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Blockchain Application in Cold Chain Logistics

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Thesis

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Preface

In front of you lies the thesis for the graduation assignment executed by Soeber Farax on behalf of the client Spark! Living Lab. The thesis is a part of the module ILEAFS40 for the bachelor of Logistics Management. This bachelor is conducted at the Hogeschool of Rotterdam.

I also want to thank my guides on behalf of Spark! Living Lab, Mr. Maxime Bouillon and on behalf of the Hogeschool of Rotterdam, Martin Ligtenbarg.

Soeber Farax

Rotterdam, 30 may 2021

Management summary

This thesis answer the research question regarding: *"How can the application of Blockchain Technology improve the cold-chain of Lamb Weston-Meijer in terms of Transparency, Traceability, Security and Sustainability as well as transforming/translating the potential findings into a universal format for small to medium-enterprises."*

LWMs supply chain is constructed in a traditional manner, and the organization has approached Spark! Living Lab to conduct a feasibility study regarding the application of BCT in their supply chain. However, the purpose of this research is also to make SME's use the potential solutions as their foundation.

Through observation of activities, interviews with manager, employees, document and literature research, the current situation could be mapped. After the description, the signalled bottlenecks were formulated, with consolation from the management, based on a future perspective. These bottlenecks are *Manual temperature processing, lack of temperature checks, energy cost dispersion and process inefficiencies.* From there, the potential risks were established and visualized through a risk assessment chart.

In this research, BCT was then further elaborated upon, explaining its principles, different types of blockchain, advantages, disadvantages, technicalities and relevancy. Blockchain is a technology of distributed ledger (DLT) category, which implies an accounting book where all the parties involved save their records. Regarding the different types of BCT, LWM should aspire towards a private permissioned blockchain. The technicalities of the technology would provide LWM in the current situation with many opportunities for overall improvement by using smart contracts and zero-knowledge proof.

The added value and application of BCT in the supply chain of LWM was then assessed. For steps towards implementation, a road map has been established. BCT In combination with IoT devices, such as Saas and RFID technology, can also be applied as digital solutions. The added value of BCT was focussed on the main objectives: *transparency, traceability, security and sustainability*. From there, the potential solutions were crossed against the potential risks, and a new risks assessment chart could be established, showing that the application of BCT could mitigate the potential risks.

The potential solutions discussed can be used for SME's as a foundation. Especially for SME's with similar branches such as *pharmaceutical, floristry & floriculture and Fruit & vegetable*. The similarity stems from the resemblance in cold chain activities. SME's should also assess when they should apply blockchain in the first place, which can be conducted using the blockchain decision tree.

For the implementation of BCT, an implementation plan and cost- and benefit analyses were developed. Formulated from a project management approach, the implementation plan consists of five phases: *preparation, development, analysis, implementation and evaluation.* The total duration would be three years, and the process is visualized using the Gantt chart model.

The costs for quality assurance, maintenance, consulting, designing development were calculated, totalling the blockchain project costs to be **€250.113,75**.

The application of BCT also proves to be a real benefit with these realistic factors and assumptions. The cost savings especially would make the organization more financially sustainable In the future. The return on investment would take approximately **six years**.

Table of Content

List of Figures and Tables

Glossary

Concept	Meaning
Blockchain Technology (BCT)	“The blockchain is an incorruptible digital ledger of economic transaction that can be programmed to record not just financial transactions but virtually everything of value.”
Internet of Things (IoT)	“Are all devices (Things) that are in contact with other devices or systems via internet connections and exchange data with each other.”
Software as a Service (SaaS)	“Software that is offered as an online service.”
Conditioned Good	“Products/goods put under a certain condition, E.G. temperature, the temperature of a good needs to be maintained in order to be of sufficient use.”
Radio-frequency identification (RFID)	“ Technology that makes it possible for data to be transmitted, read or altered until a certain distance.”
Zero-knowledge proof (ZKP)	“Functionality of BCT that allows a prover to convince a verifier about a specific part/fact without reveal the actual information as a whole.”
Smart Contracts	“Smart contracts are programs stored on a blockchain that run when predetermined conditions are met”
Minimal viable ecosystem (MVE)	“The least complex ecosystem that allows participants to learn more complex, future ecosystems with minimal effort.”
Encryption	“A scrambling data method so that only authorized parties can access the data contained.”
Cold chain logistics	“Is the continuous system of refrigeration in the transport of food, pharmaceuticals and chemical products from the producer, via transporters, wholesalers and shops, to the end user.”
Return on investment period (ROI)	“A metric to measure, per period, rates the return of invested capital in order to decide whether to undertake the investment.”
Time stamps	“Digital recording of the time occurring during a particular event.”

1. Introduction Spark! Living Lab

In this chapter, information will be given regarding the backgrounds of the companies involved in the project, the problem analyses of the research, the research question and sub-questions, the research scope accompanied with research unit and data-gathering method, the theoretical framework and the deliverables.

1.1. Educational Framework

the description of the educational framework. This clarifies the organisations and important stakeholders that are involved in the project.

1.1.1. Spark! Living Lab

Spark! Living lab is a co-creation of business, research and education that works on applications or projects that provide more sustainable and circular supply chains through blockchain technology (BTC) and the Internet of Things (IoT). One of the key aspects of Spark! Living lab is that the organisation is a non-profit organisation. This means Spark will not have the intention to create something and sell it at the highest possible price. Instead, they focus on improving the world and, in most cases, the Supply Chain. The products that will or have been developed at Spark! will be available for the public through an open-source system. In this way, everybody who thinks this technology can help them, can use the products to make their company/organisation better, faster, more efficient or more sustainable without any charge from Spark! Living lab.

1.1.2. Rotterdam University of Applied sciences

The Rotterdam University of Applied sciences works with other institutes for expanding its network opportunities and knowledgeable welfare. Students participating in various majors will take part in internship programs or assignments which is often made possible due to the university cooperating with other institutes.

1.1.3. Windesheim University of Applied sciences

The Windesheim University of Applied sciences works narrowly with specialists from Spark! Living Lab. Cases from Spark! are most of the time conducted by students of the Windesheim University. Also, the University provides a lot of network related opportunities for Spark! Living Lab to use. During this project, Windesheim University will provide Spark! Living Lab with three students who follow the minor Industrial engineering. These students will also work narrowly with this project with the goal in mind of mutual benefit.

1.1.4. Lamb Weston-Meijer

Lamb Weston is a world leading brand in high quality potato products and is sold in over 100 countries around the world. Lamb Weston is the local company of a US group. Lamb Weston has six factories in Europe, Middle East & Africa (EMEA). Four of these factories are located in the Netherlands, the other two in Austria and the United Kingdom.

Lamb Weston therefore produces high quality potatoes for various purposes. The main branch is French fries. The potatoes are processed at Lamb Weston into a final product which is then frozen to minus 80 degrees Celsius. The frozen products are then transported to the customers. These customers are mainly active in the catering industry (Lambweston.eu, 2018).

1.1.5. Lineage Logistics

Lineage Logistics is an international warehousing and logistics company owned by Bay Grove, LLC. As the world's largest refrigerated warehousing company it has around 200 facilities in North America, Europe, and Asia (Lineage-Logistics, 2020) .

1.1.6. Daily Logistics Group – DLG

Visbeen and Post-Kogeko merged into Daily Logistics Group (DLG). With this merger DLG strengthens their market position in multimodal refrigerated transport throughout Europe. The companies forming DLG want to continue developing sustainable solutions for multimodal transport of fresh, chilled and frozen food products (DLG-Logistics.com, 2021).

1.2. Background

Spark! Living Lab has researched the application of BCT in the Supply-Chain for Conditioned Goods. There has been a lot of research conducted for the application of BCT in the Supply-Chain but not specifically for Conditioned Goods. However, using the gathered information regarding the application of BCT in the Supply-Chain, Spark! Living Lab wants to conduct a feasibility study for the Conditioned Goods.

The term Conditioned Goods regards products/goods put under a certain condition, E.G. temperature, the temperature of a good needs to be maintained in order to be of sufficient use. Lamb Weston-Meijer, a world leading brand in high quality potato products, needs to process their fries to a temperature of minus 18 degrees Celsius.

In a Conditioned Goods based Supply-Chain there are a lot of additional factors that need to be considered. If the condition of the goods are not maintained it can affect the quality of the goods. For instants, in the agriculture sector quality plays a huge. Therefore, agriculture organisations want to prevent alterations to their conditioned goods in every part of their Supply-Chain to safeguard the quality of the good.

