rule in the global system is needed for across jurisdiction worldwide transaction scale of supply chain.

The United Nation Commission of International Trade Law (UNCITRAL) has begun the work on uniform legal rule. Although, blockchain technology development could assist in expediting laws and regulations development, is it insufficient. World Economic Forum (2019) explains that the regulation development is immature at this stage.

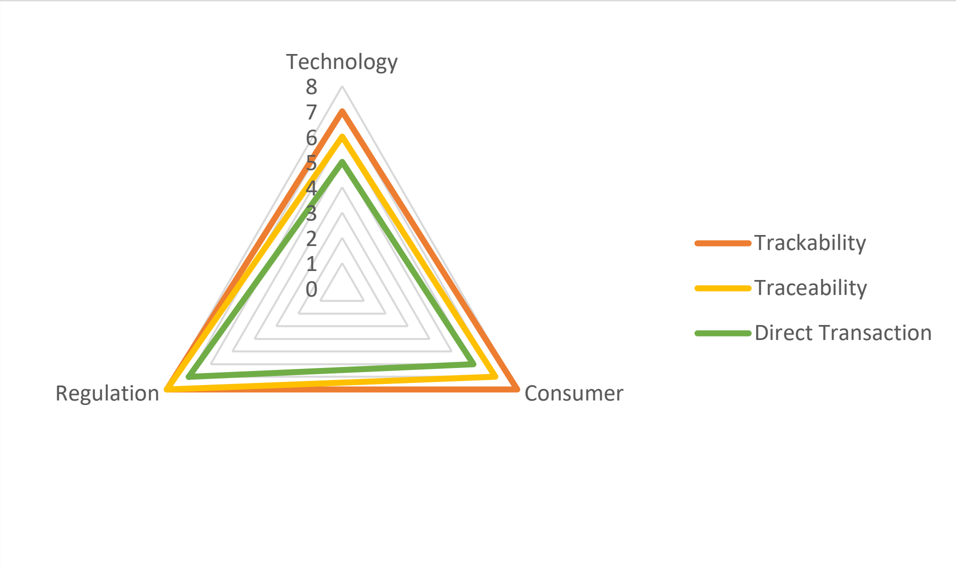

Figure 8-6: Summary of maturity analysis for the three clusters of use cases relevant to logistics services

In summary, use cases in the cluster of trackability, traceability and direct transaction have been analysed. Figure 8-6 illustrates the maturity analysis of these use cases. Short summaries for each clusters maturity analysis are elaborated in the next three paragraphs.

Firstly, the trackability use cases address the issue of document digitisation and electronic data sharing in a single platform for all relevant parties. These use cases have a high overall rating. Due to the clarity of the selected technology, to the solution offered to the consumer and to the minimum gap from the current process. The consumer has been engaged from the beginning in a co-creation process. Although "hard" law is not available, "soft" law is available to regulate the market.

Secondly, traceability use cases address the issue of providing product history that can be trusted by all parties. The use cases in this cluster have a lower maturity level in comparison to trackability use cases. A traceability use case could benefit more industries than trackability use cases. Thus, each use case has a clear pilot project and solution to address the consumer's challenge. But, it is not clear if these use cases have advanced to large scale implementation. Nevertheless, the use cases in the traceability cluster are addressing a fundamental challenge (e.g. food safety, originality of drugs). These challenges are relevant to highly regulated industries. Therefore, regulation readiness is the highest among other clusters.

Lastly, direct transactions use cases are addressing the efficiency issue beyond trackability and traceability use cases. The use cases in this cluster are solving the issue of processes' automation end-to-end. The automation is created with smart contract activated electronic data and connecting digital assets. The use cases did not progress beyond proof-of-concept. Therefore, technological and customer readiness is low. Regulation in the area of digital assets and its automation for enterprises is unclear. Therefore, this cluster has the lowest maturity level. Research shows that all clusters have relevancy to logistics services and blockchain technology. Enterprises should consider all models when planning to improve logistics services with blockchain technology. The three models provide a holistic perspective of blockchain technology application to improve various parameters of logistics services quality. There are various consumer dynamics scenarios that could be leveraged from each model. Scenarios analysis are available in chapter ten.

As the analysis of part two is concluded, the next chapter delivers the summary of part two as a recapitulation of what has been done so far.

9. Summary of Part Two

Part two of this report addresses the issue of model selections of blockchain applications for logistics services. The methodology for this research is a use cases analysis. The internet search engine is utilised as a tool to find use cases. However, the expansion of logistics services over the years and the internet search engine resulted in a broad variety of use cases. A prioritisation model was applied to the long list of use cases to identify the clusters of use cases relevant for logistics services.

The prioritisation method comprises of a three-step approach. These steps are inventory building, evaluation and model selection. The first step is to create an inventory of use cases from unstructured and mixed information from the world wide web, which resulted in a long list of use cases. Several grouping applied to list: idea, year of ideation, main industry to benefit and the need for logistics services. Subsequently, the clusters of industry and the need for logistics services create clarity on use cases relevant for logistics services. This cluster provides the basis for the next step of model selection.

The second step to select a model is an evaluation step. In this step, the use cases relevant to logistics services are evaluated, based on the type of challenges to be addressed. The benefit of blockchain in logistics identified in part one uses to create three clusters. These clusters are trackability, traceability and direct transactions. Use cases in the trackability category address the challenge in sharing digital data to relevant parties in a single platform. These use cases align directly with the logistics industry. Meanwhile, use cases in the traceability category address the issue of providing information that can be trusted and shared with confidence to consumers and other parties on the history of a product. The information could be product origin, how and by whom the product was made, originality, etc. The type of information available in the blockchain platform can address various perspectives on product history. E-commerce, retail and pharmaceutical industries are industries that benefit from this process. The clusters of use cases were further analysed based on their maturity level.

In the last stage of prioritisations, the maturity of use cases in the clusters is reviewed in three areas. Firstly, technological readiness reviews the technology selection and stage of project development. Secondly, consumer readiness reviews the clarity of the solutions to address the challenge and consumer comprehension of the solution. Lastly, regulation readiness evaluates the regulation surrounding the industry's challenge.

Research indicates that trackability has the highest maturity level, follow by traceability and direct transactions. Therefore, trackability, traceability and direct transactions are the model of blockchain application in logistics services. Due to time constraint, the analysis has been simplified. Therefore, it comes with limitations. This limitation has been elaborated in section 1.3.2 and each section, as the results were first presented.

The prediction of the logistics services industry's future in grey literature is inconsistent. Strong globalisation trends, increased competition, higher consumer demand and resources conscientious are obstacles of logistics services' industry (Melkonyan & Krumme, 2019; Zijm, et al., 2019). However, with appropriate preparation, obstacles in the logistics services industry could open new service opportunities. Blockchain technology could potentially address some of the challenges mentioned above. Although, implementing blockchain technology in logistics services, like other innovative technology, comes with a negative impact that requires further analysis (Heiko & Darkow, 2010; Darkow, et al., 2006; Flint, et al., 2005). Part three investigates and argues on the implementation of the three models of blockchain application in logistics services from a third-party information technology provider.

Part Three: Information Technology Enterprises Implementation of Blockchain Technology for Logistics Services

Part three is the last part of this report. It addresses the research question: How does the information technology enterprise optimise itself to implement blockchain technology within the industry? This part begins with how scenario analysis becomes a tool for an enterprise to develop strategic visions. Followed by how scenario analysis can be utilised to optimise blockchain technology implementation. Lastly, the blockchain application models identified in part two are applied and analysed in various scenarios. The analysis offers a basis for a digital enterprise to optimise the business process when using blockchain technology.

10. Introduction: Analysis of Future Scenarios to Assist Enterprises' Development Plan

Logistics services enterprises, like many other enterprises, have been experiencing turbulent times in recent years (Zijm, et al., 2019; von der Gracht, 2008). The economic crises that caused turbulent time have increased in frequency and magnitude over the years (Krys, et al., 2013; Fink, et al., 2010; von der Gracht, 2008). The logistics enterprise has been through several evolutions of logistics enterprises model, as elaborated in part one. The evolution within the logistics enterprise resulted in more comprehensive logistics services. The enterprises' management needs to develop a plan to stay competitive in this turbulent market.

In the holistic perspective, enterprise management planning comprises of strategic, tactical and operational level (Fink, et al., 2010). Each level has its own activities and external factors to consider. Figure 10-1 describes a holistic perspective of an enterprise development plan and activities and factors. Dr. Ing. Alexander Fink et al. (2010) elaborate the concept further as follows. The strategic level is needed to define an enterprise's vision and commercial desires. The tactical level developed a business model and a detailed roadmap from an enterprise's vision. While in the operation level, the business model guides investment decision. Additionally, the operational level identifies the risks of investment decisions. Based on the above elaboration, the strategic level requires a broad perspective of the future. Therefore, an analysis of future scenarios provides a strategic level core foresight.

