Blockchain Technology & Logistics of Conditioned Goods Report

Real-world case application - Polish poultry producer and processor

Learning Task 1

Written by: *Jan Kajkowski, Cristian Carpi, Sebastian Dociu*

Supervisors: *Patrick Burgess, Pieter Vlaar, Emmanuel Anom*

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Preface

This University report on the subject of blockchain and conditioned goods, was written by three students: Cristian Carpi, Sebastian Dociu and Jan Kajkowski. The report is an in-depth analysis of blockchain technology with a special focus on its possible applications in logistics of conditioned goods. It consists of background and related work as well as a literature review that aims to investigate if there is currently any academic research that investigates the possible applications of blockchain in transport of conditioned goods. We would like to thank our coaches at AERES University, for their guidance and support throughout the duration of this project.

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Introduction

The food supply chain has always been under observation for possible improvements, today some of the main objectives to achieve in this sector are:

- Traceability
- Transparency
- Security
- Sustainability

Topic	Definition
Traceability	The ability to document and trace a product forward and backward its history through the whole, or part, of a production chain from harvest through transport, storage, processing, distribution and sales (Vorst, 2005).
Transparency	Transparency of a supply chain network is the extent to which all the network's stakeholders have a shared understanding of, and access to, product and process related information that they request, without loss, noise, delay and distortion. (J.M.Beulensa & Douwe-FritsBroens, 2005)
Security	Food security is a term used over the time to mean different things; generally is used to describe the access to enough food to meet dietary energy requirements. It could be used to describe the food availability in a country or to explain the nutritional security of products (Pinstrup-Andersen, 2009)
Sustainability	Sustainability commonly refers to how the needs of the present human generation can be met without compromising the ability of future generations to meet their needs. It includes environmental aspects as well as a social dimension, also related to waste and refrigeration related to storage, and foodservice operations during preparation and service (Adler & Akkerman, 2013).

Table 1 – Introduction

These objectives were born with the development of a globalized market in continuous growth that has highlighted some shortcomings of the classic supply chain system. As a result, new regulations have been developed that induce its development such as the European community directive EN 92/1 CEE (Bogata, 2005) which concerns food products that are more dependent on the food supply chain, conditioned goods specifically. These require more complicated quality maintenance as in the case of the control of temperature variations during the life cycle of the products, which can influence the growth of pathogens or different types of deterioration. Being able to develop visibility of flows, especially in conditioned goods, is therefore always a relevant topic. An answer could be Blockchain, a distributed book (ledger) with many potential applications of traceability and not only for financial exchanges (jardams, 2019). We think that blockchain technology can prove to be useful even if applied in the food supply chain of conditioned goods to increase efficiency, transparency and to speed up the flow of products. Moreover, it can also prove useful as proof of the sustainability declared by the products, thus respecting sustainability criteria. Although blockchain technology has existed for about ten years it is still in early stages of

development, this is one of the vulnerabilities/challenges of this technology. It require more time for the verification of every transaction because it need acknowledgement of every node in the network (jardams, 2019).

The aim of this research is to demonstrate the potential utilization use of blockchain technology in the conditioned goods sector, with the demonstration of the advantages and disadvantages that can derive from it and with a clear comparison with the alternatives available today.
To reach that aim the following objectives are (1) a traditional literature review to evaluate the current state of art in the conditioned goods and blockchain technology sector;
(2) to understand the differences between the supply chains of traditional conditioned goods networks and blockchain-based and knowing when and why blockchain technology is to be considered a possible substitute; (3) to understand the feasibility of blockchain from the perspective of managers of food SMEs to analyze the value of blockchain within SMEs in conditioned goods supply chains.

1. Background and Related Work

Blockchain's ability to guarantee the reliability, traceability, and authenticity of information, along with smart contractual relationships for a trustless environment all portend a major rethinking of supply chains, supply chain management.

Influences on the short supply chain product and material flows also exist. Every product may have a digital presence so that all relevant actors can have direct product profile access. Security measures may be set in place to limit access, where only the parties with the correct digital keys have access to a product. There is a range of data that can be collected for conditioned goods, including the status of the product, the type of product, and the standards that are to be implemented for the product.

In our case, in short supply chain and for conditioned goods an information tag attached with a product represents an identifier that links physical products to their virtual identity in the blockchain.

One interesting structure and flow management characteristics are how a product is "owned" or transferred by a particular actor. Actors gaining permission to enter new information into a product's profile or initiate a trade with another party will likely be a significant role, where gaining permission may require smart contract agreements and consensus. Before a product is transferred or sold to another actor, both parties may sign a digital contract or meet a smart contract requirement, to authenticate the exchange. Once all parties have met contractual obligations and processes, transaction details update the blockchain ledger. The records of data transactions would be automatically updated by the system when a change is initiated.

2.1 Key Product Dimensions

In short supply chains the blockchain technology can highlight and detail at least five key product dimensions:

- The nature of the product (what it is);
- The quality of the product (how it is);
- The quantity of the product (how much of it it is);
- The location (where it is);

- And the ownership (who owns it at any moment).

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2.2 Desirable properties of blockchain in short supply chains

Blockchain and smart contracts can help guarantee that a product is genuine, allowing buyers to see all the shipping information, how and when the product left from the retailer, up until it arrived at the end point.

Here are some properties of blockchain used in short supply chains:

Source		Factor	Description
https://modex.tech/academy/		Data integrity	Immutability or integrity equates to the inability to delete or modify data once it has been introduce in the blockchain network.
		Source code integrity	
		Network distribution	
		Decentralization	Is a feature that define blockchain technology
	Security	Blockchain technology represents a milestone in the field of technology when it comes to security and data protection.	

Table 2 – Properties of blockchain

1. *Data integrity* – Software products based on blockchain database are able to demonstrate data integrity and the fact that data was not changed or altered by third parties. Any changes are recorded and logged properly, thus software products users receive guarantees about data integrity which can be sustained in court of low if the need arises.
2. *Source code integrity* – Applications can be implemented in blockchain environment directly as source code which can't be altered, without anyone becoming aware of the changes. In the same manner, source code integrity ensures a high level of trust between software users.
3. *Network distribution* – Blockchain is actually a network of computers where each is storing applications, immutable data and product functionabilities. Distribution adds a new layer of utility and value to enterprise software products because it guarantees availability and fast access to the system.
4. *Decentralization* – The decentralization mechanism allows a blockchain based infrastructure to have no single point of failure, no centralized server, while mostly everything is hosted and maintained by all parties involved in the business flow. In this case, decentralization translates to increased security and transparency.
5. *Security* – The concept of blockchain emerged from the need of a secure and stable framework. Bitcoin was designed as a digital payment system. As a result, security, cryptography and data protection are core features of this technology. All off blockchain's inherent properties come together and make a secure environment.

https://modex.tech/academy/

2.3 Value Gained by Using Blockchain

Unsurprisingly, the below characteristics add a whole new layer of value to industries and business, especially for short supply chains and for conditioned goods:

- Factors
- Cost reduction
- Middleman become a thing of the past
- Improve customer service
- Faster transcription
- Fraud perversion
- Competitive edge
- Increased security
- Transparency
- Recordkeeping
- Globalization

Table 3 – Value gained by using blockchain

Traditionally, every transaction follows an established pattern, which relies on a intermediary third party who verifies the credentials of the participants involved. This established dogma allows for secure transactions, but it increases the time required for verification and also the costs involved.