The application of BCT in a Conditioned Goods based Supply-Chain can potentially improve the whole chain. In the agriculture sector it can help achieve these existing objectives even better, these objectives are: Traceability, Transparency, Security and Sustainability.

Traceability	Transparency	Security	Sustainability
Traceability is 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.	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.	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	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

Table 1. Blockchain Objectives

Spark! Living Lab wants to conduct a feasibility on the application of BCT. This project focusses on the applicability of BTC in the Conditioned Goods based Supply-Chain in correlation with the above-mentioned objectives. However, the purpose of this research is also to make small to medium-sized enterprises (SME's) use this feasibility study as their basic foundation for developing their own method of BCT application in a Conditioned Good based Supply-Chain (Windesheim, 2020) .

1.3. Problem analyses

The conditioned supply-chain (in this context a cold chain) is constructed in a traditional manner. This means that there is a lack of digitalisation concerning the information flow (how data is administrated, managed and distributed) which can pose problems for companies. Organisations and their partners nowadays need to be more transparent with each other than ever before. The transparency can create more trust in the origin of the goods, delivery/lead times and can prevent potential disputes. For this kind of transparency to occur, trust between partners needs to be established, which can be achieved with applying BCT.

Lamb Weston-Meijer approached Spark! Living Lab with a use case regarding their own supply-chain. The problem Lamb Weston-Meijer is facing concerns the possible increase of temperature regarding their frozen French fries that are transported from their production site in Oosterbierum until the cold storage in Bergen op Zoom. The company works with the partners Lineage Logistics and Daily Logistics Group (DLG). Lineage Logistics accepts, stores and distributes the goods that are transported from the production site of Lamb Weston-Meijer by the Logistics Service Provider DLG.

Lamb Weston-Meijer produce their French fries at 170 degrees Celsius and then cool them down at around minus 7 or 8 degrees Celsius. Then the fries are transported to the cold store. It will stay in the cold store for a couple of days in order to get cold enough for delivery towards final customers.

In order to deliver/start delivery the product has to be minus 18 degrees Celsius. The problem occurs when the product arrives at the cold storage warmer than the agreed temperature, which causes the following:

- it will require more energy to get the product colder;
- The product will decrease in quality because it doesn’t have the required temperature;
- It will require more time to get the product colder, which postpones the start of delivery to the customer.

As a result, all of the above mentioned consequences could create dispute between the partners.

For all the companies involved, it is unknown when, whether and where the temperature of the French Fries increases. Lamb Weston-Meijer wants to know how the application of BCT can be of any use for this situation.

For Spark! Living Lab the foundation of use for BCT are there, solely because of the main principle being the “the lack of trust between partners”. BCT can anticipate on the lack of trust by offering:

- Transparency, regarding the origin of the good and its current condition (temperature);
- Traceability, BCT can make real-time track and trace possible;
- Sustainability, in the sense of availability of the data for everyone in the chain for which then companies can anticipate upon and improve certain aspects;
- Security, it is impossible to manipulate the data once it in the chain.

Spark! Living Lab also wants to generalise its potential findings in this research, so that other companies can use that as their basic foundation.

In the appendix the 6W-analyses (mangelaars, 2019) has been conducted for the whole description of the problem analyses (Appendix II).

1.4. Stakeholders

This paragraph concerns the stakeholders, these stakeholders want to work collectively towards a fitting solution regarding the current problem that exists in their Supply-Chain. These stakeholders are *Spark! Living Lab, Windesheim University, Lamb Weston-Meijer, Lineage Logistics and Daily Logistics Group.* The stakeholders are also directly involved in this research. In appendices III and IV the project organisation and the secondary stakeholders can be found. In the underlaying image a visual representation of these stakeholders is made.

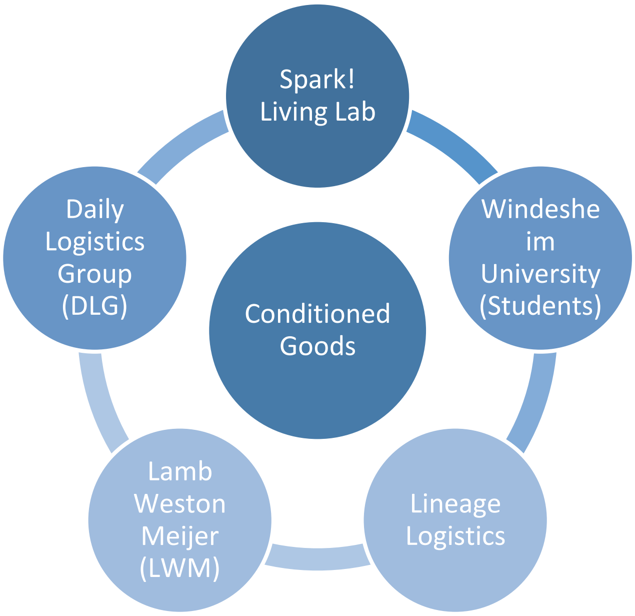

Figure 1. Stakeholders Visual

To further elaborate upon the stakeholders in the conditioned goods use-case each stakeholder will be briefly highlighted regarding their role, problem and desire in this research.

Spark! Living Lab: Spark! Living Lab role in this research is investigating the use-case provided by LWM and its partners to come up with a fitting solution for their existing problem. LWM and its partners desire towards a solution concerning BCT application in their supply-chain and tasked Spark! Living Lab to conduct a feasibility study. Spark! Living Lab also wants to generalise the potential findings by conducting this research.

Windesheim University (Students): The students of the Windesheim participate in this use-case by investigating LWM, their project is guided by Spark! Living Lab and the university itself. The potential findings they make can be applied in this Report as well.

Lamb Weston-Meijer: LWM provides the use case for Spark! Living Lab and Windesheim University. At the moment they have a problem in their Supply-Chain, starting from the production site until the storage. They share the existing problem with their partners DLG and Lineage Logistics. They are indulged in a BCT related solution and tasked Spark! and Windesheim to conduct a feasibility study.

Daily Logistics Group: DLG is a Logistics Service provider(LSP) and direct partner of LWM. To prevent potential dispute in the future and create sustainability as well they want to cooperate in this research.

Lineage Logistics: The storage and distribution partner of LWM. Their reasoning is similar to DLG with certain additions such as reducing costs and increasing effectivity.

1.5. The Research Question

The central question forms the foundation for the research that is carried out for Spark! Living Lab. In Appendix II the central question is further elaborated upon using the SMART-method. Based on the problem analysis, the following central question can be formulated:

"How can the application of Blockchain Technology improve the cold-chain of Lamb Weston-Meijer in terms of Transparency, Traceability, Security and Sustainability as well as transforming/translating the potential findings into a universal format for small to medium-enterprises."

1.5.1. Research Goal

The research goal consists of an internal research goal and external research goal. The internal goal implies what the investigator wants to achieve with the research report. the external goal regards what the client wants to achieve with the research report. The internal and external goals are made using the SMART-method.

Internal goal

The internal goal is to provide both parties, Spark! Living Lab and LWM, with a suitable research report questioning the two main important aspects of the use-case, being the BCT applicability in the chain of LWM and The generalisation of BCT-related solutions in the cold-chain for Spark! Living Lab with the goal in mind of creating mutual benefit, while conducting this research within a period of twenty weeks.

External goal

The external goal is to provide the companies involved in the existing use-case a report that will help them in the process of creating Transparency, Traceability, Security and Sustainability in their supply-chain as well as in other chains by generalising the findings made during the research period of twenty weeks.

1.5.2. Sub-questions

The following sub-questions are established to answer the research question as concrete as possible.

- What is the current situation and process of Lamb Weston-Meijer?
- What bottlenecks are Lamb Weston-Meijer facing in the current situation?
- What is Blockchain technology and to what extend can it have an impact/serve as solution to the existing problems?
- To what extend can Blockchain Technology be applied to the processes of Lamb Weston-Meijer, creating transparency, traceability, sustainability and security?
- How can the current potential proposals be generalised so that Small- to Medium sized Enterprises can use these findings as for their cold-storage cooperation?

1.6. Research Scope

To execute the research effectively within a period of twenty weeks, the investigation scale needs to be demarcated to a more realistic scope. Lamb Weston-Meijer (LWM) want to explore the opportunities of BCT across multiple modalities and locations. However, in this research the focus in the supply-chain of the company will be on the process from the production site (of Lamb Weston-Meijer) until the cold storage in Bergen op Zoom using trucks.

The emphasis will be on the Condition and Track and Tracing of the goods (in relation to the four main objectives, being transparency, security, traceability and sustainability).

Furthermore, the solutions will not be brought into full depth but generalised so that especially Small- to Medium sized Enterprises can apply the potential findings for their own use.