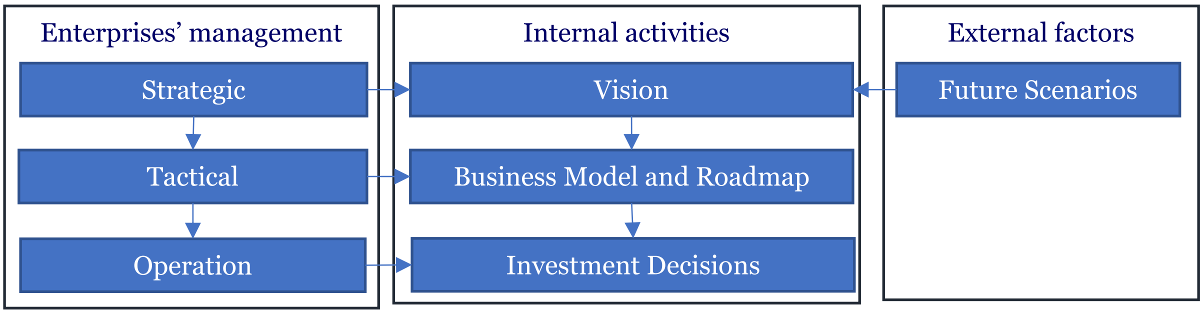

Figure 10-1: Enterprises' holistic perspective of enterprise development planning tools (Inspired by (Fink, et al., 2010)

Future scenarios analysis assists enterprises to be flexible and agile in turbulent times (Schwenker, et al., 2013; von der Gracht, 2008). Therefore, enterprise planning based on scenario analysis has become a popular tool today for enterprises and academics. Von der Gracht (2008) and Varum and Melo (2010) research revealed that 70% of scenarios planning articles were published after the year 2000 (von der Gracht, 2008; Varum & Melo, 2010). Therefore, scenario planning is an increasingly popular tool to be used by enterprises to create a strategic vision. Blockchain technology as emerging information technology can benefit logistics services, as it has been elaborated in part two. Therefore, the next chapter elaborates on the methods to utilise scenario planning as an enterprises' tool to develop a strategic vision.

11. Methodology: Analysis of Future Scenarios for Information Technology Enterprises when Implementing Blockchain Technology

This section elaborates on the methodology of scenario analysis in this research. Firstly, section 11.1 explores a classical scenario analysis. Secondly, section 11.2 elaborates on the methodology of scenario analysis for this research. Lastly, the survey questions developed to obtain feedback on blockchain technology enthusiast and on the demography of the respondent are explained (section 11.3). Chapter 11 serves as a foundation for the scenario analysis results in chapter 12.

11.1 Scenario Analysis as an Enterprise's Tool to Plan in Uncertain Futures Scenarios

This section describes how scenario analysis can be utilised as enterprises' management tools. Two variations of scenario analyses for strategic analysis purpose are elaborated. First, the work by Fink et al. (2010). Second, the work by Schwenker et al. (2013). Lastly, the strengths and weaknesses of this method are explained. Chapter 11.1 provides an introduction for the methodologies of scenario analysis results explains in chapter 11.1 to chapter 11.3.

Scenario analysis assists an enterprise to be more prepared for various future scenarios (Schwenker, et al., 2013; von der Gracht, 2008; Fink, et al., 2010). These authors conducted extensive research on scenario analysis in enterprise and the impact on the enterprises' strategic vision. Furthermore, these authors, Schwenker, et al., 2013; Chermack, 2011; Camillus & Datta, 1991; Eisenhardt & Sull, 2001; Grant, 2003, agrees that scenario planning is the suitable to incorporate uncertainty and complex environment in enterprise' strategic vision. First, the work by Fink et al. (2010) elaborates how scenario planning could be utilised for a strategic decision-making process for the company. Second, Schwenker et al. (2013) and von der Gracht (2008) propose a structured approach of scenario planning for enterprise strategic decision-making process. The latter method has seen an improvement in the time required for the development. Next paragraph elaborates scenario planning based on Flint et al. (2010).

Fink et al. (2010) explain how scenarios interconnect with strategy. Figure 11-1 illustrates this relationship. Firstly, scenarios can be developed by using a combination of corporate/business environment, type of industries and technological development, specific global issues. Secondly, the scenarios are organised by re-examining the current business market, industry and global environment from a future perspective. Fink et al. (2010) recommend a combination of internal/external organisation perspective and an intuitive approach to organising the scenarios. Thirdly, future scenarios are organised as a consideration factor in strategic planning tools. Several known instruments for strategic planning tools (e.g. portfolio, success factors, value chain analysis) are utilised in combination with future scenarios to define one or more strategies. In the fourth level, the strategies are evaluated, revised and mapped. The exercise will compare the existing strategy and identify inconsistencies that could reveal potential improvement. Lastly, the strategy is framed into a scenario matrix. The exercises will identify the suitability and robustness of various strategies defined in the previous steps into scenarios.

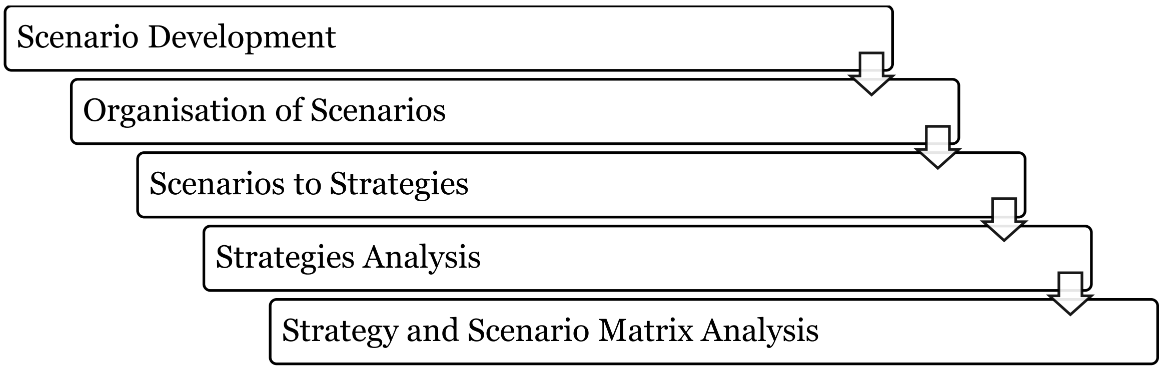

Figure 11-1: Scenario Development and Strategy for Enterprise (Fink, et al., 2010)

The above explains the steps to develop scenarios planning. Each step is wide-ranging, non-prescriptive and generally ambiguous. Therefore, it will require a long development period. The next paragraph explores a method proposed by Schwenker, et al., 2013; von der Gracht, 2008. The research found that traditionally there are six steps of scenarios analysis strategic planning (Schwenker, et al., 2013; Chermack, 2011)

1. Defining the scope of work. The scope of work provides limitation and a foundation for the analysis. The goal, strategic level analysis, participants, time horizon and stakeholder should be defined in this stage. (Schwenker, et al., 2013; Schoemaker, 1995; Shell, 2003; Schwartz, 1996; van der Heijden, 2005)
2. Developing a list of factors that could potentially impact the future of the enterprise based on a perception of internal and external stakeholders (Schwenker, et al., 2013; Schoemaker, 1995; Shell, 2003)). This is the beginning of strategic vision planning. Interview of internal stakeholders are challenged with external stakeholder to reveal potential loopholes in the company strategy. A survey can be utilised to obtain a more in-depth understanding of stakeholders.

3. Identifying the primary trend and critical uncertainty analysis. This is the most common step found in all scenario plannings (Schwenker, et al., 2013). Factors developed on the previous step are classified into potential impact and uncertainty analysis. Factors with high potential impacts are aligned with the trend. The trend and uncertainty factors are assumed to be the key drivers affecting the company or industry (Schwenker, et al., 2013; Schoemaker, 1995; Schwartz, 1996; Shell, 2003; van der Heijden, 2005)
4. Building scenarios. The uncertainties and trends graph identified in the previous steps provides indicators of essential factors to be considered in scenarios planning. The information is used to develop various scenarios (Schwartz, 1996; Shell, 2003).
5. Defining strategy. At this stage, several decisions or strategic options are tested against various scenarios generated above. Various combinations and permutations should be tested in this process to achieve robust and flexible strategic options depending on future scenarios (Schwenker, et al., 2013; Schwartz, 1996).
6. Monitoring. At this stage, the company has selected a specific strategic strategy. This process monitors the factors in step two. Scenarios can be updated from time to time, as factors define in step two changes. Therefore continuous monitoring is needed (Schoemaker, 1995; van der Heijden, 2005). The scenarios development process should be repeated when a drastic change in the environment arises.

Hitherto, two methods of scenarios development and how it can be used to develop an enterprise's strategic vision have been explained briefly. Fink et al. (2010) and Schwenker et al. (2013), explain the method to improve and assist the enterprise in navigating in the uncertain environment today. However, it was found that the methods took five months to a year to develop (Schwenker, et al., 2013). The time frame of traditional scenario planning development is in contradiction with strategic planning (Schwenker, et al., 2013; Moyer, 1996). Furthremore, scenarios planning is, usually, for long term horizon, while strategic planning is utilised in planning a medium-term horizon. Therefore, adaptation in strategic planning using scenario analysis is needed to address this contradiction.

