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PROBLEMS IN ACHIEVING CONSENSUS IN SUSTAINABLE SUPPLY CHAIN FORMATION

Bachelor’s thesis
Degree programme in business logistics

April 2019

South-Eastern Finland University of Applied Sciences
The main objective of the thesis is to find actions or technologies which might facilitate interaction among different supply chain members or help to achieve consensus in the sustainable supply chain formation. The study will compare the supply chains of new generations with the ones existing at present. It is necessary to highlight societal benefits for customers owing to changing supply chain management to demand-supply chain management. Customer satisfaction is the reason for the implementation of new technologies based on the demand to provide the highest possible quality of products and services.

Qualitative research was deemed the most suitable way of exploring the topic. This research method is based on collection of data about life experiences as well as the meanings that researchers attach to them. It helps to understand complex concepts such as supply chains or blockchain technologies. This type of research is useful for studying how or why something occurred and describing why special actions were chosen to achieve the final result.

This thesis is based on the analysis of documents such as articles, white papers, and other research materials, in order to find relevant information. Almost all sources used in the thesis are websites and online research papers.

Supply chains are essential attributes of trades on local and international levels. In fact, well-planned supply chains and supply chain management give strong competitive advantages to a company.

One of the best solutions for improving the supply chain management process and achieving consensus in sustainable supply chain formation is the implementation of blockchain-based technologies and smart contracts.

Blockchain technologies can improve present supply chains. This will increase the speed of material, good, service, cash, and information flows. Deliveries will become seamless at the same time. Possibilities of frauds will be reduced to the minimum amount. Track-and-trace systems will be additional benefits of implementing blockchain technologies into supply chains.

**Keywords**

supply chain, supply chain management, consensus in supply chains, blockchain
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1 INTRODUCTION

The topic of this thesis is important nowadays because the world has changed during last years, and usually goods are consumed not in the country of production but in countries which are often located far away. The human need in goods and services is growing on a daily basis, and it has been a challenge for transportation companies to create the best methods of transportation. The only solution today is to create a supply chain from the place of production to the place of consumption.

Supply chains have complex structure, and they are operated by a supply chain management strategies. The process of management is time and money consuming because it requires the controlling and monitoring of wide range of activities to maintain functioning supply chains.

Numerous middlemen may appear in the delivery process of goods because they may have better arrangements or prices. Actually, all companies involved in the delivery process may create supply chains. A high number of companies involved in one supply chain create more problems in the deliveries. Problems can be of different types: payment delays, shortage of information, lack of staff qualification, poor or unsafe conditions of transportation, and failure to follow timetables.

Also, transparency in supply chains may be on a poor level. Intermediaries involved in supply chains may not properly interact with each other. This occurs because numerous intermediaries use different software to perform actions concerning product and information flows.

A solution for these problems can expedite delivery processes and reduce costs, increase trust level, and help to reach consensus among supply chain members. Well-planned supply chains and supply chain management could easily give a strong competitive advantage to a company.
1.1 Aim of the study

The main objective of the thesis is to find actions or technologies which might facilitate interaction among different supply chain members or help to achieve consensus in the sustainable supply chain formation. The study will compare the supply chains of new generations with the ones existing at present. It is necessary to highlight societal benefits for customers owing to changing supply chain management to demand-supply chain management. Customer satisfaction is the reason for the implementation of new technologies based on the demand to provide the highest possible quality of products and services.

1.2 Objective

The objective of this thesis is to determine existent problems and find possible solutions to achieve consensus in the sustainable supply chain formation. Also, it is necessary to define which solutions are currently used in order to make interaction in supply chains less complicated. It is essential to consider the following sub-questions:

- What is the main supply chain challenge nowadays?
- How to achieve consensus in a supply chains formation using blockchain technologies?
- What are the possible problems in reaching consensus in supply chains?

These questions will be helpful in understanding the essence and complexity of supply chain formation.

1.3 Research methods

Qualitative research was deemed the most suitable way of exploring the topic. This research method is based on collection of data about life experiences as well as the meanings that researchers attach to them. It helps to understand complex concepts such as supply chains or blockchain technologies. This type of research is useful for studying how or why something occurred and describing why special actions were chosen to achieve the final result. (Research Methods: What are research methods, 2019).
This thesis is based on the analysis of documents such as articles, white papers, and other research materials, in order to find relevant information. Almost all sources used in the thesis are websites and online research papers. The nature of the topic does not encourage the use of such research methods as questionnaires or experimental studies. The topic is little researched nowadays, and there are few comprehensively aware researchers or companies that possess useful information.

1.4 Theoretical background

The theoretical framework of this thesis includes such subjects as supply chains, supply chain management, blockchain technologies in supply chains, and consensus in a sustainable supply chain formation.

It is necessary to know the structure of supply chains and components of supply chain management to understand on which stages misunderstandings can appear. Also, it is necessary to focus on currently used ways of reaching consensus in supply chains in order to define how to make this process easier and more effective.