1.6.1. Research units

The parties involved in this research are Spark! Living Lab, Lamb Weston-Meijer, Lineage Logistics and Daily Logistics Group. The research is limited to the conditioned products leaving the production site until stored in the cold storage.

1.6.2. Research data-gathering methods

The research is qualitative and quantitative based. During the research phase there will be two main methods of data-gathering applied, these methods being the field research and desk research. Field research implies observations and conducting interviews and desk research implies gathering information from online sources and literature. The following methods of data-gathering will be executed during this research:

- Document research;
- Conducting interviews;
- Brainstorming sessions;
- Literature research;
- Usage of relevant files;
- Observation of processes.

In the conceptual model each phase of the handling cycle is accompanied with the above-mentioned data-gathering methods. Also, these methods will be discussed in the theoretical framework as well.

1.7. Theoretical framework

The theoretical framework presents the concepts, models, theories and ideas that relate to the research. It explains what the models entail and why they are relevant to the research. In this research the theoretical framework consist of research/supply-chain tools and a conceptual model.

1.7.1. Theoretical Framework – Research Tools

Handling cycle

The structure of the Report will be based of the handling cycle of Jan Leen and Jef Mertens (Mertens, 2021). The handling cycle consists of five steps for a clear research structure, these five steps are Problem identification, Diagnostic, Design, Transition and Evaluation. These steps will also be linked with the research activities in paragraph 2.1.

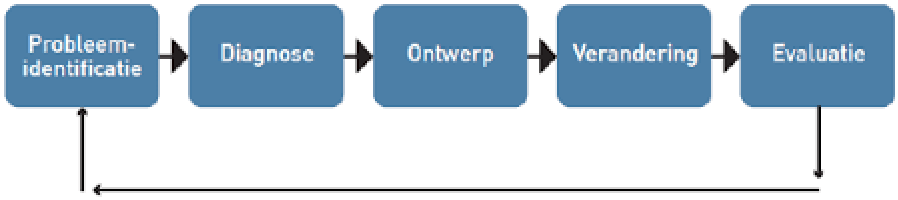

Figure 2. Handling cycle

- **Problem Identification:** in this phase the problem needs to be identified and the process analysed to concluded where the bottlenecks are;
- **Diagnostic:** in this phase the seriousness of the problem and its causes will be identified;
- **Design:** in this phase potential proposals will be suggested, defined and discussed;
- **Transition:** In this phase the proposals are worked out and generalised;
- **Evaluation:** in this phase the proposals get evaluated in search of small improvements.

Integral Logistics Framework

The integral logistics Framework is a model that will be used to map the current situation. It describes how the money, goods and information flow are matched. The model is mostly used when there is dissatisfaction with the internal performance within a company (Goor & Visser, 2016)

The Integral Logistics Framework Consist of Strategy, Logistical targets, Basic form, Operating system, Information system, Personal organisation and Logistic performance indicator.

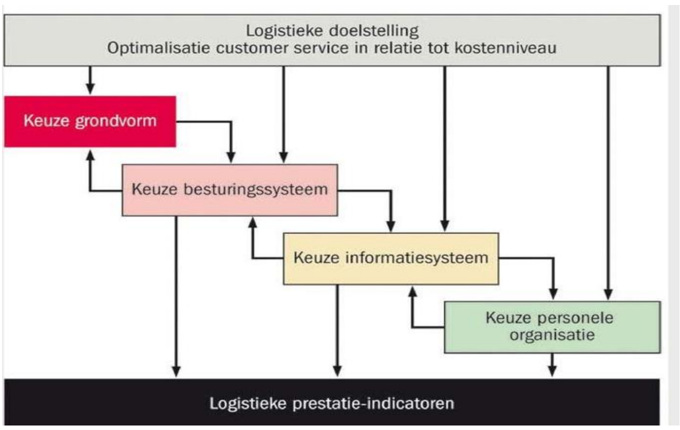

Figure 3. Integral Logistic Framework

1.7.2. Theoretical Framework – Research Content

Blockchain Technology (BCT)

Blockchain is a technology of distributed ledger (DLT) category, which implies an accounting book where all the parties involved save their records. BCT became widely known due to digital currency Bitcoin which allows for payment transactions via an open network with safeguarding the users anonymity.

BCT is considered to be one of the safest technologies to exist nowadays. It is almost impossible to hack which makes it very interesting for applications like storage of financial transactions or sensitive data. The high safety is made possible by making each record time-stamped and linked to the previous one. Each block has a kind of code assigned to it, called a cryptographic hash. If a party attempts to change a record, the hash code changes, a verification process (proof of work) starts and all the participants will become aware of this alteration. That makes the possibility to change the records very difficult. The data can only be updated if all the parties agreed on it and the entered records cannot be erased (Mearian, 2019). One of the particular features is that the information is kept on multiple servers, which makes it decentralised, so no party has a complete control over it. This gives the technology an interesting potential for many companies to integrate their data (DataFlair, 2020). Even though the technology seems very promising, it also has some challenges, for example:

- Transparency versus privacy, the choice whether sharing data is better than confidentiality of it.
- Exception management. The companies usually have exceptions from general rules which also need to be incorporated in the software (Mearian, 2019).

Properties of BCT in the Supply-Chain

Blockchain can help guarantee that a product is genuine, allowing consumers and partners to see all information regarding the transport, how and when a product left from the production sight, up until at arrived at the end point in the storage facility. Furthermore, there are a few properties of blockchain that can be of use in the Supply-Chain:

Properties	Added Value
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 (ModexTech, 2021);
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 (ModexTech, 2021);
Network Distribution	Blockchain is actually a network of computers where each is storing applications, immutable data and product functionalities. Distribution adds a new layer of utility and value to enterprise software products because it guarantees availability and fast access to the system (ModexTech, 2021);
Decentralisation	The decentralisation mechanism allows a blockchain based infrastructure to have no single point of failure, no centralised server, while mostly everything is hosted and maintained by all parties involved in the business flow. In this case, decentralisation means increased security & transparency (ModexTech, 2021).

Table 2. Properties added value

These properties will have an influence on the supply-chain. In regards to this research the added value will have an impact in the terms of the research objectives (Transparency, Traceability, Security and Sustainability. Therefore, the added values these objectives will be discussed in the following table:

Objectives	Added Value
Transparency	In terms of transparency Blockchain and its properties will create more visibility in the chain. For the companies involved (LWM, Lineage and DLG) BCT will provide adequate visibility in terms of handlings made in the existing processes and real-time measurements (Windesheim, 2020);
Traceability	The real-time measurements makes it possible for companies to track and trace products in the supply-chain and in case of an error the origin of the problem can be traced back, preventing a possible dispute (Windesheim, 2020);
Security	Blockchain makes it impossible for information that has been placed in the chain to be manipulated, preventing corrupting and creating trust between stakeholders. Security in itself is a property of BCT. Nevertheless, it is also an important topic when it comes to supply-chain (Windesheim, 2020);
Sustainability	BCT is a new distributed ledger based technology which creates more sustainability for companies who make use of this technology. BCT is also part of the 4th industrial wave and in order for organisations to remain sustainable they will have to follow these new trends of technology (Windesheim, 2020).

Table 3. Added value of BCT to the Supply-chain objectives

1.7.3. Theoretical framework – Conceptual model

The conceptual model shows the form of the current use-case that has been provided by Spark! Living Lab and Lamb Weston-Meijer. The three key factors mentioned in the underlaying illustration play an important role in the shape of the Conditioned Goods use-case. The three main factors are highlighted in funnel-based illustration.

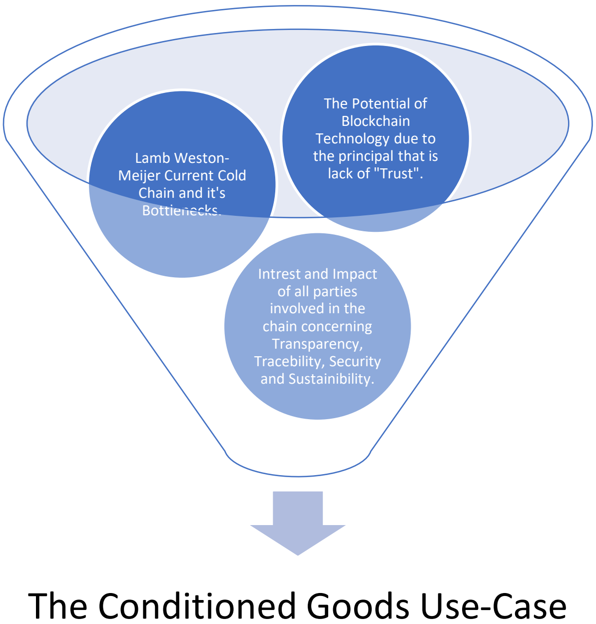

Figure 4. Visual Conceptual Model

1.8. Research activities

In this paragraph research activities will be discussed. The report will be structured using the handling cycles as the basic foundation. Per phase there discussed what activities will be performed. The research activities are also accompanied with a project time-schedule, which shows the steps that will be taken during this research. The schedule can be found in Appendix I.