Schwenker et al. (2013) reason that the long development period is caused by the complexity and non-prescriptive explanation in the scenario development method. Therefore, Schwenker et al. (2013) research adds frameworks to the six-steps scenarios analysis for the strategic planning above. The frameworks provide the structure that makes it easier and quicker to apply in practice. Figure 11-2 explained the improvement made in the methodology to improve the development time.

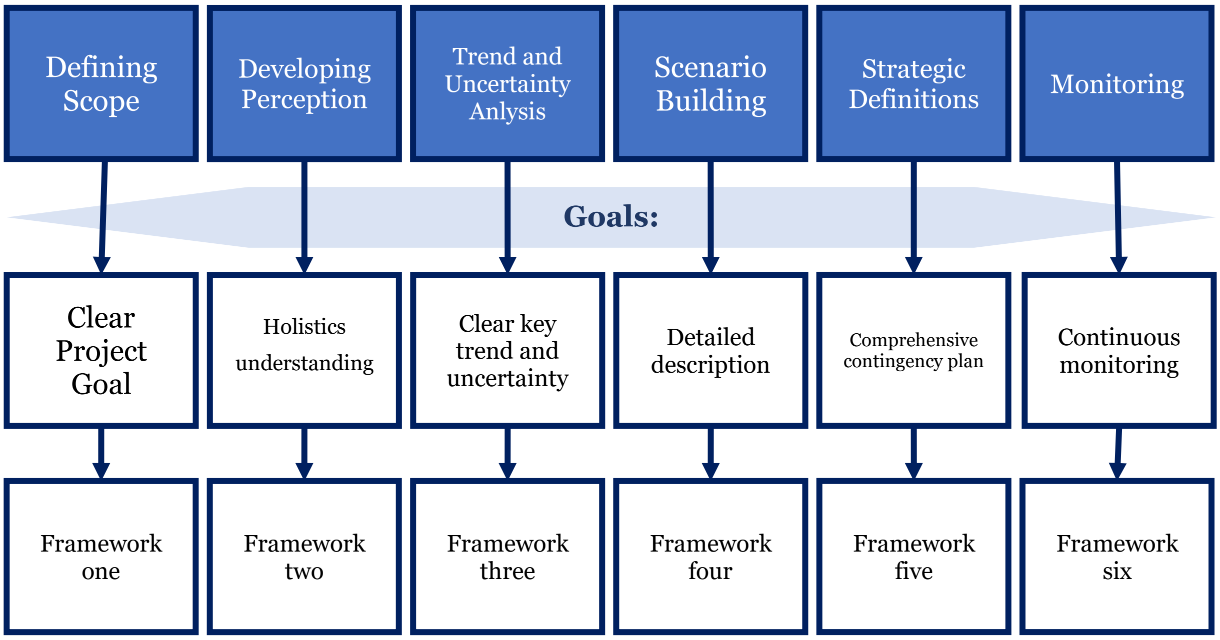

Figure 11-2: Scenario development process for strategic decision-making tool (Schwenker, et al., 2013)

Schwenker et al. (2013) mention that this new method improves the scenario planning process up to four to six weeks. Therefore, it is in a similar time frame as strategic planning process (Schwenker, et al., 2013).

Frameworks one to six contains a series of questions that help to address the main task. The main task of each framework is:

- Framework one: identify the core problem and frame analysis (clear project goal).
- Framework two: identify assumptions and models (holistic understanding).
- Framework three: discuss and evaluate trends and uncertainty (clear key trend and uncertainty).
- Framework four: develop scenarios based on critical uncertainties factors (detailed description).
- Framework five: develop enterprises' specific action plan (comprehensive contingency plan)
- Framework six: monitor continuously

As explained above, time is of the essence and significant resources required to develop complete strategic planning based on scenarios analyst. Furthermore, the tactical and operative level has to follow upon completion of the enterprise' strategic vision. In the increasingly uncertain future, speedy tools are needed to briefly analyse the risk of adopting new technology as a strategy to address uncertain environment scenarios.

11.2 Methodology: A Quick Tools to Analyse Technology Implementation Using Scenario Analyst

This research proposes a brief version of scenario-based strategy analysis to provide a glance on the effect of uncertainty factors, before intensive resources are invested in the scenario analysis. The uncertainties factor considered is emerging technology and the focus is on an information technology enterprise. This method aims to address the trends and uncertainty analysis and scenario building, as shown in figure 11-3.

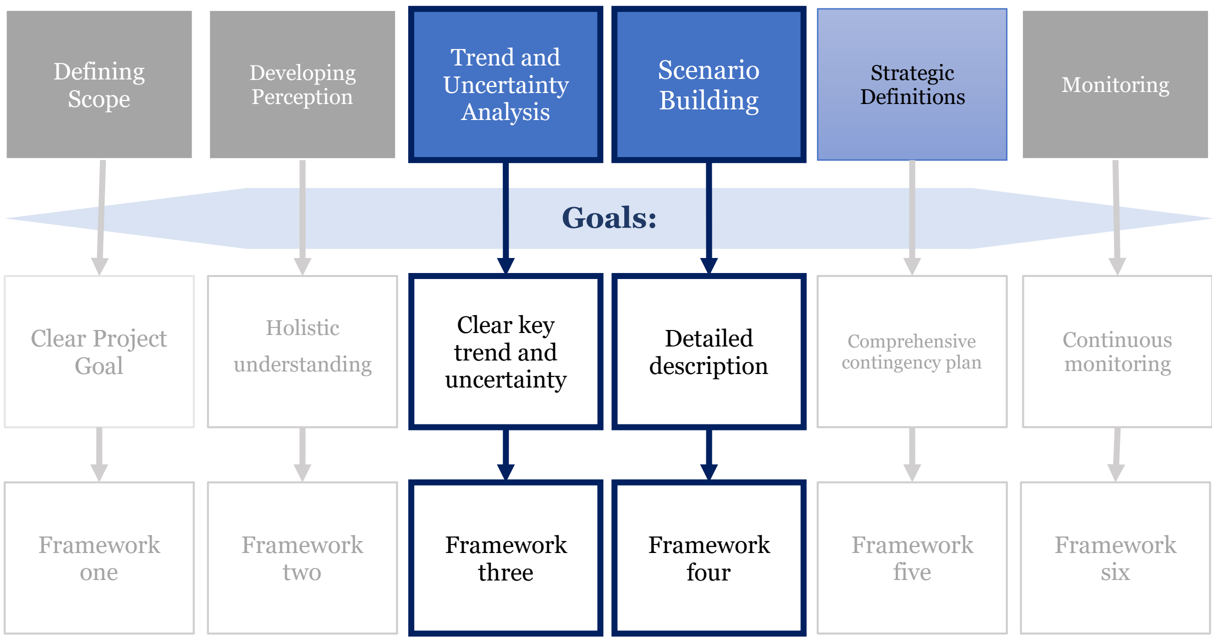

Figure 11-3: Illustration of a quick scenario analyst tools for information technology enterprise

This paper proposes to address the trend and uncertainty analysis, scenario building and (simplified) strategic plan, as shown in figure 11-3. A three-step process is elaborated below:

Step One: Defining future scenarios

This paper proposes to develop future scenarios based on possible consumer preferences. This information can be obtained from literature review or perspective from a major organisation.

Step Two: Identify enterprise actions based on technological trends

This research assumes blockchain technology is selected as the technology of choice to address the uncertainty as described in the scenarios.

Step Three: Compare the technology with the existing system

Blockchain technology is compared with an existing system in several factors:

- Challenges of existing business processes

- How comprehensively blockchain technology can address the above challenges
- What is the existing model of blockchain technology to address the above challenges?
- What are the technological, customer and regulation challenges from the existing system?

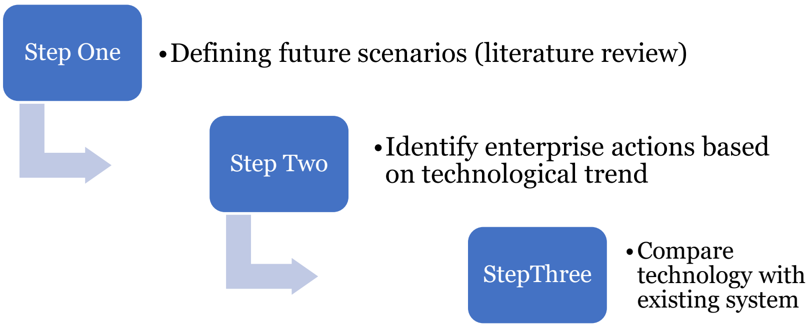

Figure 11-4: Research method to develop a quick glance of emerging technologies impact on an enterprise

The elaboration of the above could serve as indicators of potential resources to be made, should the information technology enterprise decide to invest in the blockchain technology as one of the tools to address business process challenges. The proposed methodology is supplemented with a survey, to obtain brief feedback on blockchain technology implementation in a leading information technology enterprise.

11.3 Survey

A survey was conducted to obtain feedback on the methodology above. Nineteen blockchain enthusiasts responded to the survey. Three of the surveys were conducted over the phone, while the others submitted their feedback using Netigate. Sixty-eight per cent of the respondents are operation level employee, while thirty-two per cent are tactical level employees. Ninety-five per cent of the respondents are employees of the information technology company. Figure 11-5 illustrates the respondent.