Today, global trades are in a process of development. New technologies are being implemented in different spheres of business on an everyday basis. Supply chains are not an exception. Main tendencies of supply chains will be reviewed in order to find the best practices of achieving consensus in a sustainable supply chain formation.

Potential problems in achieving consensus will be taken into account in order to define means to form supply chains with the least risk and in the most cost-effective way.
2 THEORETICAL BASIS OF SUPPLY CHAIN MANAGEMENT

This chapter presents historical facts and general information about supply chains, supply networks, and supply chain management. The most important definitions and concepts concerning supply chain management will be introduced in order to understand the complexity of the topic.

2.1 Definition and essence of supply chains

In ancient times, production places were not usually located near consumption places. This was because the places of production were established near natural resource deposits or not far away from raw material sources. The necessity of the goods exchange processes was a controversial issue because some products were plentiful in one region but in scarcity in other region.

Communication was on a rather low level, and deliveries were made on short distances. The whole exchange process was usually completed on a local level. Technological development created possibilities to explore the world, and more developed countries started to do it.

The first ancient trade routes, such as Silk Road or Spice Route, appeared as a result of exploring world and a solution to products deficit in different countries. Trade became possible on local and international levels, and this lead to the development of transportation processes. Goods were delivered directly from a production place to final customers. (Sanjeev, 2012).

Technologies became sufficiently developed to create small networks or supply chains only in the 18th century. It is generally believed that the first supply network was used in the rum industry. That supply network consisted of four stages:

- Transportation of sugarcane from India to the Caribbean islands in order to make plantations
- Import of slave labour from West Africa to the Caribbean islands in order to work on plantations
- Transportation of sugarcane molasses to New England for distillation
- Transportation of rum to customers
Transportation processes and technologies were further developed during the following two centuries. Ocean delivery costs dropped by 70 per cent between the middle of 19th century and the beginning of 20th century. This was because a new type of ship was created. (Sanjeev, 2012).

Nevertheless, communications were still on a poor level. The complexity of communication systems was a reason for slow deliveries. Major development in communications occurred only with the creation of the telephone. It quickly multiplied the quantity of contracts between foreign companies. (Sanjeev, 2012).

Almost at the same time, in the middle of the 20th century, deliveries and transportation processes were significantly developed with the integration of standardized containers in supply chains. Containers made possible the seamless changing of transportation modes. The possibility of losing freight or transporting it to a wrong customer was reduced. (Sanjeev, 2012).

The latest major improvement in supply chains occurred with the Internet creation. This invention provided sellers and buyers with more modern communication facilities and increased the speed of response.

The main supply chain differences from freight transportations are:

- Partnership of companies rather than competition
- Income maximization for all companies engaged in a supply chain
- Involvement of various separated organisations
- Joint distribution of incomes and profits (Malikov, 2015, p. 12).

Contemporary science offers numerous variations as to how to define a supply chain, but very commonly it is seen as a network of people, companies, organizations, activities, information and resources which are involved in numerous processes of creating transportation goods or services from suppliers to final customers in order to create a value-added chain (Christopher, 2011, p. 9–13). Basically, it is a transformation process of raw materials into finished products combined with transportation and value-added services in order to satisfy the needs of a customer.
It is generally accepted that supply chains can be divided into three different groups in accordance with the complexity of structure:

- Direct supply chains
- Expanded supply chains
- Advanced supply chains (Smirnova, 2009, p. 13–14).

Direct supply chains consist of a first-level supplier, a central company or a focus company, and a first-level consumer (Smirnova, 2009, p. 13–14). A central company usually establishes the supply chain structure and the future relations of all involved companies. The scheme is shown below in Figure 1.

![Figure 1. Direct supply chain](image1)

Additional second-level supplier and second-level customer change the type of a supply chain from direct to an expanded alternative (Смирнова, 2009, p. 13–14). The scheme is shown below in Figure 2.

![Figure 2. Expanded supply chain](image2)

Advanced supply chains are the most complex ones. Generally, a supply chain of such a type can include all stages of product lifecycle from raw materials or
natural resources to consumption by a final customer. The scheme is shown below in Figure 3.

![Diagram of supply network](image)

Figure 3. Advanced supply chain (supply network)

It has been argued that nowadays a supply chain may not be the most appropriate term to use (Rajgopal, 2016, p. 4–5). A supply network is an evolution of a supply chain. The term 'supply network' puts a greater focus on the complexity of processes which occur in material, information and cash flows on the way from the place of production to the place of consumption.

Every step in supply network can include:
- Facilities, plants, and factories
- Inventory
- Storage resources
- Transport resources
- Human capital (Rajgopal, 2016, p. 6–7).

Reverse supply chain processes appear more frequently than before. This is caused by willingness to decrease the usage of natural resources, prevent global environmental problems, and increase the sustainability of a company. Also,
producers are interested in recycling their products to reuse them in the future. The scheme of a reverse supply chain or movement of used products from customers to supplier is shown in Figure 4.

![Reverse supply chain diagram](image)

Figure 4. Reverse supply chain

Supply chains are essential attributes of trade on local and international levels. Actually, well-planned supply chains and supply chain management will very likely give strong competitive advantage to a company.