1.8.1. Research activities per cycle (handling)

Problem identification Phase

At the beginning of this period, the organisation will be introduced as well as the field of activity. Oriented related interviews will take place to understand the organisation and its processes. All the different aspects of the assignment are discussed, and the requirements of those involved are drawn up by means of a plan of action.

This is part of an orientation report in which the problems are identified, and the research is defined. Subsequently, in the following weeks, the processes are gone through by observing them, which means that there will be a visit to LWM and Lineage Logistics, the production site and storage facility, respectively. The whole process from start to finish will be monitored to understand the current situation of the research.

There is also an in-depth look at the available research documents and the appropriate literature. The literature and documents mainly consist of methodology articles concerning the practicality of BCT application in the supply chain provided by Windesheim University and Spark! Living Lab.

Diagnostic Phase

In this phase, research has been conducted for the causes of the bottlenecks. This is done based on the models described in the theoretical framework. The results will be discussed with the respondents involved in the use-case, shown in the underlying table;

Name	Company	Function/Role
Maxime Bouillon	Spark! Living Lab	Co-leader Conditioned Goods use-case
Andrea d'Auria	TNO innovation	Blockchain Engineer
Jos Gommers	Lamb Weston-Meijer	Strategic Supply-Chain
Mathijs Tomeij	Lamb Weston-Meijer	Innovation Specialist
Martijn Timmermans	Lineage Logistics	Logistics Improvement Manager
Diana van Zielst	Daily Group Logistics	Manager Business Process and Communication
Luca Gelsomino	Windesheim University	Supply-Chain Finance/ Senior Researcher
Victor van der Hulst	Windesheim University	Co-leader Conditioned Goods use-case

Table 4. Respondents involved in use-case

All of the respondents mentioned above are involved in the use-case and greatly influence the supply chain's current processes. The most effective way to research the bottlenecks is to understand their perspective on this matter. Twice a month, all of the respondents (including the researcher) will come together to discuss the current results and issues.

Design Phase

In this phase, the results of the diagnostic step have been used to suggest potential solutions in relation to BCT. By means of brainstorming with respondents from Spark! Living Lab and the Windesheim University, whom via networking, will provide opportunities with experts to brainstorm about design concepts regarding the potential proposals (or even establish them). By means of desk research and field research and by means of conducting interviews with stakeholders (with the mentioned respondents in the diagnostic phase) from which concrete improvement proposals will ultimately emerge out of this phase.

Transition Phase

In this phase, how the proposed improvements can be successfully implemented has been researched. Tactical use of the proposals and cost- and benefit analyses has been developed for this phase.

Evaluation Phase

This phase describes how the implemented solutions will not fade in the company. Also, the potential implemented proposals has been evaluated and generalised so that other companies can use this thesis as an essential foundation for their own implementation of BCT.

1.8.2. Conceptual Design Research Activities

The underlaying table represents the different correlations between the five phases of the handling cycle, that's structures the report, and the corresponding Sub-questions, Models, Data gathering methods and respondents.

Research Activities	Problem Identification	Diagnostic Phase	Design Phase	Transition Phase	Evaluation Phase
Sub Question	What is the current situation and process of Lamb Weston-Meijer?	What bottlenecks are Lamb Weston-Meijer facing in the current situation?	What is Blockchain technology and to what extend can it have an impact/serve as solution to the existing problems?	To what extend can Blockchain Technology be applied to the processes of Lamb Weston-Meijer, creating transparency, traceability, sustainability and security?	How can the current potential proposals be generalised so that Small- to Medium sized Enterprises can use these findings for their cold-storage cooperation?
Models	Integral Logistic Framework	Ishikwa Diagram, Scatter Plot Diagrams	Architecture lay-out	Implementation plan, Cost- And Benefit analyses	
Data Gathering Method	Observation, Literature research and Interviews	Literature Research and Surveys	Interviews, Literature research and Brainstorming	Literature research and Brainstorming	
Respondents	LWM, Lineage Logistics, DLG, Spark! Living Lab	LWM, Lineage Logistics, DLG, Spark! Living Lab, TNO	LWM, Spark! Living Lab, Windesheim University	LWM, Spark! Living Lab, Windesheim University	Spark! Living Lab, Windesheim University

Table 5. Conceptual design research activities

1.8.3. Project Time-Schedule Planning

A time Schedule has been drawn up on the basis of the research activities. It shows per phase of the handling-cycle what the steps of the investigation are and which task will be carried out in which week. A date is also indicated above the week in which the relevant phase ends. Furthermore, the time schedule is planned with buffers in mind because projects always can take up more time than originally planned. The time-schedule was made in Microsoft Projects and can be found in the appendix (Appendix I).

2. Current Situation

In this chapter, Lamb Weston-Meijer (LWM) 's current processes will be shown, regarding the first sub-question, "What is the current situation and process of Lamb Weston-Meijer?"

The current process will be shown using the integral logistic framework. Furthermore, a visual representation will be conducted regarding the demarcated supply chain. The second sub-question will also be discussed regarding "What bottleneck are Lamb Weston-Meijer facing in the current situation?" These bottlenecks will be identified using the Theory of Constraints (TOC) model. Lineage Logistics and DLG will also be processed in the current situation connected to the defined supply chain for the conditioned goods.

The data from which the current situation processes are mapped stems from interviews with Logistics-, innovation, and supply-chain managers, observations of current processes such as production-, transportation-, storage and provided documents.

2.1. Integral Logistic Framework

The integral logistic framework (Goor & Visser, 2016) consists of Strategy, Logistical targets, Basic form, Operating system, Information system, Personal organisation and Logistic performance indicator. Chapter "1.7.1." elaborates on the usages of the integral logistic framework. In this research, the integral logistic framework will be restricted to strategy and basic form.

2.1.1. Strategy

LWM is as a global player in the potato process industry. Their mission is "*to serve and inspire customers and consumers with inventive potato products and solutions they love.*" Their vision regards "*to create shared value in all aspects, with sustainability as a prerequisite, creating long-term shared value.*" The organisation believes that a positive impact is necessary for its shareholders, customers, growers, society and employees (Lambweston.eu, 2019).

With LWM core aim targeted at shared value and sustainability, the organisation manages a differentiation strategy based on the theory of van Visser & van Goor (Goor & Visser, 2016). The differentiation strategy implies that the organisation focuses on the differentiation of service so that the company can clearly distinguish itself from its competitors in the market.

2.1.2. Basic form

The basic form will highlight the demarcated supply chain where the focus will lay on during this research. The whole process begins at pre-frying and stops when the pallets are stored at the cold storage. There are three parties involved in the whole process, LWM, Lineage Logistics and DLG. The processes are shown through a flowchart. The flowchart is based on information from interviews and the observations made during the visits at LWM and Lineage Logistics.