The respondents were asked:

1. What is the perception of blockchain technology adoption maturity?
2. How can an enterprise optimised themselves to adopt technology?
3. Which resources should be invested in?
4. How are the various industries affecting blockchain technology?

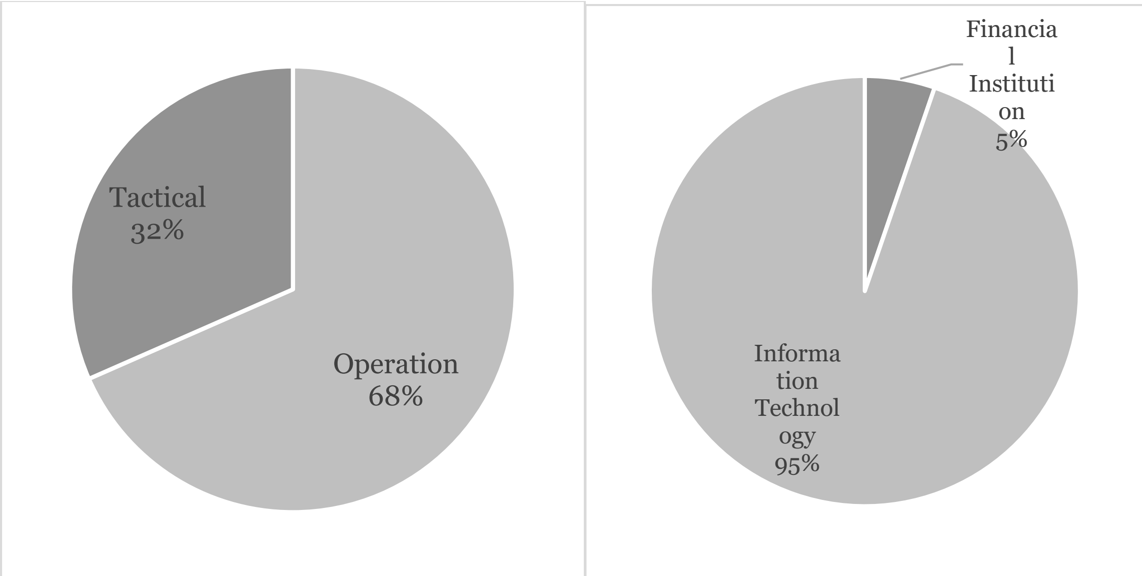

Figure 11-5: Survey respondent demography. (Left) The respondents' demographic from enterprise holistic management perspective. (Right) The respondents' demography from the type of enterprise where the respondent works at.

Due to the natural language use in the process, and low diversity in the respondent demography, only selective responds from the survey is used to supplement the findings in this report. The full profile list of respondent and results of the survey can be found in appendix II.

12. Scenario Analysis and Discussion

Gil-Saura & Ruiz-Molina, 2011; Kawa & Maryniak, 2019; Melkonyan & Krumme, 2019 have conducted extensive research on trends in logistics services. However, for the purpose of this research only two factors are considered. The factors are the increase in competition due to product diversity and the fact that sustainable products have become a preference. Therefore, there are three scenarios researched in this paper. These scenarios are an increase in product diversity (business as usual), sustainable product focus and a combination of both. The research explains in three steps. Firstly, the condition of each scenario will be described. Secondly, the enterprise is assumed to use blockchain technology. Therefore, the way blockchain technology can improve the system will be described. Thirdly, an analysis on disparity with existing enterprise process is explained. Lastly, a discussion on the strengths and weaknesses of adopting technology as a logistics company or information technology provider.

12.1 Scenario one: diverse product selection (business as usual)

Step One: Defining future scenarios

In this scenario, the parameters for logistics service quality developed by Mentzer et al. 1999 (cited in Mentzer et al., 2001) were found to align with the concept of business as usual, because it has been repeatedly tested over time. There are several attributes in this scenario (non-comprehensive): the consumer requires precision in delivery time, the suppliers and logistics company require information on product condition before, during and after delivery, and all parties need to know the location of the product at any time during delivery. This information is used to prepare a contingency plan if needed. Refer to table 12-1 for a summary of scenario attributes.

The characteristics of the above scenarios could be addressed with trackability use cases. The following paragraph explains how blockchain technology can address the challenge in this scenario.

Step Two: Identify enterprise actions based on technological trends

This research assumes, an enterprise leverages on blockchain technology to address the uncertainty in the scenario mentioned above. The trackability model addresses this scenario. In the trackability model, blockchain technology is utilised as shared data ledger. However, the consensus component employed in blockchain technology means data entering the system must be authenticated regardless of the participants. A change in the data can not be done by a central party. Instead, several nodes/participants have to agree with the change request before it can be accepted. The consensus components provide a kind of secure access to users. Therefore, all relevant users (e.g. customer service staff, customers, etc.) can directly access the same system without having to do a manual communication with a various party to identify the location of a product during delivery or to access the individual database. Each participant in the delivery process (e.g. warehouse owner, shipper, trucker, manufacturer, last-mile delivery) can contribute information to a blockchain system. Onboarding a user or actor can be done by looking up for encrypted blockchain network addresses (Yaga, et al., 2018). The encryption can be provided to the users.

Table 12-1: Attributes of scenarios one and impact to logistics services

<table>
<tr><th>Step One: Scenarios attributes</th><th>Step Two: Logistics Services Impact</th></tr>
<tr><td>The customer requires precision in delivery time</td><td rowspan="3">Trackability model becomes relevant for the logistics service enterprise:
• Efficient communication between various transport modes and all logistics parties is a must.
• Faster clearance between geographical boundaries
• Efficient transfer between one mode of transport to another</td></tr>
<tr><td>Suppliers and logistics company requires information on product condition before, during and after delivery</td></tr>
<tr><td>All parties need to know the location of the product any time during delivery, and if contingency plans need to be made.</td></tr>
</table>

Step Three: Compare the technology with the existing system

This scenario proposes all participants in delivery services to share data with the blockchain platform. For example, in the trackability scenario, this data already exists in the current process. although, the data is currently in manual or paper-based format, or in digital format but not shared or in a central database (O'Marah, 2017; Hackius & Petersen, 2017). The availability of this data on a shared platform makes it convenient for all participants to access information, without data discrepancy due to duplication and human error. It significantly reduces the manual verification process between participants. Furthermore, participants can be sure that the information is entered by the original owner and verified by relevant parties in the network. Therefore, blockchain technology ensures the originality of the information. In the following paragraph the challenge to engage the consumer are discussed.

Despite the high technological, consumer and regulation readiness of trackability use case, the user might argue that the existing system works, and a single platform system can be enforced by the leading supply chain company to address data digitalisation. Therefore, the trackability model is functional. However, should users spend additional resources on developing extra services that could be enforced and funded by the leading supply chain company? A similar critical statement was brought up by Gordon Brown, Credit Suisse APAC Director, during the survey (Browne, 2019). He mentioned that the existing system had accumulated significant investment and it can address the trackability model somewhat. Furthermore, in the trackability models, the value of data digitalisation in a blockchain platform is not seen by the users, especially when not all parties are using or contributing to the same system.

12.2 Scenarios two: preference for sustainable product

Step One: Defining future scenarios

The trend of sustainable centric consumers has been elaborated by many authors: Darkow, et al., 2006; Kawa & Maryniak, 2019; Zijm, et al., 2019; Yakovleva, et al., 2019. They explain that there are several attributing factors to this scenario (non-comprehensive): a buyer becomes conscientious on the product selection and consumption pattern. Information that the buyer desire is: knowing precisely the where, by who and how the product was made, how the material was being sourced, how product selection impacts the environment. Refer to table 12-2 for scenarios attributes

The characteristics of the above scenarios can be addressed with traceability use cases. The following paragraph explains how blockchain technology can address the challenge in these scenarios.

Step Two: Identify enterprise actions based on technological trends

Blockchain technology addresses these challenges in a similar way as with the trackability case. However, more granular and sensitive information about the product is being digitised and uploaded into the blockchain platform by a broader range of participants, for example, certification of the farm, the result of farm inspection, ownership of a (luxury) product. Therefore, this data provides a more holistic history on the product directly from the creator, without the possibility of unauthorised change. Thus, the consumer can be confident the open access to information is truthfully from the origin. In the following paragraph the gap with the existing system will be discussed.

Table 12-2: Attributes of scenarios two and impact to logistics services

Step One: Scenarios attributes	Step Two: Logistics Services Impact
Users know precisely the where who, by who and how the product was made.	Traceability models become relevant for the logistics service enterprise
How was the material being sourced?	
How does product selection impact the environment?	

Step Three: Compare the technology with the existing system

Consumer concern on the history of the product is currently addressed by a certification organisation. These organisations issue a certificate to assure the history of the product, such as originality, sustainability, quality, etc. The certificate is typically issued after conducting several processes as verification steps. The certification process is usually a paper-based system. Therefore, it can be easily duplicated and manipulated. However, blockchain technology could push digitisation of information and ensure the certification data is never altered. In the same way as trackability, the consumer can access certificates, and other relevant product information contributed by various participants in the same blockchain platform. Additional participants could also serve as reviewers in the process. In the following paragraph the challenge to engage the consumer are discussed.