By implementing blockchain technology in short supply chains the following changes occur:

- The need for intermediary third parties is removed;
- Reduced costs and operations become more time efficient;
- Access to a secure, transparent database which allows participants to store and view in real time all the data relating to a transaction;
- Global transactions are empowered because national currency borders are removed;
- Cross-border payments and taxes become a thing of the past;
- Payment can be automated;
- By storing information on blockchain network, verifying and controlling ownership rights can be done in mere seconds;
- A blockchain based crowdfunding platform can record funding transactions transparent to all contributors;
- Digital advertising become less costly because intermediaries are removed.

Nowdays it's very difficult and time consuming to trace back the origins of food and goods.

2.4 Innovation in Supply Chains caused by Blockchain

Clients should be able to track a product and confirm its authenticity. Blockchain can trigger a new wave of innovation in supply chain:

- By making use of distributed ledger, all transaction data becomes easy to access, allowing individuals to see how their products were handled and exactly pinpoint their origin;
- In case of contaminated goods, an epidemic can be avoided by tracing the origin of the product in a timely fashion, allowing authorities to take action more quickly;
- Anybody can read but only specific applications can write/add data to the blockchain making the system completely secure;

- Warranties and serial numbers can be stored in the immutable ledger as legal evidence to quickly resolve any eventual dispute, and of course to allow product verification and remove counterfeit suspicions;
- Blockchain and smart contracts can help guarantee that a product is genuine, allowing buyers to see all the shipping information, how and when the product left from the retailer, up until it arrived at the end point.

2. Literature Review

3.1 Introduction

Blockchain technology was first invented in 2008 as a way to manage transactions of the cryptocurrency 'bitcoin'. Since then, much research was conducted on this subject to uncover possible new applications for this technology, such as logistics. It was discovered that blockchain can be used to solve numerous issues involved in supply chain management such as lack of traceability and the overwhelming amount of paperwork involved in exporting goods. A supply chain is a system of producing and delivering a product or service, from the very beginning stage of sourcing the raw materials to the final delivery to the end-user. (Corporate Finance Institute, 2015)

Logistics of conditioned goods provides an additional layer of difficulty in supply chain management, because of the need to control the temperature of the goods being transported. Much literature has been written about the difficulties in maintaining a cold supply chain and the possibilities of improving the relevant processes with the use of IoT or GPS technology. The cold chain logistics industry is being crippled with challenges like increased product volume and sensitivity, ever growing regulations and infrastructural gaps in the form of location tracking issues and controlled environment monitoring all along the cold chain. (Mohsin, 2017) However, none of the research and proposed innovations attempt to use blockchain technology and apply it to the transport of conditioned goods. This results in a clear knowledge gap.

3.2 Research on Technology Currently Being Implemented

There is a clear trend of increasing the use of advanced technology and analytics in the area of supply chain management. When researching supply chain trends in relation to conditioned goods, one technology in particular is often discussed; *'radio frequency identification'* which is said to improve the performance of the cold chain (Garcia, 2010). Until recently, RFID did not have logistics applications, due to the short range, however recent advancements made logistics applications possible. They now allow companies to receive a signal if their product has fallen below the required temperature. This is described in detail in the book titled 'Sustainable Radio Frequency Identification Solutions', which goes in depth into possible advantages, requirements, and even data modeling and storage of RFID solutions in the cold chain.

The book proposed possible data models for tracking items and the infrastructure that is required. In addition, it proposed the use of a bitmap data type that collects the electronic product code of the goods which are then split into groups to identify the product and the manufacturer. On top of that, it contains a section which discusses a possible data sharing system and mentions the infrastructure required to support multiple databases that can share information with one another. The technology is called ***electronic product code information services*** which act as servers that connect the companies involved in the supply chain. It would act as a form of decentralized system that shares traceability information among the servers. It is not a blockchain because there isn't a single database that all members have access to, it is instead a group of servers that are connected, which is a form of a decentralized system. This book was published in 2010, and even back then it mentioned the possibility of sharing information among stakeholders and the possibility of using multiple data servers to increase traceability in the cold supply chain. Surprisingly, there is not any other research on this subject that mentions blockchain or even the idea of a shared database in conditioned goods.

3.3 Current Research on Blockchain in Supply Chain Management

Despite there not being any research on conditioned goods and blockchain, there is much research about the applications of blockchain in logistics. 'Blockchain for an in Logistics: What to Adopt and Where to Start' looks at all the possible benefits of implementing blockchain as well as the right business opportunities where blockchain has the best chance to bring the most benefits. This is quite rare, because most of the available research just focuses on the benefits of blockchain, rather than asking in blockchain is the right fit. In response, this paper identifies potential blockchain applications and a blueprint of how a business can begin to implement blockchain and slowly increase its prevalence in the chain.

- ***Single-use cases*** are the recommended way for logistics companies to start implementing blockchain. Single-use cases can be based on existing systems and often do not require external help. It is also a good way for companies to learn the skills necessary for more complex blockchain projects down the line. The paper emphasizes the importance of including all stakeholders in the project so that the solution impacts the whole chain, rather than just one party.

- After successful single-use projects, the report recommends applying blockchain in ***international transfers*** and the paperwork that is associated with international transfers. Cross-continental transfers require much paperwork, which is subject to being fraudulent and extremely expensive. For example, a shipment from East Africa to Europe requires stamps and approvals from around 30 people and involves interaction on more than 200 occasions, where bills of lading might also be subject to fraud. (Dobrovnik, 2018) The cost associated with this long trail of paperwork and the processing is estimated to make up between 15 and 50 percent of the costs of the physical transport. (Dobrovnik, 2018) A shared ledger that is fully visible to all stakeholders can decrease the amount of middlemen required and in turn optimize the whole process.

- Blockchain should also be considered when a business has to deal with ***expensive and inefficient operations***. If blockchain can alleviate the inefficient operation, than it is likely that it will get traction and be implemented across the whole chain. It could

be applied in any industry that requires certificates and there are questions about the origin of a product such as the diamond industry.

3.4 Public vs Private Blockchains

When considering implementing blockchain technology in a business, it is important to understand the distinction between a private and a public blockchain and decide which of the two is the more appropriate for the case at hand. A Public Blockchain is a permission less blockchain. Anyone can join the blockchain network, meaning that they can read, write, or participate with a public blockchain. Public blockchains are decentralized, no one has control over the network, and they are secure in that the data can't be changed once validated on the blockchain. (Massessi, 2018). On the other hand, a Private Blockchain is a permissioned blockchain that place restrictions on who is allowed to participate in the network and in what transactions. (Massessi, 2018) An example of a public blockchain would be 'Bitcoin', that is open for anyone to join and contribute on a public ledger. A private blockchain could potentially be a system within a company and its suppliers that is prohibited from accessing by members not involved with the chain.