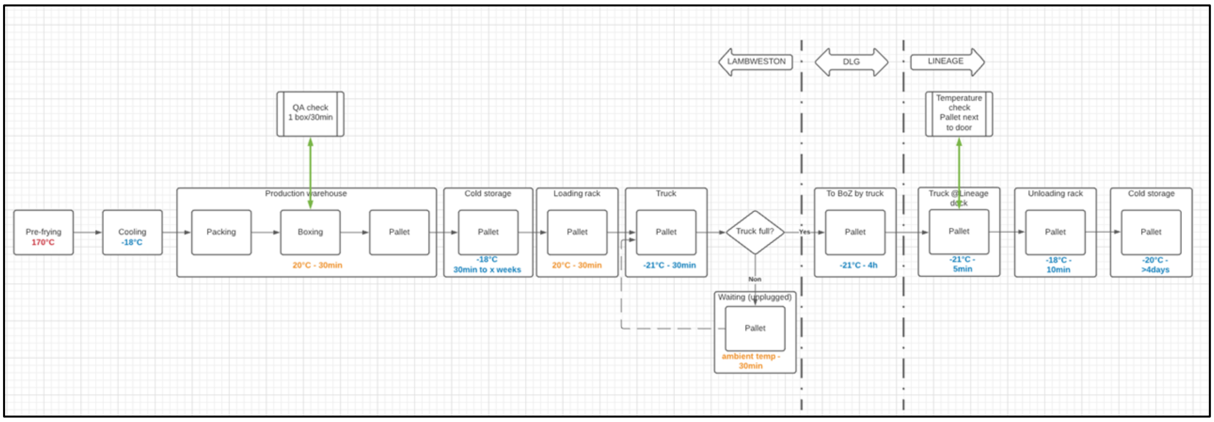

Figure 5. Flowchart LWM, Lineage and DLG

Process	Description	Area Avg. °C	Min. Time
Pre-frying	The whole process starts with pre-frying the fries at a temperature of 170 degrees Celsius. LWM in Oosterbierum produces on average 15 ton of fries per days which is equivalent to 15-20 pallets a day of fries. The pre-frying implies that before the end-customer can bake the fries themselves, the fries will already have been cooked. During pre-frying, potatoes are blanched in hot water and then fried in a certain oil. After pre-frying, the fries are cooled down to a temperature of minus 18 degrees Celsius and sent to production.	20 °C	10 min
Production	During production the fries are packed and wrapped in plastic bags and then placed in boxes. Every 10 minutes, a random box is checked for its current temperature, which fluctuates between minus 6 and 8 degrees Celsius. The temperature will then be manually processed in the QA-entry system. The QA-entry system is the software management system of LWM. After the fries are put into boxes, they will be placed on a pallet, totalling an amount of 24 boxes per pallet. The pallets are then wrapped with foil so that the boxes won't fall off during transportation, and then a label is placed on the side of the pallet. After that, the pallet will be sent to storage.	20 °C	30 min
Storage	After the pallets are wrapped and labelled, they will be sent to storage via treadmill. The storage is a separate room where the pallets are stored and cooled down again. The reason why the fries are stored instead of forwarded immediately is because: • The fries became warmer during the production process. • The fries are stored for transportation which can vary from 30 minutes until weeks. • The fries are then pre-compromised in temperature as they will be put in room temperature during the loading process The cold storage has a temperature of minus 18 degrees Celsius and a capacity of 3000 tons which is equivalent to 4000 pallets. The pallets are sent via treadmills towards a single machine that is responsible for inbound and outbound processes of the storage racks. The whole storage process is automated.	-18 °C	30 min
Loading	LWM gets a hour beforehand notice that a DLG truck is underway. During that hour pallets from the storage are forwarded to the loading treadmill that connects the storage to the back end of the LZV-truck. The loading treadmill is located just outside of the production warehouse and the storage. The treadmill is filled per pallet, one by one, after it reaches a certain amount it will be loaded into the LZV-truck. The LZV-truck is loaded twice, first the trailer of the LZV is loaded which has a capacity of 30 pallets and then the truck itself is loaded which has a capacity of 18 pallets, totalling an amount of 48 pallets. The loading treadmill is accompanied with sensors that tells the treadmill when the specific amount of 18 or 30 has been reached. The temperature of the space where the treadmills are located is around 20 degrees Celsius. The whole loading process takes approximately 30 minutes. During this process no temperature checks are conducted and the bill of loading is printed out.	20 °C	30 min

Transportation	LWM outsources all activities regarding transportation to DLG. There are four LZV-trucks in total and every trucks goes from Oosterbierum to Bergen op Zoom and back twice a day, totalling 8 trips back and forth. The LZV-trucks are capable of maintaining the cooled down temperature of the pallets by providing as an isolated space during transportation. The LZV-truck can generate a temperature of minus 25 degrees Celsius, which is also the minimum it needs to be for transportation. The LZV-trucks are equipped which generators which keeps the pallets cooled. The generators are first filled with energy by an energy sources at LWM and then the generators are self-powered by the truck's engine	-21 °C	4 hours
Docking	Once the LZV's arrive at Lineage they will have put beforehand a thermometer on the last placed pallet in the truck. The thermometer is placed between two boxes and from there the temperature is measured. The temperature is then written down on a spreadsheet before it is manually typed in the software management system of Lineage. After the temperature is measured the driver will dock the truck and attach a cable to the rear.	-21 °C	5 min
Unloading	The attached cable makes it possible for the ankers to flip down and form a treadmill bridge from truck to the expedition area. The treadmill moves automatically making the unloading process fully automated, the truck driver only has to push a button in order to make the treadmills move. After the button is pushed all pallets from the trailer will move through various checkpoints in the expedition area. these checkpoints determine if the pallets are in good condition, are at the right hight for storage and etc. If all the right conditions are met the pallet will be assigned a label which contents the pallet number, location of storage, when its due to outbound and longevity of storage.	-18 °C	10 min
Cold Storage	After the pallets receive a label they will be allocated to a robot that will lift the pallet up and inbound it for storage. In each hall there are multiple robots that are capable of inbound and outbound. Every hall has good isolation as well, when there is a temperature drop the sensors will take notice and signal the conditioners to cool down the hall. When the pallets are cooled down enough, transport to the end-customers can take place. Pallets will stay for approximately 3 or 4 days. The temperature of the cold storage area is minus 20 degrees Celsius (average of the three halls LWM occupies).	-20 °C	4 days

Table 6. Process description and measurements

2.2. Bottlenecks

LWM produces the fries at their own production facility in Oosterbierum, outsources its logistics-related activities to DLG, which in turn delivers the products to Lineage Logistics cold storage in Bergen op Zoom. LWM, Lineage and DLG all play an important role in the sustainability of the products' quality. Maintaining a high quality requires good collaboration and trust. Therefore, it is necessary to highlight bottlenecks that could possibly derange these requirements.

2.2.1. Signalled Bottlenecks

By mapping the whole process from start to end, bottlenecks can be signalled. A bottleneck is a point of congestion in the supply chain which causes inefficiencies. In the context of this research, the congestions are related to potential disruption in the quality of the products by the sudden increment of temperature or indirect causes thereof. These bottlenecks will be discussed in the table below:

Bottlenecks	Description
Manual temperature processing	Currently, temperatures are measured using a thermometer. From there, the temperature is read from the thermometer. The temperature will then be processed manually on paper and then in the system. The lack of automation provides opportunities for alteration in the measured temperature of the product.
Temperature checks	There are only two checks for temperature during the whole process. The first check is during boxing in production at LWM, the second check is during unloading at Lineage. The lack of frequent checks brings scarcity in the products' certainty of being at the right temperature during the whole process. If the fries unfreeze even once during the entire process, their quality can be significantly affected.
	Furthermore, besides the lack of temperature checks, there is also a concern regarding the lack of checkpoints in the entire process. The current two checkpoints are deemed insufficient to provide meaningful information of where the increase in temperature occurred in order to prevent a potential dispute between the stakeholders.
Energy cost dispersion	Cooling down products requires energy which can be directly translated to costs. There is an unofficial temperature conditioned agreement meaning that products need to arrive at the cold storage at around minus -8 degrees Celsius. LWM has the tendencies to produce their products a bit warmer than agreed, saving them money but at the same time costing Lineage Logistics because it will require more energy to cool them down again, and in some scenarios, the pallets full of fries will be sent back.
Process inefficiencies	In the current situation, there exist multiple efficiency-related bottlenecks that can be improved. The most significant inefficiencies occur during the production of the fries. These process related inefficiencies are: Time congestion: meaning that some activities unnecessarily take too long. For example, loading takes 30 min.
	Lack of machine occupation: the machines at LWM aren't continuously working, meaning that they aren't always supplied with tasks. Currently, In the storage area, the machine there is only responsible for inbound and outbound of the pallets meaning that afterwards, it remains inactive.
	Monitoring placement: currently, checks are conducted at the beginning of the production. However, during the whole process, the fries are getting cooled down further and get affected ambient temperature (during loading). Having the checks placed at the beginning of the production cycle is an inefficient method to sustain the promise that the quality of the product has not been affected.

Table 7. Signalled bottlenecks and description

2.3. Risk Management

According to the strategy of LWM, the organisation aims towards shared value and sustainability (paragraph 2.1.1), which means that the bottlenecks described could in the future potentially form a hindrance towards their goals. Nevertheless, before any precautions are taken to either eliminate these bottlenecks, the severity of them need to be understood. Therefore, risk management will take part in this research to understand the severity of each bottleneck, its risks and what possible consequences could arise in the future.