### 2.2 Supply chain management

Supply chains have expanded during the last fifteen years, and nowadays they can be seen as supply networks (Uhlenberg, 2017). All interactions among numerous suppliers and customers are conducted faster than before. Supply chains have reached such a level of complexity that proper management is necessary.

Supply chain management is a type of management which controls materials, goods, services, cash, and information flows and includes numerous processes
in which an added value is placed on raw materials in the process of transforming them to finished products (Kenton, 2019). These processes imply resource rationalizations in accordance with business strategies to provide a company with advantages over their competitors. Furthermore, supply chains seek to satisfy increasing customer needs with new value-added services.

The main components of supply chain management are shown in Figure 5.

![Figure 5. Main components of supply chain management](image)

The planning stage implies analyses of customer needs, formation of distribution requirements, determination of supply sources and volumes of manufacturing. The main aim at this stage is to develop cost-effective deliveries of high-quality products with the lowest costs. (The Eight Components of Supply Chain Management).

The selection of supplier requires a search for the most suitable provider of services. Furthermore, delivery quality inspections and contracts are made at this stage. Also, the company should plan future deliveries and payment methods. (The Eight Components of Supply Chain Management).
Goods are produced, tested, and packed in the manufacturing stage. The quality level and labour productivity are constantly measured to define possibilities of optimization. This component of supply chain management is the most important for companies. (The Eight Components of Supply Chain Management).

Order, warehousing, and transportation management are inherent attributes of shipping processes. Order management includes the creation of new orders, price establishment as well as the creation and maintenance of customer bases. Warehousing management implies the configuring of orders, packaging, and tagging of packages. Transportation management regulates commodity flows and the quality of deliveries. (The Eight Components of Supply Chain Management).

Reversion process is the final component of supply chain management. The company creates a special network which will collect damaged or poor-quality goods and production surplus to reuse them in future. Also, service for sold products can be seen as a reversion process (The Eight Components of Supply Chain Management). Companies started to regard this process as a value-added part of supply chains less than twenty years ago. Reversion processes in particular can create advantageous proposals compared to competitors because the company which offers them is seen as more environmentally friendly one.

Each component can be optimized and should be under control in order to decrease costs and delivery times, which is always highly appreciated by final customers. The supply chain costs structure is shown in Figure 6.

Figure 6. Supply chain costs structure (Collinson, 2010, p. 45–49)
Generally, the main challenge of supply chain management is to make a customer satisfied with the delivery time and, at the same time, with the affordable price of a product, thus means that supply chain management should control the quantity of middlemen, help to achieve consensus among supply chain members, and reduce the quantity of non-essential actions if necessary.

2.3 Trends and tendencies in supply chains

Technological progress never stops. New ambitious technologies and processes for supply chains appear annually, if not even more frequently. New customer needs and the fierce competition have made it necessary to implement new technologies in existing supply chains.

Some innovations are ground-breaking and revolutionizing, while others are little more than passing buzzwords. The main trend in today’s market is globalization. Developed countries are relocating their plants and factories to developing countries. New transportation routes are created to transport goods, and usually different combinations of transportation modes are required. Main trends in supply chains will be described below.

Figure 7. The logistics trend radar (Chung, 2018, p. 15)
Outsourcing is a prevailing tendency in supply chains. Numerous companies offer their services in order to help with non-core activities and save both time and money. The common name for such companies is middlemen. Some of them are needed, others are futile.

Robotization is a revolutionizing process for supply chains. Several warehouses have become fully autonomous and some warehouses use robotics for the automation of routine processes in varying degrees. Robotics can be used in planning, manufacturing, shipping, and reversion processes of supply chains. The main advantages of robotic systems are their high productivity, reduced number of accidental mistakes, and an ability to work 24/7. The most likely disadvantage of robotics is the possible unemployment of workforce.

Self-driving trucks can be seen as a robotization process. It is a well-known fact that people might make mistakes, so self-driving systems are introduced to prevent road accidents. Such trucks can easily follow other trucks and a traffic, drive 24 hours in a row or more without fatigue, and avoid traffic jams due to vehicle-to-everything connections. The company can be confident that the truck is following its route, and goods will be in the perfect condition after the delivery.

Green logistics is the most important trend for environment. Trucks operating in the area of the European Union produce 931 million tons of CO₂ each year, and the amount of emissions is growing by 1–1.5% annually. Also, trucks create noise pollution. Populations of animals are changing their habitats, and the global nature is changing as well. DHL started to use electrified vehicles for the last-mile deliveries because these vehicles are so quiet that deliveries can be done in the night-time when there is no heavy traffic in urban areas. (Chung, 2018, p. 26; Greenhouse gas emissions from transport, 2018).

Blockchain can be a solution for the complexity of supply chains. The main idea of this technology is the transition from centralised ledger technologies to decentralised systems. It will provide supply chain members with transparent information about material, cash, and product flows. Users of this technology can
verify the origin and life-cycle of a product with track-and-trace technologies. Also, Blockchain will make supply chain activities almost seamless. (Gesing, 2018, p. 41).