Although there is a potential for blockchain technology to improve traceability use case, the consumer needs to be familiar with the added value of secure, authenticated information in a blockchain platform. This challenge is similar to the trackability use case. Although there is an apparent flaw in the existing process, additional resources spending when implementing blockchain technology should be justified.

12.3 Scenario three: increase product diversity and focus on sustainable products

Step One: Defining future scenarios

This scenario is a combination of the above scenarios at an intense level. In this scenario, the increase in competition due to product diversity and sustainable products becoming the preference, are intense. Therefore, the consumer become very selective on the purchase made. Below are several attributes to this scenario.

Step Two: Identify enterprise actions based on technological trends

Due to the variety of scenario attributes, a table is created to compare step one and two.

Table 12-3: Attributes of scenarios three and impact to logistics services

Step One: Scenario attributes	Step Two: Logistics Services Impact
Product customisation becomes a standard service across all range.	The trackability and traceability models with electronic data input, applied to each individual product. Therefore, more granular information in comparison to scenario 1 and 2.
Faster products from the design table to the retail store	The logistics service enterprise utilises the trackability features as follows: • All the trackability features mentioned in table 12-1. • Electronic data input can increase data granularity and quantity.
Doorstep delivery and return products are highly desirable	The logistics service enterprise utilises the trackability features as follows: • Product condition before, during after delivery must be fully documented. • Warehouse for return product must be ready to manage the return product flow. • Input from an electronic device can increase data granularity and quantity.
The consumer wants to know the impact of the product on the environment and the quality of product	The logistics service enterprise utilises the trackability and traceability features as follow: • Trackability model is utilised to track carbon consumption during delivery. • Traceability model is utilised to know where, when and how the product was made
Seller assists the buyer in creating value after-sales,	Trackability and traceability features are essential as the product move from one owner to the other
Seller assists in upcycling, recycling and managing waste	Direct transactions become an essential model because transaction value goes lower, in comparison

	when there is no upcycling, recycling and waste management.

The following paragraph explains how blockchain technology can address the challenge in this scenario based on the impact on logistics services.

Based on the impact on logistics services, explained in Table 12-3, several commonalities were found. First, scenario attributes require an increase in data input through the use of electronic devices. Second, the role of the smart contract, combined with electronic devices becomes an apparent service based on the scenario attributes. As a result, the logistics service enterprise can provide automation from origin to destination. Smart contracts with crypto-based payment can create a seamless payment system between parties. In the following paragraph the gap with the existing system is discussed.

Step Three: Compare the technology with the existing system

There are two factors that can be improved with blockchain technology. Firstly, the system can digitise the ecosystem and address consumer requests. The improvement that blockchain technology is described below. First, using electronic device input with smart contract makes it possible to activate back-up delivery earlier. Second, payment with cryptocurrency makes smaller transaction value possible as the cost for intermediaries is not needed. However, an increase in efficiency is desirable. This has been proven by the hype of bitcoin and many participants across the world (Verhelst, 2017). Regardless of the immaturity of direct transaction models, this model has the highest potential to improve logistics services. Therefore, enterprises adopting this model have the highest potential to become a leading enterprise. The next paragraph describes the component to be improved to achieve scenario attributes based on the survey.

The survey conducted on 19 blockchain enthusiasts in June 2019. The results indicate that the enterprise should work on the network types and consensus models in this scenario. When questioned about at which level of deployment an IT enterprise should focus on "network types" was again the most popular answer. Figure 12-1 and 12-2 illustrate the results of the survey. While the finding is rather ambiguous, comments from several respondent clarified the intent. Billstrom (2019) and Huss (2019) explained that as the product is yet to be mature, the IT enterprise should strive to build from the foundation.

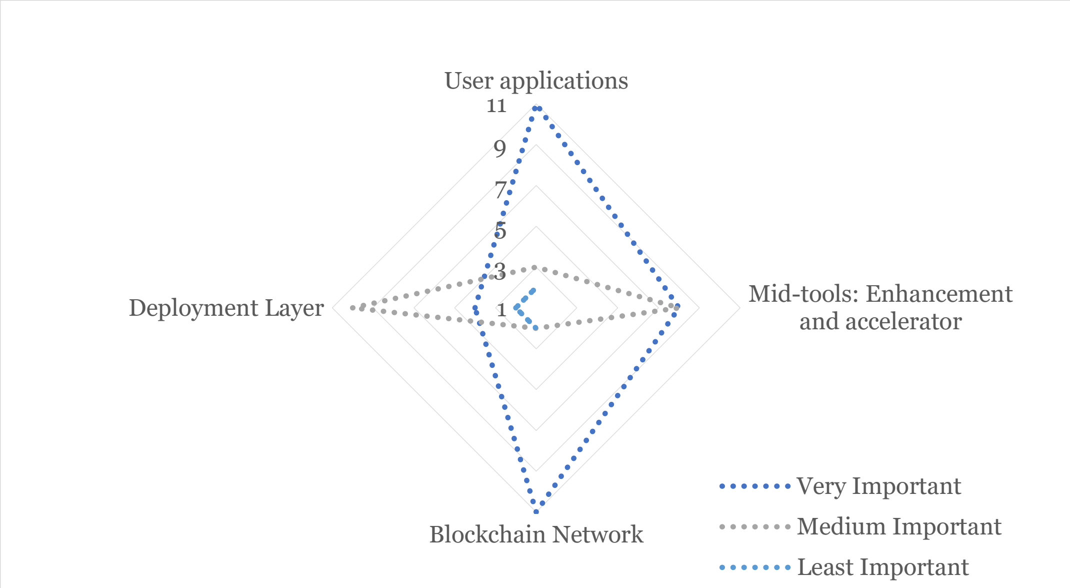

Figure 12-1:Types of blockchain components

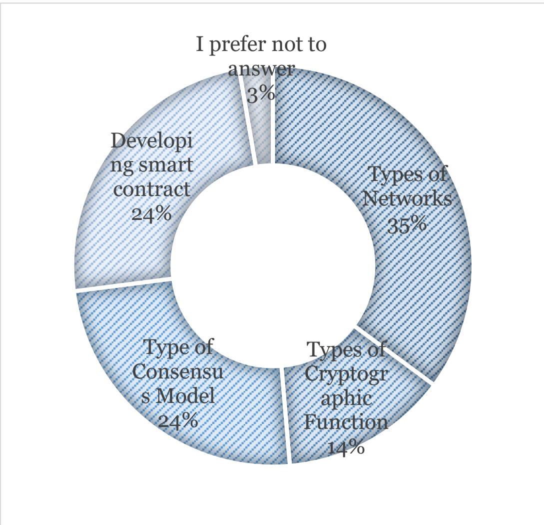

Figure 12-2: Types of blockchain component an IT enterprise should focus on.

12.4 Conclusion of Scenario Analysis for Blockchain Technology Model Application in an IT Enterprise

Scenarios analysis have been conducted and elaborated on the three models of blockchain applications in logistics services. The three scenarios have shown that blockchain technology has the potential to improve logistics services quality. Figure 12-3 describes the impact of various blockchain technology model clusters on logistics services. The following paragraph will describe each cluster in brief. It follows with a recommendation of adoption for IT enterprises.

Trackability models provide information on a more precise location of the product during the delivery. This cluster is the most matured use case among all models of blockchain technology application in logistics services. As analysed in part one, trackability affects the order quality and timeliness factor of logistics services quality. These LSQ parameters are affecting how the enterprise improves its service after the order is received and during the delivery process to the consumer. Blockchain technology makes data secure and authentic. Therefore, an authority such as custom and border control can utilise the information in the blockchain platform. Logistics enterprise could bring the product pass custom and border control in a shorter time frame. A decentralised database with an encrypted login system enforced by the authority could partially address the issue. However, all scenarios indicate that a product might need to cross more than one geographical boundary to reach the buyer. Additionally, will you trust a single third party enough to maintain absolute control on all logistics information across the glove? Therefore, a universal system that does not have a central authority control seems to offer fair access to everyone. Nevertheless, blockchain technology assistance is limited.

Traceability model provides information on the history of the product. This cluster is less mature than the trackability use case cluster. However, traceability model can benefit a more extensive range of users. The industry analysis in part one shows that more industries (e.g. e-commerce and retail, pharmacies) can leverage on blockchain technology benefits (refer to section 8.1.2). Furthermore, the need to know the history of a product in the traceability model has existed. Currently, organisations are offering a guarantee of product origin in the form of paper certification or a digital format. This information is currently desirable. Blockchain technology makes it possible for all parties to access the system and update the data directly. Therefore, misinformation caused by human error or general inefficiency can be eliminated. However, blockchain technology describes so far is non-tangibles for the buyer/user. Blockchain technology is utilised primarily as a secure distributed storage system. Therefore, it is not utilising the complete automation capability of blockchain technology. Bitcoin has shown a direct transaction is possible to be maintained without a third party.