2.3.1. Risk assessment

To understand the severity of each bottleneck, a risk matrix will be established. The risk matrix consists of impact (which is related to overall costs) and probability (which is related to potential dispute). However, before elaborating on the severity of each bottleneck, the risks that are paired with them will be formulated in the table below:

Bottleneck	Risk	Reasoning
Manual temperature processing	(R1) Non-confidential processing	The lack of automation provides opportunities for alteration in the measured temperature of the product.
	(R2) The necessity of quality checks	Because the temperature is processed manually, there will be a need for quality checks regarding the adequacy of current measurement methods.
	(R3) Higher error rate	Despite a low probability, there will always be a chance of human error in comparison with an automated process.
Lack of Temperature checks	(R4) Lack of frequent checks	The lack of frequent/continuous checks regarding the temperature of the goods could potentially result in non-factual control of the total conditioned products.
	(R5) Lack of checkpoints	The lack of checkpoints dismisses the opportunity for transparency during the whole process because when the temperature of the product drops, the origin cannot be traced back.
Energy cost dispersion	(R6) Unfair additional energy costs	Failing to meet the agreements regarding the delivery of the goods at a specific temperature creates additional costs for all the parties involved, which can potentially create dispute.
Process inefficiencies	(R7) Lack of occupation machines	The machines used during production aren't used in an efficient manner, resulting in a lot of inactive that, when accumulated, creates a lot of unnecessary expenses.
	(R8) Inaccurate measuring	Where the temperature is measured also plays an important part. Measuring only at the beginning and at the end doesn't show the condition of the product in between.
	(R9) Inefficient process overlap	If processes do not overlap efficiently, there will be a moment of downtime, meaning that the condition of the goods can be affected by surroundings such as ambient temperature.

Table 8. Bottleneck risks and reasoning

2.3.2. Risk assessment chart

In the risk assessment chart, each potential risk that has been formulated in the previous paragraph will be allocated to a risk factor representing the risk, graded with the severity of impact and probability. The grading is based on interviews and meetings with LWM, Lineage and DLG. The table of the risk assessment chart is shown below:

Risk description	Risk factor	Impact (on cost)	Probability (of dispute)
Non-confidential processing	R1	3 (High)	2 (Medium)
The necessity of quality checks	R2	2 (Medium)	1 (Low)
Higher error rate	R3	2 (Medium)	1 (Low)
Lack of frequent checks	R4	2 (Medium)	3 (High)
Lack of checkpoints	R5	3 (High)	3 (High)
Unfair additional energy costs	R6	3 (High)	3 (High)
Lack of occupation machines	R7	1 (Low)	1 (Low)
Inaccurate measuring	R8	1 (Low)	3 (High)
Inefficient process overlap	R9	2 (Medium)	2 (Medium)

Table 9. Risk assessment table

The combination of the impact and probability of a risk places the risks factors in separate categories. Therefore, the visualisation of the risk assessment chart can be seen in the image below, illustrating the risks factors in different sections:

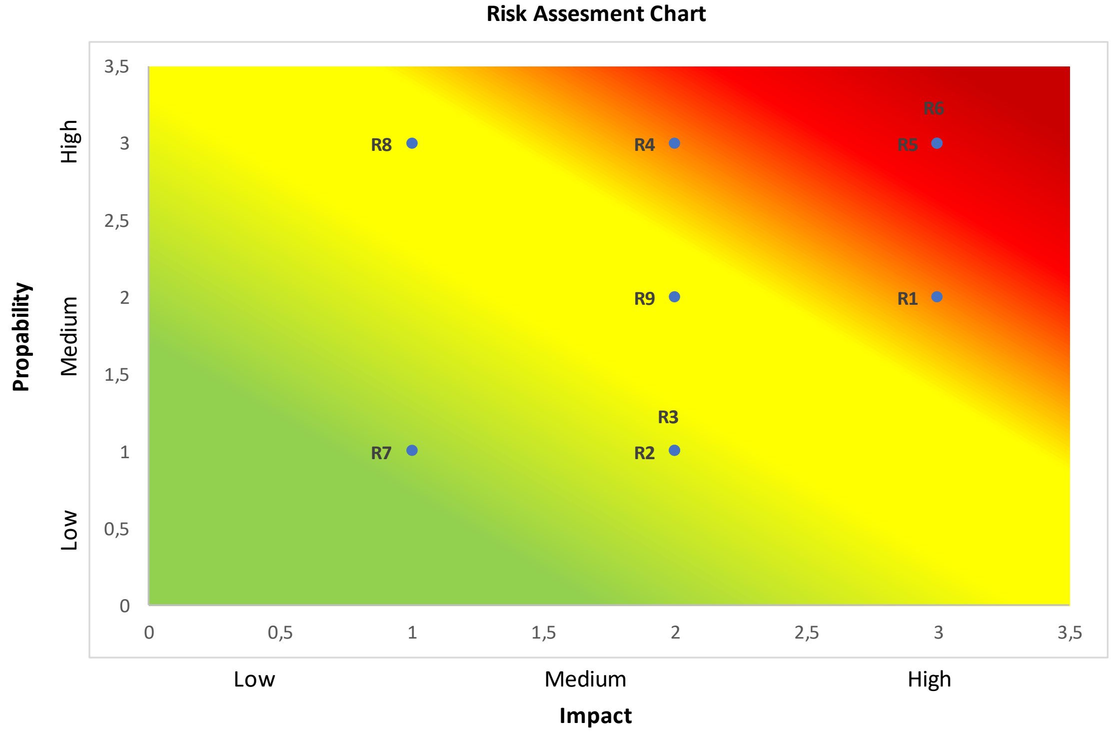

Figure 6. Risk assessment chart visual

Regarding the risk assessment chart visual, the sections are divided into High Risk (Red section), Medium Risk (Yellow section) and Low risk (Green section). High risk consists of the following risk factors: ***R1, R4, R5 and R6***. Medium risks consist of ***R8 and R9,*** and Low risks are ***R2, R3 and R7***.

2.4. Conclusion

Having established the current situation of LWM by outlining its basic form, using the integral logistics concept as a framework. It can be concluded that the current situation does not have many bottlenecks, and therefore there are not many risks at the moment. This is because there exist only a few points during the whole chain where impairment of the quality of the product could potentially occur, those points being production and loading due to the fluctuation in temperature, which could affect the quality of the product. However, by means of testing, this has yet to be proven.

Nevertheless, analysing the existing bottlenecks, potential risks have been formulated, with some of these risks having a high probability and impact in the near future when LWM seeks out to expand their activities. These risks will eventually come in conflict with the strategy of the organisation that is striving towards sustainability. Therefore, BCT could play an important role.

3. Blockchain Technology

In this chapter, Blockchain Technology will further elaborated upon to show how the technology can be useful. Certain technicalities will be described as well, such as smart contracts and zero-knowledge proof. This chapter emphasises the third sub-question, “What is BCT and to what extent can it have an impact/serve as a solution to the existing problems?”

Blockchain is a technology of distributed ledger (DLT) category, which implies an accounting book where all the parties involved save their records. A further explanation of what BCT is can be found in paragraph 1.7, how it works, the advantages and disadvantages, case study (appendix VI) and relevancy for Lamb Weston-Meijer will be formulated in the following paragraphs.

The information regarding BCT stems from an interview with blockchain developers, previous documentation from Windesheim University and desk research.

3.1. Blockchain advantages and disadvantages

A blockchain consists of multiple blocks attached, forming a chain. The moment when a block stores new data, it will be added to the blockchain. However, before a block can get added to the blockchain, four things must occur first:

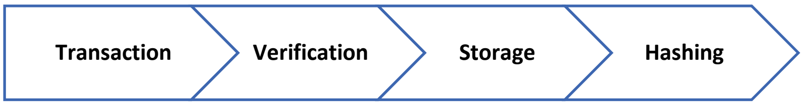

Figure 7. Four requirements for a block

- **Transaction:** A transaction must happen first. In most cases, a block and will group with other transactions, forming the chain of the blockchain (Reiff, 2020);
- **Verification:** a transaction must be verified with other records of information. Usually, this would be the responsibility of a third party. However, with blockchain, that task will be executed by a network of computers (Reiff, 2020);
- **Storage:** The information contained in that transaction needs to be stored in a block—for example, currency amount, documents and measurements (Reiff, 2020);
- **Hashing:** A hash must be given to a block. Once all transactions have been verified, the blocks must be given a unique identification code called a hash. Every new block will be given the hash of the most recent added block in the blockchain (Reiff, 2020).

When the new block is added to the blockchain, it will become available for everyone who participates in that platform (Reiff, 2020).