Blockchain is a beneficial technology. If it is the well-implemented in supply chain processes technology, it might help to achieve consensus in the sustainable supply chain formation. It might optimize the quantity of middlemen, reduce costs, increase speed of the transportation, and simplify document and cash flows. The track-and-trace system is an indirect bonus of this innovation.

Supply chains and supply chain management are facing some challenges at the present time. All new technologies can push supply chains to the next level. Companies should use a combination of new technologies to create a strong competitive advantage. Innovations should be implemented in every step of supply chains in order to achieve the maximum level of effectiveness.

3 CONSENSUS IN SUPPLY CHAINS

Consensus is a mutual agreement between interacting companies in order to provide parties to the agreement with the best possible solution for both (Anwar, 2018). All members of supply chains should negotiate all terms of future processes. The process of reaching consensus is usually time- and money-consuming and it requires a great amount of paperwork. Long distances complicate already complex processes. Even minor challenges that occasionally occur can stop supply chains.

A few solutions have created in order to reach consensus in supply chains. The main idea of them is a mandatory usage of generally accepted rules and terms to ensure seamless flows. The most well-known solution is international commercial terms or the Incoterms rules. The newest solution is blockchain technologies which are decentralised and, particularly, smart contracts. The main benefit of Blockchain is transparency. These solutions will be described below.
3.1 International commercial terms

The Incoterms rules are global trade rules which provide a clear-cut interpretation of numerous terms. They have become an internationally recognized standard. The Incoterms rules can be used for the sale of goods on international and domestic markets. The terms give traders valuable information about compulsory tasks, costs and risks which can occur in the delivery processes from a place of production to a place of consumption. (Segal, 2019).

The first version of the Incoterms rules appeared in 1936 along with the rapid development of global trades in order to regulate processes, and areas of responsibilities for both suppliers and customers (Incoterms rules history). They were common guidelines for traders. The Incoterms rules were periodically updated to keep up with growing and changing markets and ways of transportation. The growth of transportation by rails appeared during the Second World War. The second edition of the Incoterms rules was published in 1953 in order to avoid lack of understanding of areas of responsibilities in non-maritime transportation. (Incoterms rules history).

After that, the Incoterms rules were regularly changed with the development and the main tendencies of global trades and supply chains. A complete revision of the Incoterms rules occurred in 1990 (Incoterms rules history). The contemporary Incoterms rules are Incoterms 2010. They contain 11 terms divided into 2 groups: rules which apply to any transportation mode and rules which apply maritime transportations (Incoterms rules 2010). Groups are shown in Figures 8 and 9.

Figure 8. Rules for any transportation mode (Incoterms rules 2010)
The terms specify which payments are carried out by the supplier or the customer, who is responsible for actions relating to products, and when areas of responsibilities are changed. There are four different groups in the Incoterms rules structure in accordance with responsibilities (Incoterms Groups). The scheme is shown in Figure 10.

Figure 10. Incoterms groups in accordance with liabilities (Incoterms Groups)

The Incoterms rules can be seen as a method of reaching consensus in the supply chain formation because customers and suppliers obtain conditions of deliveries, payments, and liabilities for both parties. Customers and suppliers do
not even need to spend time to discuss complicated issues because researchers and lawyers of International Chamber of Commerce put much effort in finding the best solutions to the common problems.

3.2 Blockchain in supply chains

Blockchain is an innovation which can be extremely valuable in supply chains and supply chain formation. The technology of Blockchain makes supply chain processes transparent and easily visible for all included parties. The easy access to the current information gives all members of supply chains more confidence to deal with others. Blockchain provides all members of supply chain with the same version of a ledger, seeking to ensure that no disputes will appear inside a supply chain (Marr, 2018). When companies are confident in the other parties of a supply chain, consensus can be achieved in an easier way.

Blockchain technologies can be used to monitor all activities related to a product from its origin to the end of a lifecycle.

3.2.1 Blockchain

The blockchain idea was originally introduced at the beginning of 1990's. Stuart Haber and Scott Stornetta were trying to solve a problem with the verification of a document's editing history keeping the document's content encrypted at the same time. They suggested to form a chain of blocks with hashes which will be shared to numerous users for time stamping and a later approval as a solution to the problem. (Hallamaa, 2018).

The development of the blockchain concept and theory development lasted 20 years before it was implemented. The first blockchain-based technology appeared with the launch of Bitcoin cryptocurrency. (Hallamaa, 2018).

The main idea of Blockchain is Distributed Ledger Technology or DLT (Viitala, 2016). All completed transactions are recorded in a distributed ledger in a chronological order or, basically, in a chain of blocks. The validity of the ledger is
confirmed by complex calculations. Miners perform these calculations, and after that other miners confirm the credibility of calculations (Hallamaa, 2018). Transactions then form a block which is attached to a chain of blocks. The benefit of the distributed ledger is a confidence because nobody can delete or make a falsification of information in blocks without the permission of other users.