Both alternatives have advantages and disadvantages but in the case of a conditioned goods supply chain a private blockchain is a better fit. By implementing a private blockchain, the enterprise controls ***the resources and access*** to the blockchain thereby preventing access to sensitive information by competitors. A private blockchain also ***performs faster*** because there are less participants in the ledger that would otherwise decrease the performance of the whole system. In addition, it is easier to achieve compliance requirements because of having full control over the infrastructure. (Massessi, 2018)

Open source software is similar to a public blockchain in a sense that it is available to the public to use and modify free of charge. In theory, it has the potential to become incrementally better over time. On the other hand, a closed software is a proprietary software distributed under a licensing agreement to authorized users with private modification, copying, and republishing restrictions. (Saltis, 2020)

3.5 Challenges Associated with Implementing Blockchain in Logistics

'Blockchain Technology Implementation in Logistics' is a report published in 2019 that researches the possibilities of blockchain in logistics and supply chain management. Like most other papers on this subject, it also dives into the possible advantages of blockchain such as multiple data entry, order delay and order error as some of the issues that can be solved by blockchain. On top of that, the paper also contains a section which looks at the challenges associated with implementing blockchain, which is something that is not researched often, but very important.

According to the report, blockchain's biggest downside is scalability, this is because information must be processed by all parts of the chain and this becomes problematic when stakeholders are spaced out globally. (Tijan, 2019) Reduced privacy is also unavoidable with blockchain because all members have a copy of the ledger and there is no central authority is case of a security breach. (Tijan, 2019) Another disadvantage of blockchain is that it is still a relatively new technology therefore there is no single benchmarking standard to compare the efforts that are currently being implemented, which makes it difficult to track progress. All those factors lead to the perception that the technology is unsecure and unreliable.

3.6 Current Cases – Testing Blockchain in Supply Chains

Since the potential of blockchain in logistics was discovered, tests have been conducted to learn if implementing blockchain can bring financial benefits and save costs in supply chain management. *'Blockchain in Logistics and Supply Chain: A Lean Approach for Designing Real-World Use Cases'* is a report that put blockchain to the test in a real-world situation by implementing it in a European e-commerce food retailer. The company owns ten warehouses, three distribution centers and has suppliers located all over the globe the far spread of the supply chain, make it an excellent candidate to test blockchain. The goal of the research was to learn if the costs of implementing blockchain are offset by the benefits brought by the technology. The name or specific company information is not mentioned in the paper.

Possible areas of improvement begin at the inbound logistics stage, which begin with a Product order confirmation. Once the order is confirmed with the supplier, it is transported by the supplier or a third-party. Based on the agreement between the retailer and supplier, a final destination is selected for the product. Then, an ***advanced shipment notice*** is created, which is an ***electronic data interchange*** document containing delivery details. This allows the receiving warehouse to know how much goods are going to be delivered and plan accordingly. Once the goods arrive, the following operations much be completed: unloading, scanning shipment barcodes, paperwork and placing the goods on the inbound dock. There is many areas of improvement in those processes when possible drawbacks such as inaccurate quantity information, delays and inaccurate information about incoming goods are considered. Having visibility of the whole supply chain achieved with blockchain and avoiding to provide inaccurate or trustworthy information, could help to reduce the chances of human errors, counterfeits, while improving the forecast. As a consequence, the producer can optimize the production and planning processes, anticipating a situation of out-of-stock and reducing the bullwhip effect (Perboli, 2018). The inflated inventory as a measure to protect against the bullwhip effect could also be reduced, which can increase the profit margins for the producer. Those same benefits apply to the distributor and carrier as well. The customer would benefit by having more assurance that the products they purchased are safer and have not been tampered with.

To implement the blockchain, the IBM Blockchain platform was used, which required the company to hire five people (three technical experts and two project managers), however the additional costs were offset by the costs saved. Savings come from the increase of the inbound efficiency, given by 850 working hours saved by the optimization of operations, the transfer of 2 operators to a different area, and the increased accuracy of the data (and consequent reduction of recovery actions). The main savings are generated by the reduction of the waste of goods thanks to the better management of use-by-date information, and the identification of possible unsafe storage conditions. (Perboli, 2018) The annual costs of implementing a block chain were 370,000 Euros for the whole chain, while the costs saved totaled 495,000 Euros, the total money saved was the amount of 125,000 Euros.

The report also looks at the required steps before the blockchain is created like the importance of a preliminary design and a digital strategy, so that the actors, their gains, and requirements are clearly defined and understood. It is also not recommended to implement blockchain on a company-wide basis, because mistakes are much more likely to happen. It is recommended to assess which processes would benefit the most from being moved to blockchain and acting accordingly.

Oracle is a special company in the blockchain sector because they offer a blockchain solution that removes all the uncertainty and difficulties associated with blockchain implementation. Oracle offers a ready blockchain solution infrastructure that the company calls ‘plug-and-play’. It already comes with a cloud platform, with infrastructure services and other tools that reduce the implementation time from weeks to minutes. (Oracle, 2020)

Oracle allows simplified contract management through its access control functionality. The fine-grained access control functionality allows access to each piece of large datasets stored in the cloud. With this feature, smart contract developers can manage permissions’ access to easily define identities, groups, and resources. (Oracle, 2020) There is also no coding required or configuring network components, managing certificates and manually provision hardware.

IBM is also one of the leading players in the blockchain for business market. Their blockchain platform is proven and already successful among various industries. (IBM, 2020) Like Oracle, IBM gives the option of joining an existing network or starting a new one. Once on a network, IBM provides tutorials and various other tools to aid in using the system most effectively. It is also easy to add other stakeholders to the network, even if they have different IT infrastructure. (IBM, 2020)

The IBM blockchain platform has multi cloud flexibility meaning that the system is able to run across multiple environments – both on-premises and across cloud environments. (IBM, 2020) The company is the founding member of a project collaborating to develop ‘Hyperledger Fabric’ the recognized framework of permissioned blockchain networks. The platform is able to provide smooth integration between smart contract development and network management with our Visual Studio (VS) Code extension. With simplified DevOps in a seamless environment, your team can move easily from development, to test, to production, to network management. Plus, smart contracts can be developed in JavaScript, Java, and Go languages. (IBM, 2020) In addition, the user can maintain complete control of identities, ledger and smart contracts because vendor lock-in is not mandatory.

3.7 Requirements needed for data exchange in blockchain

When considering the requirements needed for data exchange in a blockchain, the literature mentions five main aspects, which are explained below.**Określono nieprawidłowe źródło.** The source used is a report titled; ‘ITU-T Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities’. The below mentioned requirements apply to blockchain technology in general, not to blockchain technology specifically used in food logistics, however there is some definite overlap.