The development of BCT creates numerous advantages and promises for great results in different industries. However, the technology has some disadvantages as well. The advantages and disadvantages will be formulated in the table below (Solomakha, 2019) :

Advantages	Disadvantages
Increased transparency	High entry and maintenance costs
Data encryption	Energy-intensive use
Increased security and trust	Scalability can be an issue
Data traceability (origin)	Need for experts
Third-party is obsolete (decentralised network)	Vulnerability if nodes aren't distributed fairly
Immutable data	Maturity of the technology
Increased sustainability	Feasibility of legal systems

Table 10. Advantages & Disadvantages Blockchain Technology

Advantages of Blockchain Technology

- BCT is known for its decentralised network. Therefore, it won't be necessary to get a third party involved anymore. Decisions are made by all participants of this blockchain without using an intermediary (Romanov & Strebko, 2018);
- Also, each block contains a time-stamp, which shows the time of the block's creation. The registration of each transaction achieves the increased transparency of the blockchain. When connecting to the blockchain, these transactions are for every participant available to view and cannot be changed or deleted, meaning immutability of data and creation of trust (Romanov & Strebko, 2018);
- The technology only exists for a decennium but has clear sustainability promises. Organisations can apply the technology to edge on their competitors in the market because it can increase efficiency in existing processes, security and quality in collaboration;
- The data in the blockchain is also immutable, meaning that I cannot be manipulated or altered once on the platform.

Disadvantages of Blockchain Technology

- The main disadvantages of blockchain (depending on the type of blockchain used) regard the consumption of energy. To maintain the real-time ledger, the vast amount of energy consumption proofs to be a necessity. Each second, minors are working to solve many solutions and validate transactions that require substantial amounts of computer power. Furthermore, signature verification is a challenge for blockchain because each transaction must be signed with a cryptographic scheme. The big computing power is necessary for the calculation process to the sign. (Romanov & Strebko, 2018);
- Also, an issue for blockchain regards the opportunity to split the chain. The nodes operating in the old software will not accept the transaction in the new chain. This chain is creating with the same history as the chain, which is based on old software. It is named the fork (Romanov & Strebko, 2018);
- Another issue of blockchain regards the balance between the nodes' quantity and the costs for the user. Costs can be higher when the nodes receive higher rewards, but the transaction completed more slowly because the nodes do not work intensively enough. However, not all nodes can provide the necessary capacity. Because of this, it breaks the immutability and transparency, and blockchain becomes a more centralised system (Romanov & Strebko, 2018).

Blockchain is a new type of ledger databases which can solve a lot of the current problems regarding a centralised system. The technology has many advantages such as transactions without intermediary, transparency, security, traceability and opportunity for sustainability. However, the technology also has some disadvantages as well that are paired with challenges.

The versatility and usefulness of the technology will differ per situation. Nevertheless, the technology is an interesting prospect to research further upon.

3.2. Types of Blockchain

There exist different types of blockchains. These types come in different classification based on access to the blockchain data (Romanov & Strebko, 2018). In the table below, each class will be formulated:

Classification	Definition
Public Blockchain	Does not have any restrictions on reading the blocks and submitting the transactions for inclusion into the Blockchain (Romanov & Strebko, 2018).
Private Blockchain	Has limited to a predefined list of users of the direct access to the blocks and submitting transactions (Romanov & Strebko, 2018).
Permissioned Blockchain	Does not have any restrictions for the users which are eligible to create the blocks of transactions (Romanov & Strebko, 2018).
Permissionless Blockchain	Has the list of the predefined users which are eligible to performed to process the transactions (Romanov & Strebko, 2018).

Table 11. Classification of Blockchain types

These four general classifications can be easily distinguished from one another because they are the opposite of each other. Public and Private are separated by whether the blockchain is open to anyone with that has an internet connection. Permissioned and Permissionless are separated by the need of approval before usage. In figure 8 , an overview is shown of how the architecture of blockchain is formed by combining these classifications. Furthermore, in this paragraph each class will be explained and what the advantages and disadvantages are.

Public and Private blockchain

In a public blockchain it is possible for anyone to join the network and participate. A public blockchain is decentralised and does not have a single entity that controls the open network. The data on the blockchain is secure and immutable once validated. The cryptocurrencies bitcoin and Ethereum are well-known examples of a public blockchain (Sharma, 2019).

Advantage: Complete transparency, which is perfect for trustless environments. It can be of great use for any sector. It is an open-network for everyone to join with cryptocurrency reward system for work done on the platform which stimulates growth.

Disadvantage: Companies that want to have somewhat of control regarding their platform will find an open public blockchain inefficient to work with.

In a private blockchain it is not possible for just anyone to join the network and participate. This blockchain is based on access controls which restrict people from participating the network. There can be one or more entities that control the network which leads to reliance on third-parties to transact. In a private blockchain, only the entities participating in a transaction will have knowledge about it, whereas others will not be able to access. Hyper Fabric Ledger of the Lunux Foundation is an example of a private blockchain (Sharma, 2019).

Advantage: A private blockchain ensures more control and stability due to the selectiveness in accessibility to network. A private network is more of a reliable option compared to a public network. It is useful for companies who want total control regarding their processes.

Disadvantage: Less participation means less growth resulting in a stagnating blockchain that does not grow over time due to development compared to a public blockchain.

Permissioned and Permissionless blockchain

A permissioned blockchain can be seen as a closed system, anyone interested in viewing data or validating transactions must first get approval from a central authority. A permissioned blockchain perfectly fits institutions, companies, and banks that are comfortable cooperating with the regulations but are concerned about having complete control of their data (Kumar, 2019).

Advantage: A permissioned blockchain provides more efficient performances compared to a permissionless blockchain. It has a predefined governance structure, better scalability and access controls (Kumar, 2019).

Disadvantage: A permissioned blockchains' security is dependent on the integrity of its current participants, the platform is less transparent compared to a permissionless blockchain. A permissioned blockchain is easier to breach/hack and are prone to regulations and censorship (Kumar, 2019).

A permissionless blockchain can be seen as an open system. It allows for anyone to perform transactions and act as validators. The information on this kind of platform is publicly available, and copies of the ledger are stored on multiple computer across the world, meaning that it is almost impossible to hack. A permissionless blockchain has no one controlling the platform, creating anonymity (Kumar, 2019).

Advantage: Anonymity for the participants on the platform, better security, more transparency compared to a permissioned blockchain (Kumar, 2019).

Disadvantage: Validation is relatively slow compared to a permissioned blockchain, prone to the 51% attack (A hostile intent mining group that has more than 50% of the networks mining hash rate) which can form a big threat for the platform. High amounts of energy consumption (Kumar, 2019).

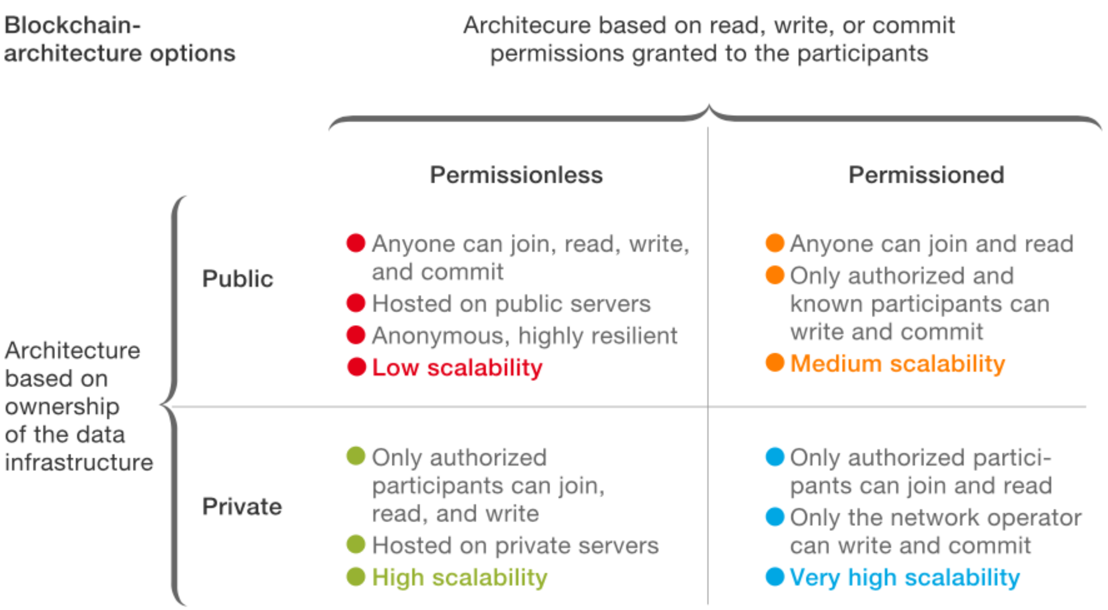

Figure 8. Types of Blockchain

3.3. Blockchain Technicalities

In this paragraph, the two main blockchain technicalities will be formulated to understand the technology a bit better. For this research, not every technicality will be discussed. It's essential, however, to elaborate upon these main points namely Smart contracts and Zero-knowledge proof

Smart contracts

Smart contracts are programs stored on a blockchain that run when predetermined conditions are met (Ibm, 2020). They are used to replaces intermediary's that would otherwise facilitate, execute and enforce agreements between the parties. Smart contracts can also automate workflows by starting the next action when the predetermined conditions are met.