When a new block appears in a chain, a special hash is created. The hash is created by calculating the content of a block. After the hash is created it will be recorded to be a part of the next block. An example is shown in Figure 11.

![Correct scenario in a chain of blocks](image1)

**Figure 11.** Correct scenario in a chain of blocks (Brooks, 2018)

Any attempt of a falsification will be shown to other users. An example of an incorrect scenario is shown in Figure 12.

![Incorrect scenario in a chain of blocks](image2)

**Figure 12.** Incorrect scenario in a chain of blocks (Brooks, 2018)
Blockchain technologies have elements of decentralization, transparency and immutability. It can be extremely valuable because these properties are needed in the sustainable supply chain formation (What is Blockchain Technology, 2019).

### 3.2.2 Reasons for blockchain integration in supply chains

Blockchain was launched in order to avoid lack of trust among all participants of the logistics sector or more generally in supply chains. It is a well-known fact, which appeared with the developing of global trades, that from the place of production to a final customer the product may change ten carriers or more. Right now the logistics sector is faced with the problem of enormous amount of paperwork, and blockchain technologies can bring a solution. Companies have to wait for circa six weeks in average in order to receive payments. This occurs because unnecessary paperwork is required by current technologies. (How Blockchain is Revolutionizing The World of Transportation And Logistics).

Another well-known fact is connected with the crossing of borders and customs. It is not a secret that trucks are waiting in queues for days to enter foreign territories. Companies are losing money because vehicles stand idle. All complexity with customs might disappear with blockchain technologies because the correct information will be in «blocks», and customs officers can inspect a cargo with less resources and time. Even carbon emissions can be reduced in this manner.

One more reason for an integration of blockchain technologies in supply chains is tracking systems. Goods, containers and vehicles can be tracked without any installations of an additional equipment. (How Blockchain is Revolutionizing The World of Transportation And Logistics).

There is great number of middlemen in supply chains and sometimes they do not bring added value to customers but nevertheless they cause additional costs, so a product becomes more expensive for a final customer. The quantity of middlemen can be reduced with Blockchain because the technology has special algorithms of achieving consensus avoiding unnecessary activities.
Another reason for an integration of Blockchain in supply chains is cryptography. It is a special way of protection which cannot be easily hacked. Cryptography gives supply chains a next-generation protection.

Members of supply chains have different roles in different supply chains. The traditional pattern of an interaction in supply chains is shown in Figure 13.

![Figure 13. Traditional SCM scheme (Gervais, 2018)](image)

A process of interaction usually appears between two members of a supply chain. Blockchain offers better communication. A Blockchain-powered SCM is shown in Figure 14.

![Figure 14. Blockchain powered SCM (Gervais, 2018)](image)
Figure 14 shows that all supply chain members can be involved in a process of interaction. It will increase the speed of response to rapidly changing situations.

Blockchain can improve present supply chains. It will increase the speed of material, good, service, cash, and information flows. Deliveries might become seamless at the same time. Possibilities of frauds will be reduced to the minimum amount. Track-and-trace systems will be additional benefits of implementing blockchain technologies into supply chains. The most important reason for launching Blockchain is customer satisfaction because it gives increased added value and lower prices.

3.2.3 Present examples of Blockchain in supply chains

Logistic processes involve many parties with conflicting interests and priorities as well as different systems such as ERP’s or tracking systems which do not work well together. According to the World Economic Forum, GDP could be increased by 5% and global trades could be increased by 15% only by reducing supply chain barriers to trade (Heutger, 2018, p. 13). Numerous barriers can be avoided with the help of blockchain technologies in almost all elements of supply chains.

Companies understand that blockchain technologies can bring real benefits and competitive advantages. There are some successful working examples of implementing Blockchain in the logistics sector of the market.

Some business spheres require the proof of origin and precise transaction history for goods. Such requirements usually occur when it comes to expensive purchases. British company Everledger has created a special blockchain-based system which allows to inspect the origin of diamonds, wine, and fine art. Digital records are stored in an easy-to-access blockchain system which can contain information about millions of precious goods. Blockchain records is a needed improvement because the paper-based certification process is old-fashioned. Paper-based documents can be easily falsified or lost while blockchain records are permanent. Special blocks with information contain 40 metadata points such
as colour, clarity, carat weight, and a special blockchain certificate number which can be inscribed on a diamond if a client wishes. (Heutger, 2018, p. 9).

Another example is the management of physical assets with blockchain technologies. It is very common that transportations are made by trucks. Some of them can be outsourced. This means that other companies can rent a truck. The data about trucks can be easily falsified, but Blockchain gives a solution. A dynamic digital twin of a given truck can fully represent the history and all activities related to the real truck (Heutger, 2018, p. 9). The technology allows to store information securely, and a database can be accessed at any time. Blockchain provides companies and people with the relationship of trust which will help to achieve consensus easier.

The joint Maersk and IBM venture is yet one example of implementing blockchain technologies in order to unlock efficiency in the ocean freight (Heutger, 2018, p. 14). They created a global blockchain-based system which digitize different flows and shipment tracings. The digitalized blockchain system is shown in Figure 15.