1. **Scalability:** Data exchange needs to be supported by different services and function in more than one blockchain. (International Telecommunications Union, 2019)

2. **Trusted Data Storage:** It is important that all data within a blockchain framework is stored securely and in a matter that is tamper-proof. It should also be easily accessible by the correct stakeholders in the event of an audit. **Określono nieprawidłowe źródło.**

3. **Trusted Identification:** It is strongly recommended to distribute to each stakeholder proper identification to exchange data in the blockchain. **Określono nieprawidłowe źródło.**

4. **Interoperability:** Interoperability, meaning that the data exchange tools which are a part of one blockchain, should also work in a different one. It is comprised of many

aspects such as a unified data format, unified cross-blockchain identity and transaction. **Określono nieprawidłowe źródło.**

5. **Data Security:** Data security is an important aspect of data transmission and circulation. The goal is to detect any attempts at data tampering, which can be achieved with tools such as data encryption, digital signatures and data figure prints.**Określono nieprawidłowe źródło.**

3.8 Conclusion

Blockchain is a very in-demand topic in many industries including supply chain management, as a consequence there is much research that is being conducted to learn more about the possible benefits of this technology. Unfortunately, that is not the case when it comes to the logistics of conditioned goods. Despite there being much literature on blockchain in supply chains and many reports written about the possible benefits, challenges and even real-world cases, there is still a research-gap about blockchain in logistics of conditioned goods.

3. Project Plannig

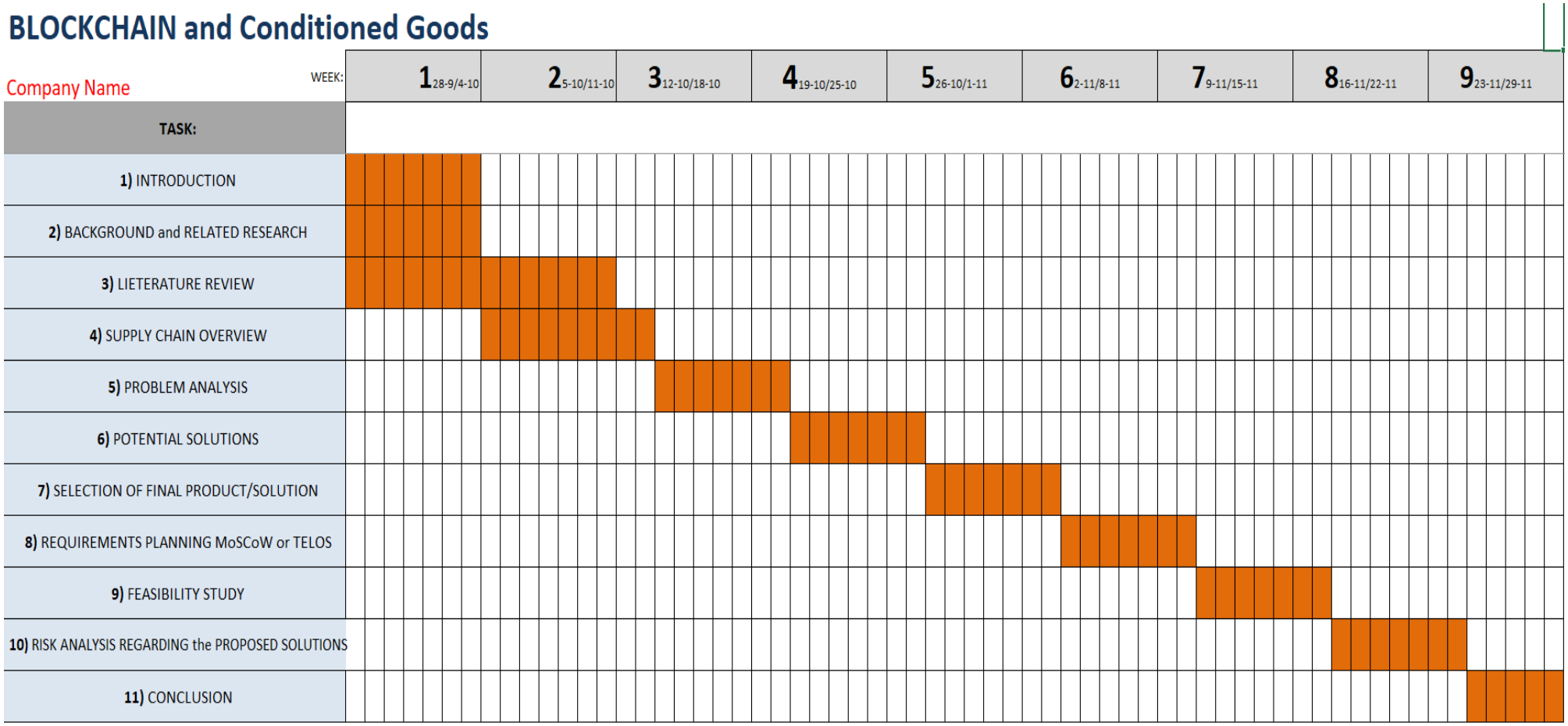


Figure 1 - Project Planning

4. Supply Chain Map - Drosed

Supply Chain Map Drosed

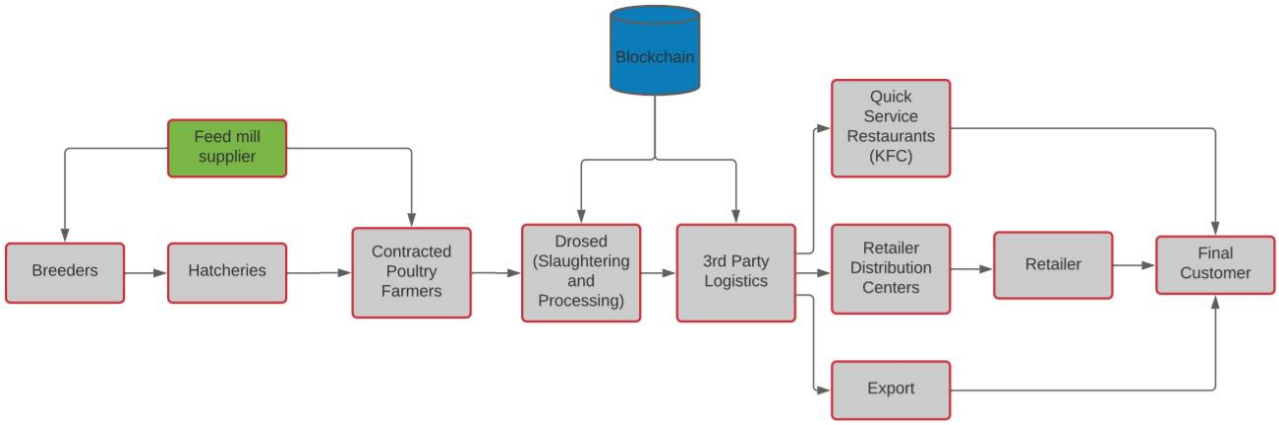


Figure 2 – Supply Chain Map Drosed

Learning Task 2

1. Introduction

In this section we will analyze better the supply chain, will try to understand the flow of goods and information. We will use the Value stream mapping, the Scatter plot diagram and Ishikawa diagram in order to highlight the issues within the supply chain of our company. Potential solutions will be find and we will take one of them and develop furthermore. Afterwards by using the MoSCoW method we will help the company to understand the customer's view of what is essential or not for them and after that a feasibility study will be made to highlight the benefits of the chosen solution and the cost of it. After the feasibility study, a risk analysis will be taken in consideration. In the end a conclusion section will be created in which can be find recommendations about short- and long-term implementation.