The direct transaction model uses blockchain technology beyond providing information. In this model, the information in the blockchain system is used to execute the clause in the contract automatically. Electronic device input and cryptocurrency utilise in this model. Therefore, this model is the least mature among all clusters. The reason is elaborated as follows: Firstly, the utilisation of electronic devices for data input to activate another machine-based process is yet to be an acceptable process worldwide. An example of this process is a preparation of another shipment batch due to failure to complete contract clauses. However, the electronic device increases the granularity of data available in the system and reduces manual labour. A more holistic history and evidence of product quality can be derived from immutable data. Secondly, the integration of digital assets (e.g. cryptocurrency) with electronic data input in the process with blockchain technology is not a normal process. However, the benefits of blockchain technology can be seen to be more tangible in this cluster of use cases because automation can be realised end-to-end.

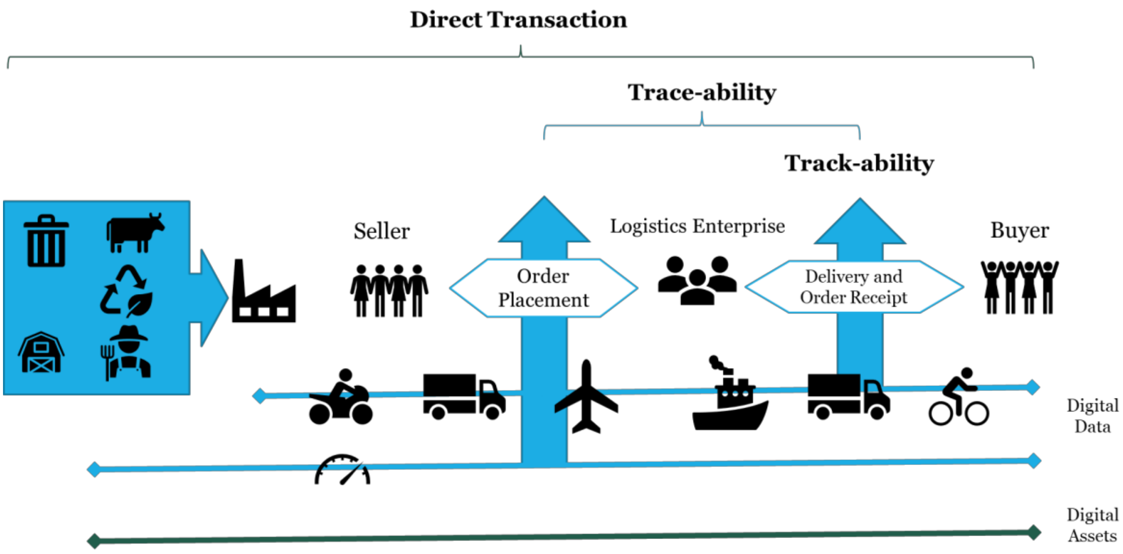

Figure 12-3: Impact of trackability, traceability and direct transaction in logistics services

In addition to the business challenges described above, blockchain technology has its own technical challenges. This challenge is applicable to all clusters of blockchain-based applications. The technical challenges are extracted from the bitcoin platform.

Firstly, the issue of scalability. The bitcoin platform is designed for the public. Therefore, if the number of participants (nodes) increases, so does the security of the blockchain system. However, an increased number of participants means more massive storage required in the nodes. The size of hardware might become a challenge to participate in the process.

The second issue is the energy required to create a block. As described in part one, nodes must solve a computationally intensive cryptographic puzzle when a proof-of-work consensus model is utilised. Therefore, the energy requirement increases as more users join the network.

In a trans-national IT enterprise, the design intents of blockchain technology implementation to improve logistics services should aim to address the issues in the direct transaction use case clusters. The main reason is that it leverages on the complete components of blockchain technology. The bitcoin case has shown that it is possible to integrate digital assets in the system. Furthermore, the technical challenges, hardware and software are applied to all clusters of use cases. Therefore, blockchain technology in direct transaction models seems to be tangible. In this model, blockchain technology has the capability to solve a challenge that has not been addressed by another technology and made it seemingly tangible. In the next section the summary of part three elaborated.

13. Summary of Part Three

The currently available strategic development tools for enterprise have been expounded. The scenario analysis has become an essential tool for an enterprises' strategic level planning. It becomes essential because of increasing future uncertainty, a need for flexibility and a broad level perspective for a strategic level decision. However, strategic level planning requires a long development time. Therefore, this paper proposes a quick tool to briefly analyse the maturity of the technology in an information technology enterprises' strategic vision.

This research uses a three-step process to address the above challenge. These steps are defining future scenarios, identifying enterprise actions based on technology trends and comparing the technology with the existing system. In this case, blockchain technology is selected as the technology in-trend. The three models of blockchain technology applications in part two serve as the action taken for enterprises. The three scenarios are product diversity (business as usual), sustainable product focus, and a combination of the previous two.

These tools provide a glance at the impact of new technology to improve business processes. Although it is incomprehensive, it identifies a small portion of the strategic development tools.

14. Summary and Future Work: Blockchain Technology Application to Improve Logistics Service Quality and Scenarios of Adoption for Enterprise.

In the first part of this report, blockchain technology and logistics services quality parameters have been researched and elaborated. A literature review has been the main method in this part. Research on blockchain technology components and logistics services quality parameters indicate that blockchain technology could improve logistics service quality (LSQ). There are three main models of blockchain technology applications that can benefit LSQ. They are in the capability to track, trace and to create direct transactions. The application of blockchain technology could improve several LSQ parameters. These parameters are timeliness, order quality, order condition, information quality, order discrepancy handling, and order procedures. There is limited literature available to develop this part of the research. Therefore, the use cases analysis can provide a broader view of blockchain technology applications in practice.

Part two of this report identifies the maturity of blockchain technology application models in part one. The use case analysis is the primary method for this part. A prioritisation process was applied to the long list of use cases. The three steps of the prioritisation process are building an inventory of use cases, clustering the use cases into blockchain application models in logistics services from part one, and analysing the maturity level based on the use cases' development in technology, consumer and regulation readiness. The results indicate that use cases in the trackability cluster are the most matured, follow by traceability and direct transactions. Although each of these models is in varying maturity levels, all of them are relevant to logistics services. Therefore, the models of blockchain technology application in logistics services are analysed in several scenarios.

Part three of this report analyse the blockchain technology models for enterprise with a brief scenario analysis method. The three-step processes are defining future scenarios, identifying enterprise actions based on technological trends and comparing the technology with the existing system. This method addresses a small component of scenarios analysis for development of enterprises strategic vision. Therefore, it only provides a perspective on how technology maturity could assist in addressing uncertain futures in a form of scenarios. Three scenarios are investigated based on a literature review. The scenarios are product diversity (business as usual), sustainable product focus, and a combination of the previous two. In the same order, the blockchain models to address the scenarios are trackability, traceability and direct transaction. The results indicate that the direct transaction model has the highest potential to address holistic logistic service challenges. However, the use cases in this cluster are relatively less matured in comparison with the other clusters.

Therefore, this research has provided several tools to analyse blockchain technology applications in an enterprise. Furthermore, this research has defined an initial model of blockchain technology applications in an enterprise. More use cases can be categorised into this process. The reiteration might result in a more precise categorisation and the finding of new benefits of blockchain technology in logistics services.

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Appendix I: Extended List of Use Cases

The idea of Use Cases	Reference
Financial audit and reporting of the logistic process	https://www2.deloitte.com/za/en/pages/audit/articles/impact-of-blockchain-in-accounting.html, https://m.ctee.com.tw/focus/jrdc/139161
Insurance program for livestock during drought, integration with visual data and machine to machine communication and smart contract	https://ripplenami.com/ripplenami-powers-kenyas-first-real-time-livestock-traceability-programme-enabling-trade-and-food-safety/
Flight Insurance	https://www.coindesk.com/axa-using-ethereums-blockchain-new-flight-insurance-product
Flight Insurance	https://etherscan.io/address/0xe083515d1541f2a9fd0ca03f189f5d321c73b872#
Underwriting and claims settlement	https://www.ibm.com/blockchain/industries/insurance
Vehicle Network on Blockchain	https://medium.com/@XAIN/part-1-technical-overview-of-the-porsche-xain-vehicle-network-f70bb117be16
Tracing components of goods for assembly	https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/consumer-business/deloitte-cn-consumer-blockchain-in-the-automotive-industry-en-180809.pdf
Vehicle Lifecycle network	https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/consumer-business/deloitte-cn-consumer-blockchain-in-the-automotive-industry-en-180809.pdf
Car Insurance	https://developer.ibm.com/patterns/build-a-blockchain-insurance-app/
Streamlining internal processes, including interactions with suppliers and other CSP by faster identification of visiting subscribers, prevention of fraudulent traffic and claims reduction	http://www.eng.auburn.edu/~uguin/pdfs/Blockchain-2018
Developing services for customers	https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/za_TMT_Blockchain_TelCo.pdf, https://www.ibm.com/blogs/insights-on-business/telecom-media-entertainment/blockchain-telecom-concept-reality/
Collaboration in the ecosystems	https://www.ibm.com/blogs/insights-on-business/telecom-media-entertainment/blockchain-telecom-concept-reality/
Streamlining internal processes, including interactions with suppliers and other CSP for hardware products delivery, pre sales and after sales service	https://www.ibm.com/blogs/insights-on-business/telecom-media-entertainment/tag/hyperledger/
Streamlining internal processes, including interactions with suppliers and other CSP for Network Function Virtualization	https://www.ibm.com/blogs/insights-on-business/telecom-media-entertainment/tag/hyperledger/
Improving efficiency of supply chain management between CSPs, suppliers and distributors	https://www.ibm.com/blogs/insights-on-business/telecom-media-entertainment/tag/hyperledger/