![Digitalized blockchain system](image)

Figure 15. Digitalized blockchain system (Heutger, 2018, p.14)
This technology gives an ability of checking the progress of particular transportation. Also, all parties included in a supply chain can see the condition of goods, customs documents, completed payments, and estimated time of the delivery. (Heutger, 2018, p. 14).

Traceability and transparency can be improved with the help of blockchain technologies. Clearly, there is an urgent need to improve the track of origin of pharmaceuticals. Counterfeit medicals are being sold every single day, and approximately one million people die annually from them. DHL and Accenture created a blockchain-based project in order to provide people with high-quality medicines. The project enables to monitor the journey of pharmaceuticals from a place of origin to a final customer, so that customers can verify the origin. (Heutger, 2018, p. 15–16).

The process of medicals monitoring is shown in Figure 16.

![Figure 16. The process of monitoring pharmaceuticals](image)

Blockchain technologies enable to improve global supply chains. Consensus can be reached easier because customers can review the history of goods. The confidence in a supplier is the main prerequisite for a sustainable supply chain formation.
3.3 Smart contracts

Smart contracts are a benefit of blockchain technologies. A smart contract is a special programme which controls the transfer of cryptocurrencies and assets between users of a blockchain network under fixed conditions and restrictions. This technology has an ability to define rules and restrictions of agreements. Smart contracts can verify compliance with obligations autonomously or with the help of anonymous users of a network. (Rouse, 2018).

The technology allows to make traceable, reliable, and irreversible transactions without the participation of middlemen (Tar, 2017). Smart contracts can streamline and automate the processes of information and document flows. The increased speed of operations and the immutability of such contracts decrease possible risks for the transaction participants. This can bring added value for the supply chain management because numerous contracts are required for a smooth functioning of a supply chain.

Required activities for the smart contract creation are shown in Figure 17.

![Figure 17. Required activities for a smart contract creation (Tar, 2017)](image)

Smart contracts have many differences in comparison with standard agreements. The main differences are shown in Figure 18.
The main benefits of smart contracts are:

- Security of transactions
- Economy and speed of operations
- Standardization

Security is achieved because of encryption and distribution of information among nodes. The costs reduction and the increased speed of operations occur due to the elimination of middlemen and the automation of such activities as the contract creations and conclusion of them. Standardization is achieved because a wide range of smart contracts was created before, and the company can choose the most appropriate option in accordance with their needs. (Tar, 2017).

Smart contracts nevertheless have negative aspects. Human mistakes can be committed in the codes of smart contracts because people write them. Blockchain-based smart contracts cannot be changed because the technology does not allow users to make improvements. Also, smart contracts are not controlled by any governmental institutions, which can be changed with only the creation of legislative frameworks. (Tar, 2017).
Smart contracts can automate and simplify interactions of customers with suppliers. An implementation of the technology requires a revision of global trade rules and law standardization of individual countries.

All the above-mentioned solutions can be used as tools for achieving consensus in a sustainable supply chain formation. Supply chains have become more complicated, and the importance of IT-systems is emphasized when fulfilling ever-increasing demands. New technologies enhance the possibilities of a company to perform on local and global markets with less risk.

4 PROBLEMS AND RISKS IN ACHIEVING SUPPLY CHAIN CONSENSUS

Supply chains are complex networks of various customers and suppliers. The main objective of supply chain management is the planning and optimization of various flows in order to provide final customers with the best possible solutions. Material, product, cash, and information flows should be seamless and smooth. Numerous risks and challenges appear in the process of a sustainable supply chain formation. These challenges must be resolved to find the most suitable solution for both consumers and suppliers.

This chapter gives a description of the most common problems in the supply chain management and guidance to avoid them.

4.1 Current challenges in supply chain management

There is a great amount of risks and challenges which can occur in the process of supply chain management. Their emergence is attributable to the complexity of inside-chain processes. Some of the challenges and risks occur more frequently than others. The main idea is that all risks jeopardize the level of customer satisfaction. The most common challenges in the supply chain management are shown in Figure 19.
Figure 19. Structure of risks in supply chain management (Uhlenberg, 2017)

Growing globalization tendencies create numerous challenges for supply chain management. Costs reduction is the main objective in the majority of companies. Developing countries have lower labor costs, lower taxation levels, and even raw materials can be cheaper. These benefits compel enterprises to think about moving manufacturing operations to such countries as India, South Africa, Vietnam, Russia and China. Large companies usually outsource their production not only in one country, but to several countries to make the manufacturing stage as cost-efficient as possible. (Uhlenberg, 2017).

The company’s procurement network also makes supply chain management complex because not all resources are available in selected areas for production. Numerous middlemen appear to collaborate with numerous suppliers, and this is a challenge for a company because when a production is in different countries, a company should consider requirements for the customs clearance. (Uhlenberg, 2017).

In addition, companies have to achieve fast delivery lead times to maintain customer satisfaction levels because they want to receive products in time, without regards for increased scales and complexity of supply chains. Also, companies need to monitor the manufacturing stage from raw materials to
finished products in the real time to be confident that the production is effective and efficient. (Smith, 2017).