2. Problem Analysis

2.1 Company Overview and Problem Description

For the real-world case portion of this project, the group chose a Polish poultry producer and processor ‘Drosed’. It is one of the largest poultry companies Poland whose products can be found in almost all major Polish supermarket chains. The company also exports its products to many European countries like Germany where the duck products made by ‘Drosed’ are very popular, besides Europe, the company also exports to Asia and Africa. Originally, the company was founded in 1957 and since 2000, it is a part of ‘LDC Group’, the largest poultry company in Europe originating in France (Drosed, 2020). ‘Drosed’ has a yearly turnover of about 390 million Euros and employs 3000 people. ‘Drosed’ is an umbrella company which controls a total of six processing plants. It is a vertically integrated company that controls most of the steps in the supply chain like hatching, slaughtering and processing. Recently the integration has reached the raw material stage of the chain due to the recent purchase of a feed producing plant ‘Polpasz’. The two remaining steps in the chain; raising the chickens and logistics are outsourced, the birds are raised by contracted Polish farmers and the logistics are done by 3rd party logistics providers.

For the purpose of this project, the company ‘Roldrob’ will be analyzed. ‘Roldrob’ is the largest factory belonging to ‘Drosed’ and it is where one of the group members completed a summer internship. The factory has both slaughtering and processing facilities where a wide variety of products such as grilled fillets and chicken nuggets are made. Besides working at the production floor, the group member also worked in the logistics department where he was able to learn a substantial amount about the day-to-day logistics operations at the company. One of those operations was to organize and send data about the temperature of the goods during transport, it was an inefficient process that was very time and labor intensive that could be greatly improved with a blockchain system combined with RFID technology.

‘Drosed’ delivers all of its products from the factory via 3rd party logistics providers, most of the deliveries are done by truck. Many clients want proof that their product was delivered properly under the required temperature conditions. Fresh, non-frozen meat is a product which has to be in a controlled environment, between 0-4 degrees Celsius (Meat Science, 2017). Leaving this temperature range can ruin the physical properties of the meat because the meat forms ice crystals thereby ruining the texture, if the upper limit is bypassed, the rate of bacterial growth increases and the meat can spoil. Therefore it is imperative that the cold chain in maintained at every step of the chain after the product leaves the factory. As a consequence, each truck is equipped with a temperature reading device that is active for the duration of the transport. After the transport is completed, the device prints a paper similar to a receipt from a grocery store. This receipt is then delivered to the company office where it is scanned and emailed to the customer as proof of maintaining the cold chain. This system is inefficient and prone to human error because the number of these papers is overwhelming and scanning them all is very time consuming. They are also very easy to misplace and sending the wrong paper to the wrong customer is a common error because they are relatively indistinguishable from one another. This process can be greatly improved with a combination of RFID and a shared ledger that would allow the company and the customer to see the temperature of the products in real-time. Below is a visual representation of the current information system in regards to temperature controlled goods.

Information System of Temp. Controlled Goods - Drosed

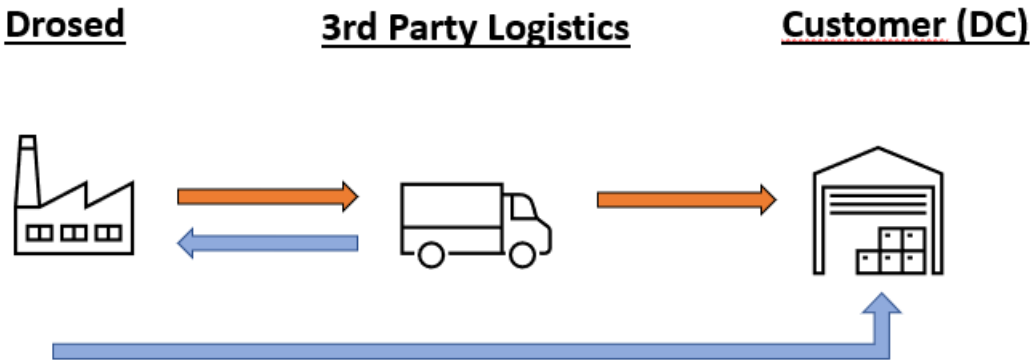


Figure 3 – Information System Temperature Controlled Goods

Flow of Information

Flow of Goods

Steps within Drosed Required to Send Temp info. to customer

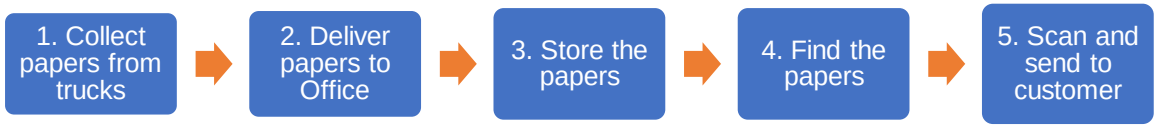


Figure 4 – Steps within Drosed

2.2 Supply Chain Tools

Supply chains processes in the food industry can be very complicated because they involve many actors, for example tier one and tier two suppliers, manufacturers and third-party logistics providers. As a result, many activities are happening simultaneously and in such situations problems can occur such as sending the wrong order to a customer or not having enough stock to fulfill the required demand. In such cases, certain tools can be used to highlight problems in the chain to clearly identify problem areas and create solutions to solve them. Some of the tools are **Value stream mapping, Scatter plot diagrams** and **Ishikawa diagrams**.

2.2.1 Value Stream Mapping

Value stream mapping is a process of creating a detailed, visual representation of the flow of goods from the supplier to the customer through a business (Kambanize, 2020). This tool shows all the steps required in making a product or providing a service from beginning to end. Even though the name has the word value, this tool also maps activities that do not direct value to a customer. The purpose is to highlight the value-adding and non-value adding activities so that the processes of a company can be streamlined and become more efficient. This makes VSM a lean management tool (Pearson, 2020). In most cases, it is used by manufacturing operations that are looking to eliminate waste in their process.