Strealining billing for inter carrier wholesale trade for IDD voice	https://www2.deloitte.com/content/dam/Deloitte/za/Documents/technology-media-telecommunications/za_TMT_Blockchain_TelCo.pdf
Allow faster and cheaper transactions	https://www.business-sweden.se/globalassets/international-markets1/amerikas/usa/blockchain-in-ecommerce-.pdf, https://www.home.barclaycard/insights/payments/Barclaycard-Payment-Solutions-and-Crowdz-partner-to-speed-up-the-B2B-supply-chain.html
Easier access to receipt and warrantty	https://www.business-sweden.se/globalassets/international-markets1/amerikas/usa/blockchain-in-ecommerce-.pdf https://medium.com/@frankvandeven/how-we-successfully-put-product-warranty-on-blockchain-using-a-facebook-messenger-chatbot-ed242e3369d1
Ensure true and legitimate reviews	https://www.business-sweden.se/globalassets/international-markets1/amerikas/usa/blockchain-in-ecommerce-.pdf
Optimising Delivery of Oil and Gas product to reduce Operational costs	https://www.digitalistmag.com/digital-supply-networks/2018/08/01/blockchain-change-how-oil-gas-companies-operate-06180775
Buy and sell electricity directly from the source. Peer to Peer trading	https://www.cosol.com.br/blog-eng/blockchain-solar-power-ethereum,
Renewable Energy Project Crowd Funding	https://www.investinblockchain.com/blockchain-startups-renewable-energy/
Automated P2P trading in Energy	https://www.powerledger.io/
Ponton Energy	https://www.ponton.de/
Energy Data Exchange Platform	http://www.ewdn.com/2017/03/03/qiwi-launches-blockchain-spinoff/
Sustainable Cryptocurrency, mined with access renewable energy. Addressing grid stability	https://veriown.com/
Energy Commodity Management and Trading	https://petrobloq.com/
Carbon trading platform	https://www.ibm.com/case-studies/energy-blockchain-labs-inc
Energy supply as a services in the remote area telecom station	Mattila, J., Seppälä, T., Naucler, C., Stahl, R., Tikkanen, M., Bådenlid, A. and Seppälä, J., 2016. Industrial blockchain platforms: An exercise in use case development in the energy industry (No. 43). The Research Institute of the Finnish Economy.
Sustainability and Life Cycle Analysis of Fashion Product.	https://www.forbes.com/sites/samantharadocchia/2018/06/27/altering-the-apparel-industry-how-the-blockchain-is-changing-fashion/#73c45a5d29fb
Provenance tracking system	https://www.forbes.com/sites/samantharadocchia/2018/06/27/altering-the-apparel-industry-how-the-blockchain-is-changing-fashion/#73c45a5d29fb
Insurance for Catastrophe with Swap and Bonds	https://www.reuters.com/article/allianz-blockchain-idUSL8N1961VY, http://www.artemis.bm/news/nephila-allianz-complete-first-wind-farm-revenue-swap-in-australia/
Morgage, Syndycated Loan, Private Equity and Crowd Funding, Corporate Debt, Assest Digitization	https://cointelegraph.com/news/symbiont-bridges-bitcoin-and-ripple-with-counterparty-gateway

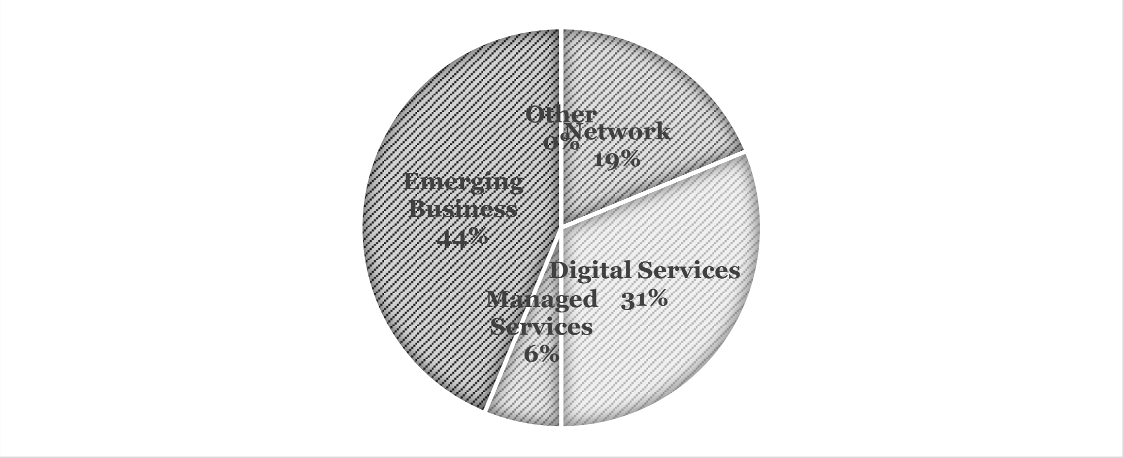
Manage identity for financial services related	https://www.ey.com/Publication/vwLUAssets/EY-blockhain-in-insurance/%24FILE/EY-blockhain-in-insurance.pdf
Venture Capital Investment	https://www.forbes.com/sites/andrewarnold/2018/11/24/beyond-cryptotrading-6-ways-blockchain-is-changing-the-face-of-investing/#7d24d9ea3011
Knowing exactly the source of the product	https://www.provenance.org/case-studies/martine-jarlgaard Tian, F., 2016, June. An agri-food supply chain traceability system for China based on RFID & blockchain technology. In 2016 13th international conference on service systems and service management (ICSSSM) (pp. 1-6). IEEE.
Knowing exactly the source of the product	https://www.provenance.org/case-studies/martine-jarlgaard Tian, F., 2016, June. An agri-food supply chain traceability system for China based on RFID & blockchain technology. In 2016 13th international conference on service systems and service management (ICSSSM) (pp. 1-6). IEEE.
Identity services for specific age group product	https://www.foodandwine.com/news/beer-vending-machine-blockchain-age-verification
Voting System	https://youtu.be/RplnSVTzvnU, https://cryptonews.com/news/russian-region-holds-world-s-biggest-blockchain-elections-3085.htm
P2P trading of energy with Arabian Cryptocurrency	https://www.unlock-bc.com/news/2017-10-16/wavex-selects-arabianchains-blockchain-based-smart-contracts
Land Ownership Title Deed Management	https://cadasta.org/resources/white-papers/bitcoin-blockchain-land/
Decentralised government for Smart Cities	https://www.ie.edu/insights/articles/blockchain-the-decentralized-government-of-smart-cities/
Integrated Healthcare Information. Facilitate patient data exchange and increase interoperability	https://pdfs.semanticscholar.org/b992/77c3eecfe6d3dd784fe572a45780ffd040e2.pdf
Integrated Healthcare Information. Facilitate patient data exchange and increase interoperability	https://medicalchain.com/en/whitepaper/
Integrated Healthcare Information. Facilitate patient data exchange and increase interoperability	https://www.hyperledger.org/blog/2016/10/03/hyperledger-announces-the-hyperledger-healthcare-working-group
Drugs traceability	https://www.newamerica.org/bretton-woods-ii/blockchain-trust-accelerator/around-the-blockchain-blog/fighting-fake-drugs-blockchain/
Drug traceability	https://www.ibm.com/blogs/blockchain/2018/12/what-are-the-use-cases-for-blockchain-tech-in-healthcare/
Ensure existence of sickness in the subject for Clinical Trial. Enable medical researchers to record of clinical data,	https://www.ibm.com/blogs/blockchain/2018/12/what-are-the-use-cases-for-blockchain-tech-in-healthcare/, https://www.forbes.com/sites/sap/2017/12/11/blockchain-surge-could-save-pharma-billions/#36c079bf8195
Manage Claim and Billing	https://www.business-sweden.se/globalassets/international-markets1/amerikas/usa/blockchain-in-healthcare.pdf