Companies are faced with numerous risks because partner companies and middlemen can make disruptions in the supply. Such situations always bring companies additional unexpected costs and undermine the customers’ trust in a brand.

Another challenge which appears with globalization tendencies is partner communications. Companies from different regions and countries are using various electronic data interchange systems to communicate. Some emerging countries are not using electronic data interchange systems altogether, but are moving to a more modern application programming interfaces. Such a situation challenges the supply chain management with risks of software incompatibilities and possibilities of losing relevant information.

Inability to control and operate the inventory appears due to problems in partner communications. When inside-network communications are on a poor level, the potential to lose inventory control grows. As a consequence, not all the existing inventory can be seen as available for use at each location. This occurs because transported materials or products disappear off the map until they reach the final destination.

Lack of visibility in inventory management is a topical issue because existing stock levels are not always visible or not taken into account in the procurement or selling processes. As a result, stock materials already available in the warehouse can be procured once again, and unavailable products can be sold at the same time. (Smith, 2018).

Traceability is an important value-added service. The company should have an ability to monitor real-time information about the location of a product and its availability during the whole production and sale cycles. The non-availability of
information can put at risk any future relationships with customers, especially in medical and food industries. (Supply Chain Management, 2018).

Fast-changing markets is also a challenge for supply chain management. Cultural, social, personal, and psychological factors can quickly change consumer behaviours. Consumer preferences are also changed with social media pressures. These factors have led to a product life cycle shortening due to rapidly changing market demands. (4 Important Factors that Influence Consumer Behaviour, 2018).

Companies are under the pressure to follow latest trends and to introduce new ones on global markets with low manufacturing costs because trends are short-termed and rapidly changing. Enterprises should create flexible supply chains which can be easily adopted for new products. (Uhlenberg, 2017).

A problem which appears with an increased number of middlemen is payment delays for up to six weeks. They occur because supply chains require enormous amount of the paperwork which is often redundant (How Blockchain is Revolutionizing The World of Transportation And Logistics).

All the above-mentioned problems and challenges can be resolved with an implementation of special modern solutions such as ERP (Enterprise Resource Planning), EDI (Electronic Data Interchange), tracking, and blockchain-based systems. (Pettey, 2018).

Enterprise resource planning tools help to automate the management of important but monotonous daily tasks. Also, ERP systems help to improve operational efficiency due to better communications and reduced quantity of accidental mistakes. (Shah, 2016).

Electronic data interchange systems can be used in order to automate manual processes of the documentation management and to improve partner
communications. Such a solution reduces the potential for errors and increase the speed of document flows. (Khoury, 2016).

Blockchain technologies provide the members of supply chains with a decreased number of middlemen, increased level of transparency, more secured data flow, improved traceability, and simplified payment systems. (What is Blockchain Technology, 2019).

A combined use of different technologies will be even more beneficial for supply chain management than a separated use.

4.2 Challenges in blockchain-based technologies integration in supply chains

Blockchain and blockchain-based technologies have risks as well as other complex systems. Risks are an integral part of the implementation of innovations. This is particularly true for the implementation of innovations in supply chains. The structure of challenges and risks in blockchain-based technologies integration in supply chains is shown in Figure 20.

![Figure 20. The structure of challenges in a blockchain integration in supply chains (Anwar, 2018)]
Blockchain-based technologies are not deprived of human impact. Initial information is entered by the staff of the first company in a supply chain. Other companies of the supply chain add new information about goods which is based on the initial information. A chance to overlook a mistake at the very beginning of a process is quite low but still exists. This means that if a mistake appears in the first stage, all the following information will be wrong. This fact can be a reason for unplanned costs because the data in Blockchain is immutable, and no one can change it. (O’Byrne, 2019).

A special key which gives an ability to add new blocks with the data is always required. If a company loses it, nobody will re-establish an access to Blockchain because the system is decentralised (Winnesota Regional Transportation).

Another challenge for the blockchain-technologies adoption is consumption of energy. New blockchain technologies are based on the original bitcoin infrastructure and a proof of work as a consensus algorithm which requires much electricity to function. This means that the technology is not green at all. (Anwar, 2018).

The next risk of Blockchain integration in supply chains is the development of Internet in different regions. If a freight is in a location with no Internet connection, it will be impossible to add the up-to-date information in a chain of blocks. Furthermore, track-and-trace systems are jeopardized due to lack of Internet connection. (Delahaye, 2018).

The level of scalability of blockchain-based technologies is low. Blockchain does not function very effectively with a very high number of users. The speed of processes and transactions inside blockchain technologies decreases when more companies are using them. A transaction can require several hours or even days to complete. Also, transactions can be further hindered due to the use of cryptography (Anwar, 2018).
One of the greatest challenges in blockchain technologies is a need to hire or outsource professionals in the programming because the creation of smart contracts is a technically challenging and complex process. There is a lack of qualified personnel that can operate complex processes, and the demand for such professionals is enormous, which results in high salaries. This means that the creation of a smart contract in the early stages of an implementation is a money-consuming process which requires more than one professional to complete. (Powell, 2018).