2.2.2 Scatter Plot Diagrams

A scatter plot diagram, is a tool that compares one variable to another in order to find a relationship between them. It involves mapping out the data points in a vertical and horizontal axis in order to identify trends and correlations. If there is a correlation, the data points will form a line or a curve, a closed proximity between the points indicates a strong correlation (ASQ, 2020). While showing correlations, it does not prove that one variable directly influences the other variable (ASQ, 2020). This is a very important distinction that needs to be taken into account when analyzing the results obtained from a Scatter plot diagram.

2.2.3 Ishikawa Diagram

The Ishikawa diagram is a problem solving tool that involves brainstorming possible solutions to a problem, grouping the solutions and finally selecting one of them. It was developed by Kaoru Ishikawa during the 1960s as a way of measuring quality control processes in the shipbuilding industry (Hayes, 2020). Sometimes, they are referred to as “fish-bone” diagrams because of their resemblance to a fish skeleton, which consists of a “spine” which shows the problem and “ribs” which show the possible solutions to the problem. This tool is often used to solve production and design problems (Hayes, 2020).

2.3 Visual Representation of Tools

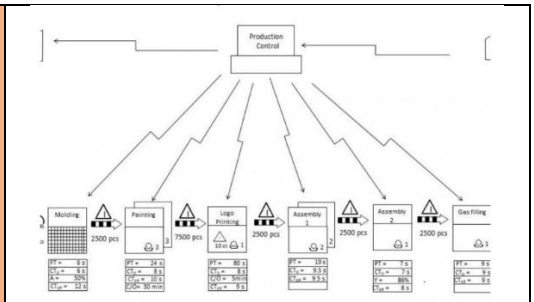
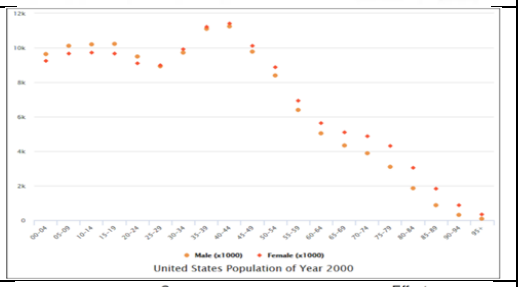
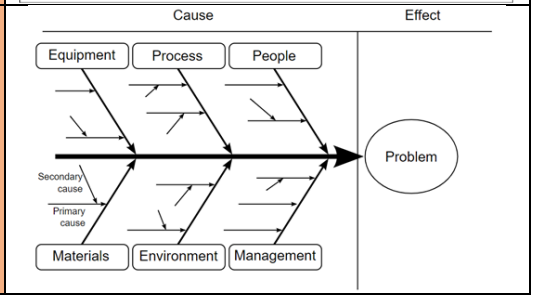
Value Stream Map	
Scatter Plot Diagram	
Ishikawa Diagram	

Figure 5 – SC Diagrams

Ishikawa Diagram Drosed

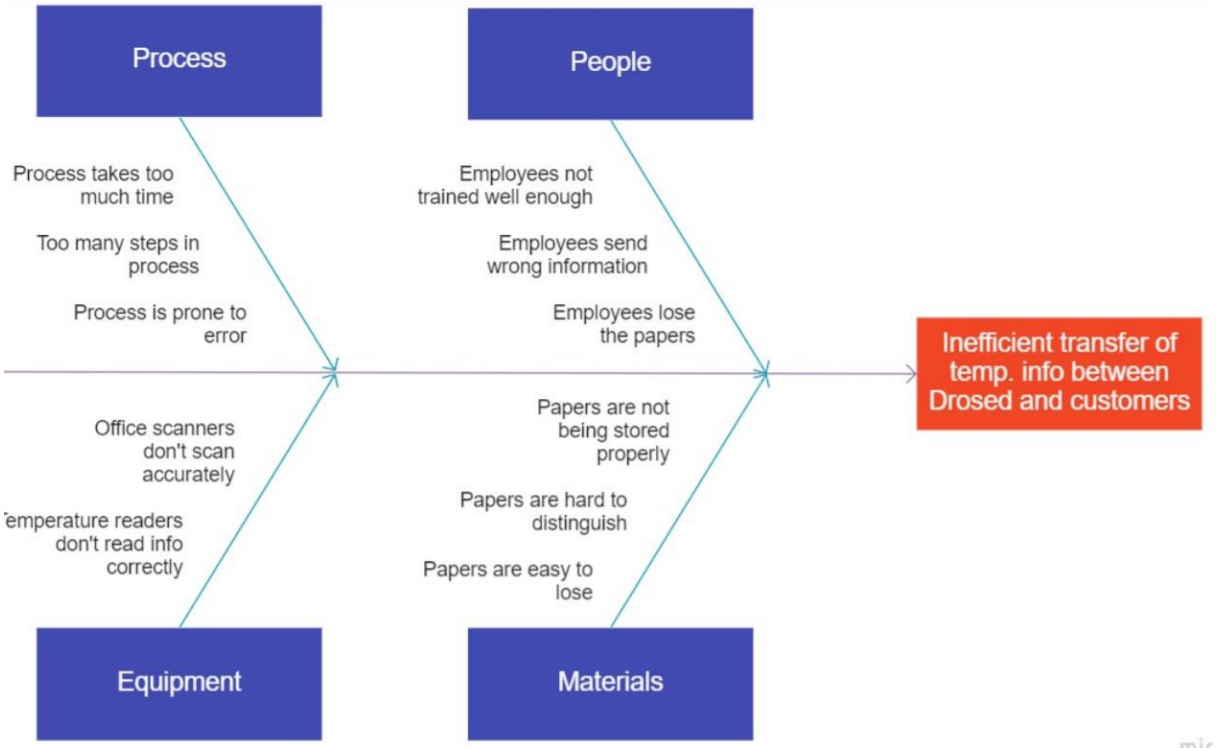


Figure 6 – Ishikawa diagram

The inefficient transfer of temperature information between Drosed and its customers is a multifaceted problem with multiple causes. Firstly, all causes mentioned in the material section of the report negatively affect the efficiency of this process. During the group members time at 'Drosed', it was clear that the papers with temperature readings were not stored properly, hard to distinguish and easy to misplace. Getting rid of the paper system and switching to a digital system would go a long way in improving the process. All problems related to the process part of the diagram are also valid because all the steps involved in the make the process too complex also delivering the information to the customer takes too long.

3. Potential Solutions

As we saw in the Ishikawa diagram, the company has more problems in many departments, so the potential solutions can be to improve each one of them (Processing, Employees, Equipment, Materials), or they can use the RFID system combined with blockchain. By improving the departments may solve the company's problem, but it will take too much time and money. So as a final solution we will develop the implementation of RFID system combined with blockchain. RFID is an acronym for "radio-frequency identification" and refers to a technology whereby digital data encoded in RFID tags or smart labels (defined below) are captured by a reader via radio waves. RFID is similar to barcoding in that data from a tag or label are captured by a device that stores the data in a database. RFID, however, has several advantages over systems that use barcode asset tracking software. The most notable is that RFID tag data can be read outside the line-of-sight, whereas barcodes must be aligned with an optical scanner (ABR, 2021).