Increased security of sensitive data	https://www.business-sweden.se/globalassets/international-markets1/amerikas/usa/blockchain-in-healthcare.pdf
Trade Finance Logistics	https://www2.deloitte.com/content/dam/Deloitte/cn/Documents/consumer-business/deloitte-cn-consumer-blockchain-in-the-automotive-industry-en-180809.pdf Hackius, Niels, and Moritz Petersen. "Blockchain in logistics and supply chain: trick or treat?." Proceedings of the Hamburg International Conference of Logistics (HICL). epubli, 2017.
Luxury product authenticity tracking	https://www.blockchaintechnology-news.com/2018/07/03/arianee-looks-to-secure-luxury-goods-with-blockchain-technologies-in-public-launch/
Implementing a Fair Pricing Mechanism	https://www.forbes.com/sites/andrewrossow/2018/09/01/appraising-the-luxury-goods-market-with-blockchain-technology/#3d6b5c1d7641
Container Optimisation	https://www.ship-technology.com/features/blockshipping-blockchain-platform/
Digitising paperwork of international shipping	https://www.maersk.com/news/2018/06/29/maersk-and-ibm-introduce-tradelens-blockchain-shipping-solution
Diamond, High Value mineral source	http://dr-reinbacher.com/2018/05/18/blockchain-use-case-analysis-on-tracking-diamonds/
Diamond, High Value mineral source	https://www.everledger.io/industry-applications
Universal Content Registry and Reliable Royalties	https://www.forbes.com/sites/shermanlee/2018/04/25/embracing-blockchain-could-completely-change-the-way-artists-sell-music-and-interact-with-fans/#494171341a25
Progress of donation (monies) delivery - Crypto currency based	https://www.kryptographe.com/top-5-blockchain-solutions-social-impact-donation/
Progress of donation (goods) delivery	https://www.kryptographe.com/top-5-blockchain-solutions-social-impact-donation/
Transaction using smart contract	https://www.forbes.com/sites/forbesrealestatecouncil/2018/11/15/three-ways-blockchain-technology-will-revolutionize-real-estate-in-2019/#481e8bd66d20
Transaction using smart contract	https://www.leewayhertz.com/blockchain-waste-management/
Property title management	https://www.forbes.com/sites/forbesrealestatecouncil/2018/11/15/three-ways-blockchain-technology-will-revolutionize-real-estate-in-2019/#481e8bd66d20
Share Ownership of a property	https://www.forbes.com/sites/forbesrealestatecouncil/2018/11/15/three-ways-blockchain-technology-will-revolutionize-real-estate-in-2019/#481e8bd66d20
Improve waste tracking from the supply chain.	https://www.ibm.com/blogs/systems/plastic-bank-deploys-blockchain-to-reduce-ocean-plastic/
Container management	http://www.smart-cm.eu/
Container management	https://www.kinno.fi/en/smartlog
Blockshipping	https://www.blockshipping.io/

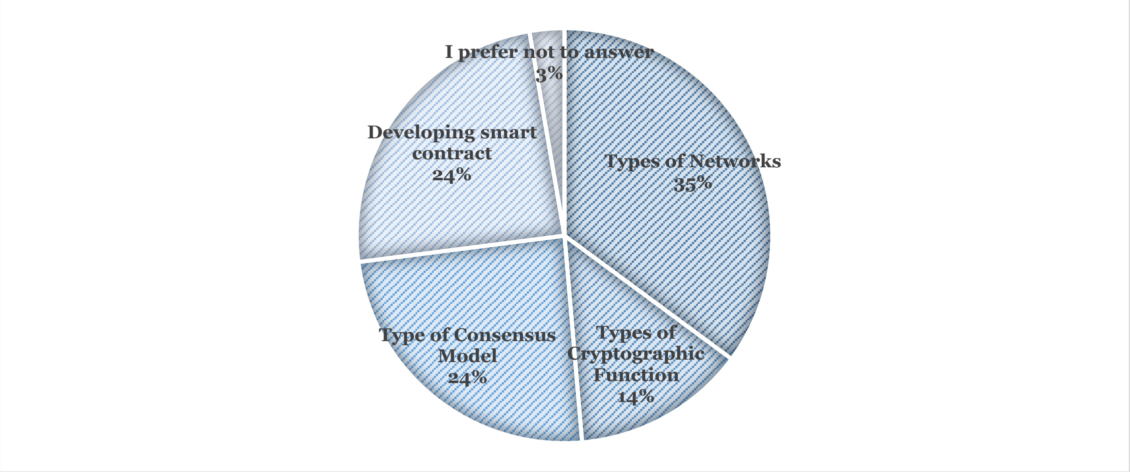
CargoX	https://cargox.io/
Cargo smart	https://www.cargosmart.ai/en/
Log chain	http://www.log-chain.eu/
AB InBev, Accenture, APL and Kuehne + Nagel	https://newsroom.accenture.com/news/industry-consortium-successfully-tests-blockchain-solution-developed-by-accenture-that-could-revolutionize-ocean-shipping.htm
PlasticBank	https://www.plasticbank.com/

Appendix II: Survey Results

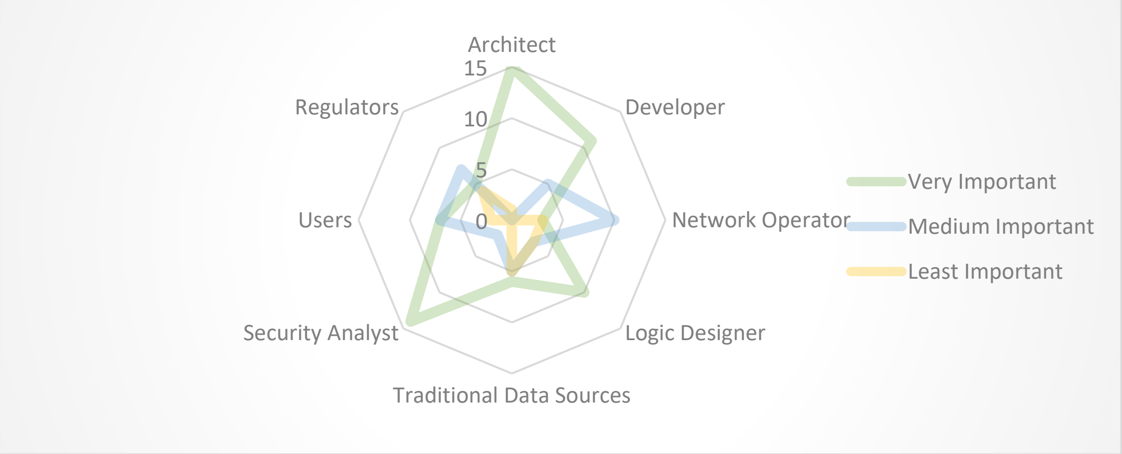
Composition of survey respondents:



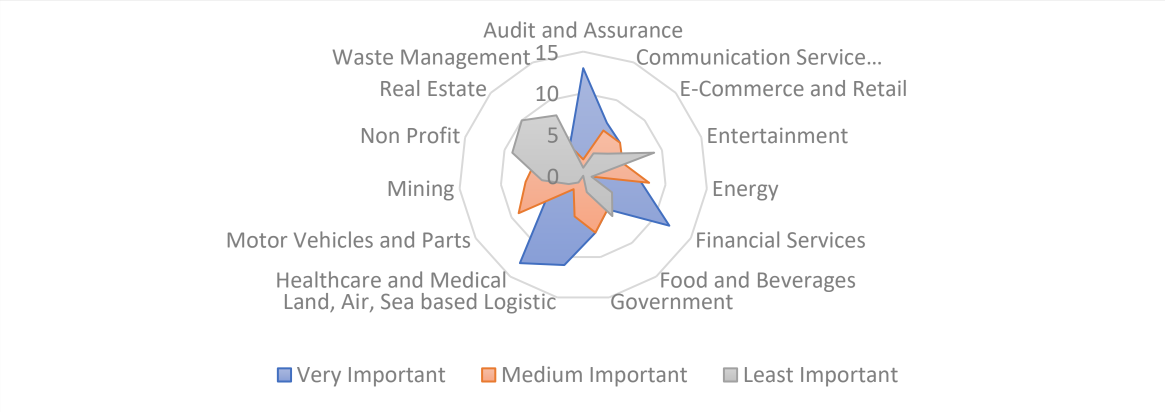
Blockchain components industry leader should be working on:



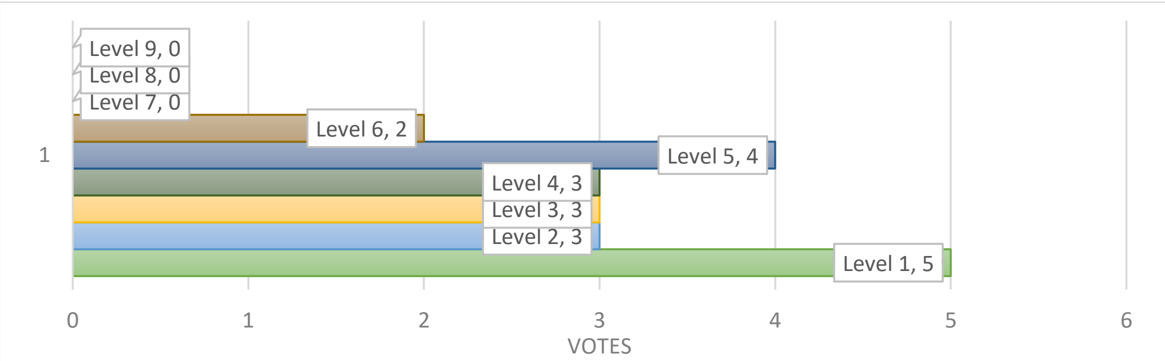
Rate the importance of each of this role in developing blockchain-based application:



Rate the importance of these industries to be addressed with blockchain technology:



Rate at which level an IT enterprise should begin adopting blockchain technology:



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