Unemployment level can be increased due to the blockchain integration in supply chains because the need for numerous middlemen create a high number of jobs (Powell, 2018). People will be in need to obtain a new qualification to continue working in supply chain management sphere.

Another challenge is the absence of an organization which could resolve disputes between parties to the agreement. Even if customers and suppliers create a smart contract, including all terms of contract, time limits, and payment obligations, some smart contracts may not freeze the required amount of money on a customer’s account. Such a situation can cause a payment delay or a lack of payment, and there are no intermediaries such as banks which would be able to deal with the situation. (Browne, 2018).

The most serious challenge for Blockchain is a scenario of 51% attack. The network can be completely changed when a group of users control more than 51% of the computing power. This scenario is extremely unlikely but, nevertheless, possible. (Anwar, 2018).

The main challenges in blockchain-based technologies integration in supply chains are energy consumption, human mistakes, lack of qualified staff, scalability and slow speed of transactions. The number of challenges and risks is great, but there are numerous benefits which compensate for all the negative aspects of blockchain technologies.
5 CONCLUSION

This chapter presents a conclusion for the study. This thesis gives answers for the following questions:

- What are the main supply chain challenges nowadays?
- How to achieve consensus in supply chain formation using blockchain technologies?
- What are the possible problems in reaching consensus in supply chains?

Supply chains are essential attributes of trades on local and international levels. In fact, well-planned supply chains and supply chain management give strong competitive advantages to a company.

Today, reverse supply chain processes and circular supply chains appear more frequently than before. This is caused by willingness to decrease the usage of natural resources, prevent global environmental problems, and increase the sustainability of a company. Also, producers are interested in recycling their products to reuse them in the future.

The main challenge for supply chain management at the present time is to make a customer satisfied with the delivery time and, at the same time, with an affordable price of a product. This means that supply chain management should control the quantity of middlemen, help to achieve consensus among supply chain members, and reduce the quantity of non-essential actions if necessary. All actions require consensus to varying degrees.

Innovations can serve as a solution for supply chain challenges and push supply chains to the next level. Companies should use a combination of new technologies to create a strong competitive advantage. Innovations should be implemented in every step of supply chains in order to achieve the maximum level of effectiveness. One of the most important innovations is blockchain technology.
Supply chains have become more complicated, and the importance of IT-systems is emphasized in fulfilling ever-increasing demands. New technologies enhance the possibilities of a company to perform on local and global markets with less risk.

One of the best solutions for improving the supply chain management process and achieving consensus in sustainable supply chain formation is the implementation of blockchain-based technologies and smart contracts.

Blockchain technologies can improve present supply chains. This will increase the speed of material, good, service, cash, and information flows. Deliveries will become seamless at the same time. Possibilities of frauds will be reduced to the minimum amount. Track-and-trace systems will be additional benefits of implementing blockchain technologies into supply chains. The most important reason for launching blockchain is the customer satisfaction because it gives increased added value and lower prices to customers.

Smart contracts can automate and simplify interactions of customers with suppliers. An implementation of the technology requires a revision of global trade rules and law standardization of individual countries.

The importance of blockchain technologies in achieving consensus in supply chains can be seen via the examples of Maersk and IBM. These companies are leaders in logistics and IT-service industries. Their engagement in one process shows the real need in an implementation of technology in supply chain management. Their system is designed to promote more efficient and secure global trades and support information sharing and transparency by bringing together more than 100 parties. According to Maersk, the blockchain solution could reduce the transit time of a shipment approximately by 40% (Huillet, 2018).

The successful use of blockchain technologies by market leaders and large companies is very significant. Small and medium businesses can see real examples and benefits of an implementation of such a technology. The scalability
level of blockchain-based technologies can be increased only with the help of numerous companies which will be competitors on a market. Also, the growing development of technology will attract new investments which will help to continuously improve the network of users.

Blockchain technologies have a high potential for revolutionizing usual supply chains into digital supply chains which will extremely change global trades with a much higher level of transparency and sustainability.

Indeed, achieving consensus in supply chains implies the existence of problems and challenges. The main challenges in blockchain-based technologies integration in supply chains are energy consumption, human mistakes, lack of qualified staff, scalability and slow speed of transactions. The number of challenges and risks is large, but there are numerous benefits which compensate for all the negative aspects of blockchain technologies.

Consequently, the objective of the thesis was achieved. Actions and technologies which might help to achieve consensus in sustainable supply chain formation were found. The main challenges and risks in new technologies implementation were analysed in order to provide the best solutions for achieving consensus in sustainable supply chain formation.

The reliability of the study was supported with the usage of various information sources in different languages: English, Russian, and Finnish. Real case examples of companies were analysed in order to collect the most valuable information from different market segments. Further development of a topic requires the appearance of new technology users which will close gaps of the statistical information.
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Figure 15. Digitalized blockchain system. 2018. *Blockchain in logistics*. Troisdorf: DHL Customer Solutions & Innovations.