Diagram of Proposed Solution

1. RFID tags are placed in the haul of trucks during the transport – collect temp. data.
2. After the transport tags are scanned with handheld scanners by warehouse employees.

3. The handheld scanners send data to the RFID reader.
4. Data is then transmitted to the data logger where it is organized.
5. Office employee then uploads data to the shared ledger where the customer can see the conditions of goods during transport.

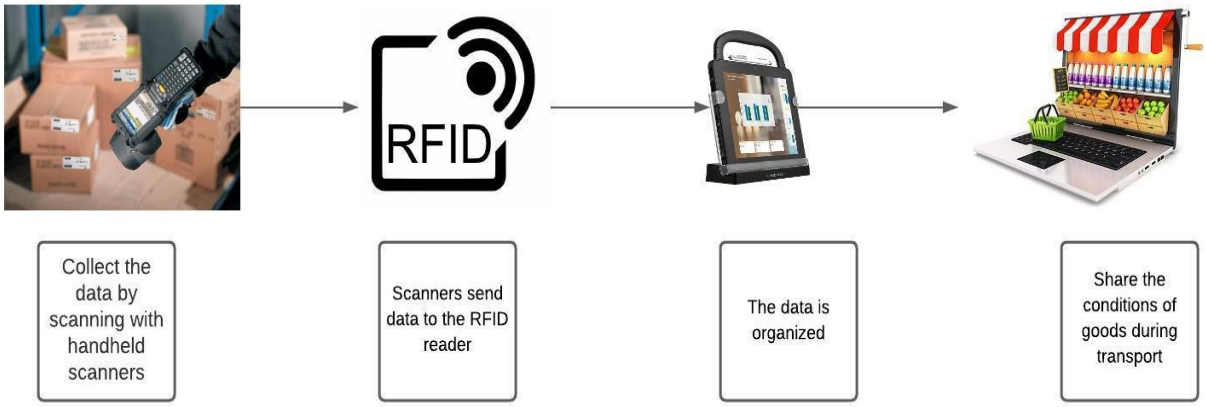


Figure 7 – Proposed Solution

By implementing the RFID system, the company will have some big advantages:

- ✓ Tracking assets and managing inventory
- ✓ Saving time and money through automation
- ✓ Improving data accuracy and availability
- ✓ Enhancing health and safety
- ✓ Better control of production
- ✓ Enhancing quality and traceability
- ✓ Increasing revenues
- ✓ More in-depth management information
- ✓ Shorter processes
- ✓ Rapid payback time

4. Requirements Planning MoSCoW/Kano

4.1 Requirements Planning – MoSCoW

The MoSCow method is a tool usually used in the early stages of developing a project, specifically in the stage of prioritizing features. It is used to sort features into priority order – a way to help teams quickly understand the customer's view of what is essential for launch and what is not (Waters, 2009). The tool is also an acronym which stands for must have, should have, could have and won't have, all the possible features of the project have to be divided into these categories. Below is an analysis of the blockchain and RFID project in relation to 'Drosed'.

Category	Features
Must Have:	1) Temperature sensors 2) Wireless capability, 3) Data logger 4) RFID fixed reader 5) Secure cloud platform

	6) RFID Tags
Should Have:	1) Alert system if cold chain is broken 2) Easy to operate software – at warehouse level 3) Easy of usage by customer
Could Have:	1) Real time tracking 2) Temperature probes for more accurate temperature reading 3) Active tags (for real-time tracking)
Won't Have:	1) Open ledger

Table 4 – MoSCow Analysis

Must Have: The must requirements should be regarded as non-negotiable, without them the project will fail (O'Loughlin, 2010). Clarity and agreement on these features is important early on, as this is the minimum scope required for the product to be useful (Waters, 2009). In the case of this project, temperature sensors are the most important feature because tracking temperature is the main premise of the project, therefore this feature is a necessity. A secure cloud platform is considered as must have for the same reason. A fixed RFID reader will be used to gather information from the individual RFID tags and a data logger will be used to store and organize the temperature data. RFID tags are the necessary component for collecting the temperature data within the trucks themselves. All features mentioned in this category are necessary to operate an RFID system combined with a blockchain platform, as a result they are in the must have section.

Should Have: These requirements should be implemented if at all possible, sometimes they can be satisfied in different ways. Despite not being critical to a launch, they are still important to a customer. The first feature considered as should have is an alert system in the case the cold chain is broken. The system should be able to notify the company in real-time if an unforeseen circumstance occurs and a fast response is required to bring the load back to the necessary temperature condition. For this feature to be implemented, the company would have to purchase active RFID tags capable of continuously broadcasting their own signal in real-time (Smiley, 2019). They are much more expensive in comparison the passive RFID tags which do not have this ability. Despite this being an important feature, that should be included in system, it is possible that 'Drosed' won't include it in the final version. The second feature which should be within the project is an easy to operate system at the warehouse level, preferably operated with hand-held scanners that can directly upload temperature data into the shared ledger. Hand-held scanners are relatively easy to operate and the warehouse employees at 'Drosed' already use them for inventory management, therefore it will be an easy system to integrate and minimize human error – which is one of the main reasons for this project. Finally, the database should be easy to access and use by the customer as to minimize the learning curve for them and increase the likelihood that they will be willing to participate in the blockchain.

Could Have: Features considered as 'could have' are beneficial to have, however they should only be included if the appropriate resources are available (O'Loughlin, 2010). They are the first features to be removed if the project timetable is at risk or if budgets are surpassed (Waters, 2009). The first 'could-have' feature for this project is real-time tracking used to monitor and upload the temperature in real-time. This feature would allow both 'Drosed' and its customers to see the temperature of the load being transported in real-time. This feature requires active RFID with the capability to transmit data during transport. This is significantly more expensive and should only be added if it can fit into the budget. Temperature probes for more accurate temperature readings are the second feature in this category, temperature probes could be placed on pallets or tertiary packaging to give a more accurate indication of the conditions for each particular section of the load. It is not a necessity and again, should only be included if there is room in the budget for it.

Won't Have: Finally, the 'won't have' features are features which will not be included in the project, however they may be included at a later time (O'Loughlin, 2010). They have been requested, but are explicitly excluded from the project (Waters, 2009). In this case, an open ledger is classified as a won't have feature because 'Drosed' will be the only party with

permission to upload data into the blockchain. If down the line, the blockchain will be used for other purposes that require input from both parties, than the blockchain can become an open ledger.

5. Feasibility Study on RFID and Blockchain

After explaining the product idea which we are talking about, having highlighted the benefits and the reason why it could bring, it is important to go through a step called feasibility study, it is a process that, after presenting the business plan, goes on to do further research on real feasibility of the product, also considering future considerations such as surveys and estimates.

The feasibility may consider as an important step for investors or organizations to make sure that their mission is officially feasible, gainful for the organization and beneficial for society. The feasibility study must generally include five types of aspects to be considered or feasibility aspects:

- **Technical feasibility**: mainly associated with the technologically evolution of the project, generally a group of engineers or technical expert study the whole projects and technical aspects, based on the results it decides whether the technical team is able to convert the idea into real (Mukherjee, 2017). The technical feasibility assessment is focused on gaining an understanding of the present technical resources of the organization and their applicability to the expected needs of the proposed system. The study must take into consideration factors that are able to define its all-round technical feasibility such as the production method and technique, the project requirements and the project location (wikipedia, 2020).

In our case the technical feasibility of a first approach seems to be confirmed by experts in the sector who have been consulted. It must be said that we are still in the early stages of the project, but there is confidence in this project above all since there is already a paper tracking system that will then have to be converted into a computer.

- **Economical feasibility**: The economical feasibility evaluation purposes to determine whether project objectives are viable with benefit to the organization (Bauser, 2014). It take in consideration price and all kind of expenditure related with the scheme before the project start also improving the project reliability, helpful for the decision-makers to decide if the planned project is to be implemented now or at another time based on financial resources (Mukherjee, 2017).

This is perhaps the factor where it is more difficult to define a feasibility with certainty, that is, the real information is not yet available as the technical project has not yet been developed and we do not have a precise figure. From what we know of other applications, however, the

economic advantage is often present, several researchs have examinated the impact of RFID technology on inventory, logistic and supply chain management. In general, literature containing an analytical assessment of RFID technology is fairly limited.

(Delanuay, 2007) classified errors causing inventory discrepancies in supply chain:

- Permanent shrinkage in the physical stock due to theft, obsolescence or breakage.
- Misplacement; temporary shrinkage
- Randomness of the supplier yield (permanent loss or surplus due to suppliers)
- Transaction type errors (it affect the information system)

(Tellkamp, 2005) proposed using RFID to reduce the impact of inventory inaccuracy and found that using RFID technology average inventory held decreased by 16% and total back orders decreased by 22%. (Wang, 2007) carried out a simulation to evaluate the impact of an RFID system and the results indicated that the RFID-enabled supply chain could effectively achieve a 6.19% in the total inventory costs.

The factors of value product value and demand uncertainty have a considerable influence on the expected benefits of RFID integrated system. If the product value increase than also the supply chain cost saving increase and if the demand uncertainty increase the supply chain cost saving decrease (Alp Ustundag a, 2008).

- **Legal feasibility**: to conclude whether the proposed plan or system is conflicts with the national or international legal requirements (Mukherjee, 2017), e.g., a data processing system must comply with the local data protection regulations and if the proposed venture is acceptable in accordance to the laws of the land (wikipedia, 2020).

In our case, however, the information processed is not generally considered sensitive, on the contrary it is the type of information that the consumer and the company require as if they were not shared the trust with respect to companies would be lost.

- **Operational feasibility**: critical aspect of systems engineering that must be an integral part of the early design stages as a system can serve its purpose when its technical and operational characteristics have been designed. therefore Operational feasibility is the measure of the ability of a proposed system to solve problems and satisfy the requirements set out in the analysis and development phase of the system. generally the requirements that are verified in operational feasibility are reliability, maintainability, manufacturability, availability, sustainability, convenience etc (wikipedia, 2020).

An RFID based auto-ID system is made up of a unique identification number, which is assigned to a particular item, an identity tag which is attached to the item with a chip capable of storing a unique identification number (Yossi Sheffi, 2003). It is an interesting and promising technology available to help the improvement of the supply chain processes. It is able to improve manufacturing and retail operations and therefore also for traceability systems (Alp Ustundag a, 2008).

With an eventual application of the RFID-Blockchain system it will be possible to exploit all the advantages that can be had from a digitization / automation of the process, thus making it more solid, with data that is difficult to alter and less risk of damage. Furthermore, the responsibility would be removed from the staff who currently collect tickets and data and the same operation would take place in real time without delays due to card analysis.

As regards the use of blockchain technology in our use-case, it has been confirmed by industry experts that the feasibility is there as the need for information exchange and their registration is already evident with the current system through paper tickets. Having said that, the thing that is still not sure is the economic advantage, further studies and insights should be done in this regard.

- **Scheduling feasibility**: it is necessary to complete the project in its schedule time, here is generally predict the time requirement to complete the tasks of the project (Mukherjee, 2017).

A project with scheduled deadlines has not yet been elaborated, this document also has the purpose of encouraging and convincing the subjects involved to accept this innovation strategy and therefore be available for a definition of work development times.

6. Risk Analysis

In this section we will analyze the main risks that can be considered with the application of this project. A first mention must be made of RFID technology which, despite proving to be safe and now almost in common use, still has some gaps and for this reason some precautions should be considered.

The first risk that we mention is the necessity of availability of internet almost all over the supply chain. The system work with internet an so it's important to implement IOT (internet of things) in the good way to be able to achieve efficiency during the utilization of the system.

(Erguler, 2015) speaks of a consideration of the "compromised reader" case, crucial in RFID authentication protocols. These protocols should provide the necessary security requirements for the closed loop RFID system. Unfortunately, this type of problem is still not widely studied in the RFID security community and could cause future complications.

Another risk to consider is the relationship between manufacturer and supplier. Obviously applying a Blockchain-RFID system to a supply chain means involving more stakeholders who must interact with each other in the design phases of the system (deciding the management of responsibilities, planning a shared scheme for routine management, etc.) It is also noted that once the system has been adapted and previously stipulated how to behave when the system detects inadequate temperature variations, paradoxically the relationships could be reinforced in some way, that is, it will always be the system that defines the responsibilities (*verba volant scripta manent*).

But the factor that is perhaps the most important is that of the real economic feasibility of the project, that is, is there really an economic advantage in the development of this procedure? would consumers be willing to pay for this type of service? To have the real answer to these questions it would be necessary to deepen the development of a technical feasibility of the project in order to communicate directly with the manufacturers and demonstrate the real economic advantage.

7. Conclusion

At the end of this paper we can draw some conclusions. The main aspect that comes out of this document is certainly the demonstration that the technology of the Blockchain system is

proving to be more and more adaptable to various purposes and the demonstration of this document is a real proof. Obviously, before arriving at a real application of this idea it is necessary to develop further research and in-depth feasibility study, but already now the technical experts who are in contact with us have shown their enthusiasm for a project which they say is very convincing and with a high probability of success. In our case, in fact, the tracking of information is already present but with an unreliable system and too exposed to human error.

Throughout the course of the report, a detailed analysis of the problem faced by the company, the supply chain and the blockchain was investigated. This solution has the ability to improve the internal processes at Drosed by reducing errors, increasing the speed of processes and increasing traceability in the chain. The only question that still remains is would 'Drosed' be interested in the additional financial investment in order to set up this system and would the labor cost saved be enough to offset the intital cost and is increasing the efficiency in the logistics department is worth the investment. That is something which should be decided by the company internally.

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