What smart contracts bring in added value regards the fact that they automatically execute the next step when the established agreements between parties are met. Therefore, smart contracts are more efficient compared to standard intermediaries. Smart contracts also economise on transaction fees.

What is Zero-knowledge proof

Zero-knowledge proof (ZKP) is a functionality that allows a prover to convince a verifier about a specific part/fact without reveal the actual information as a whole (Geroni, 2021). In other words, an encryption method that proves to party that the given statement of the other party is true. For example, a person can access their bank balance without having to access their personal information or bank details. The added value of ZKP is that it can prove specific information to be true and authentic without revealing the whole and thus maintaining privacy.

3.4. Blockchain relevancy for LWM

In this paragraph, the relevancy of blockchain technology for LWM will be discussed. Blockchain is a promising technology for the supply-chain it can be used to view the integrity of a product, tracing it down to the origin.

LWM is one of the world's leaders in frozen potato's products. LWM produces fries that need to be put under certain conditions in the supply-chain in order to guarantee the quality of the product. In the current situation, there is no real urgent risk with current methods used to guarantee these conditions. However, in the future, LWM wants to expand their current use of modalities. Their current methods in use are not preventive enough to limit the potential future risks. However, BCT could prove to be relevant for LWM and their supply-chain by limiting their potential risk with the use of this technology.

The relevancy of blockchain for LWM derives from the uncertainty and trust in their supply-chain. As explained in paragraph 2.2.1 (signalled bottlenecks) there appears to be a lot of opportunity for data manipulation and lack of transparency of the products' condition in their current processes. As a result it would affect the quality of the fries and could potentially create dispute regarding who bares the responsibility. Nevertheless, there exists certain certificates and licences that should act as guarantees about the daily operations executed. However, in practice, what happens in a closed environment is often unknown.

Improvement of the current situation can be achieved by implementing a data platform which stores the records of all the participants and guarantees the authenticity of the information contained. The information needs to be available and up-to-date for audits and other partners in the chain.

3.5. Conclusion

Having established further elaboration upon the principles of blockchain technology and its usefulness by comprising its advantages, disadvantages, classification of different types, technicalities and relevancy. It can be concluded that BCT is a promising technology for the supply chain of LWM.

Furthermore, based on the different types of blockchain, LWM should aspire towards a private permissioned blockchain because it offers more stability and control for access in the network, which is necessary for companies; LWM does not want other people to access the network without authorisation. The technicalities of the technology would provide LWM in the current situation with many opportunities for overall improvement by using smart contracts and zero-knowledge proof. Also, BCT can be deemed to be very relevant for LWMs supply chain due to uncertainties and lack of trust.

4. Blockchain application in the Supply-chain

In this chapter, the application of BCT in the supply chain will be discussed. The chapter consists of the blockchain applicability for LWM's supply chain, the added value and risk of adaptation,

This chapter emphasises the fourth sub-question, "To what extend can Blockchain Technology be applied to the processes of Lamb Weston-Meijer, creating transparency, traceability, sustainability and security?"

4.1. Blockchain applicability for LWM's supply-chain

In this paragraph, the blockchain applicability for LWM's supply chain will be discussed. In the previous paragraph (paragraph 3.4), it was concluded that there indeed is relevancy for LWM's supply chain when it comes to applying BCT. Therefore, in this paragraph, the roadmap towards implementation, the digital solutions and the applicability of the current processes will be formulated.

4.1.1. Roadmap towards Implementation

This roadmap, shown in figure 9, is to show the next step towards implementation based on the road map of the company Sodio Technologies (Saraswat, 2018). Currently, the students of Windesheim University are conducting the feasibility of BCT for LWM. However, the next step shown in the roadmap is the establishment of a proof of concept.

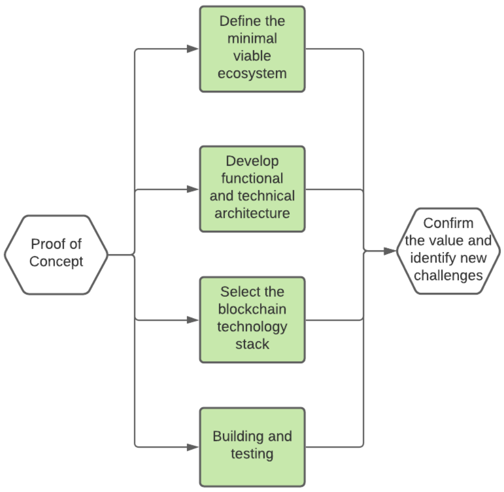

Figure 9. Roadmap Implementation

According to the roadmap of sodio technologies, there are four main processes that must take place for a successful implementation of BCT in an organisation. These are:

- **Define the minimal viable ecosystem (MVE),** which incorporates crucial aspects such as breadth scale and standards;
- **Develop functional and technical architecture,** consisting of components such as nodes within a Peer-to-Peer network, the validation process, consensus and proof-of-work;
- **Selecting the blockchain technology stack,** which entails each layer of the stack, there are three main layers: the internet layer, the blockchain layer, and the application layer;
- **Building and testing the proof of concept** is continuously required. Developers should be assigned to build and test the proof of concept.

After conducting these processes, a retrospective phase is carried out, which regards confirming the value and identifying new challenges. During that phase, the entire process is reviewed and checked for any error in judgment that might have occurred in the blockchain use case and application. The implementation of blockchain is a long process. However, it must ensure its integrity and correctness. That is why the retrospective phase is of up most importance (Saraswat, 2018).

4.1.2. Digital solutions

The application of BCT also implies that the cold chain can be monitored closely. The conditions of the good can be documented and stored throughout serval points in the chain. However, documentation and storage of requires data input. Integrating BCT with Internet of things (IoT) devices such as Software as a service (Saas) and Radio-frequency identification (RIFD) technology is the most practical way to gather adequate measurement input for the distributed ledger and create visibility regarding the cold chain inefficiencies. In this paragraph, Saas and RFID technology will be discussed for how it could function as a digital solution.

Software as a Service (Saas) – Real time monitoring

Internet of things are all devices (Things) that are in contact with other devices or systems via internet connections and exchange data with each other. Using a SaaS (Software as a Service) solution, organisations like Seidor provide Real-time monitoring for companies in the cold chain. Their software “NetCold” is used to maintain, report and control products during transportation by streaming Real-time data (Seidor, 2021). The software also allows for real-time track and tracing, instant alerts and process efficiency.

When LWM wants to scale their activities, lead-times will of course increase. As a suitability solution for the future when having implemented BCT. DLG, responsible for logistics, could make use of this software and the data would be communicated via the distributed ledger. However, Saas is a subscription based solution and the costs, services and specifics of a Saas can vary from company to company.

Radio-frequency identification (RFID) – Automatic data entry

RFID is a technology that makes it possible for data to be transmitted, read or altered until a certain distance. A RFID system consists of three main components: tags, antennas and readers. RFID can eliminate the need for manual data entry because it provides item-level tagging, each product can then be tracked in the blockchain with an unique identification and history (Mekic, 2019).

RIFD tags are accompanied with sensor technology that can measure temperature and humidity levels. The antennas power the tags and communicated the data to the reader. Tags are protected with encryption, securing the data contained and providing only availability for the ones who are authorised, creating data integrity.

RIFD technology, when implemented in the supply-chain of LWM will create data integrity because of the automatic data entry, create track and trace opportunities as the tags are continuously communicating with each other and it could improve the work flow, answering current process inefficiencies.

4.1.3. Risks of adaptation

In this paragraph the risks of adaptation will be discussed. As mentioned there are vast array of problems that can be solved using BCT. However, the adoption of blockchain does not come without any risks. Few of the risks are; behaviour change, bootstrapping and, government regulations,

Behaviour change: The world changes all the time, but resistance exists. In the world of a non-tangible trusted party, that blockchain presents, customers need to get used to the fact that there electronic transactions are safe, secured and complete;

Bootstrapping: Moving the existing contracts or business documents to the new blockchain presents a significant set of migration tasks that need to be executed. This may involve time and costs;

Government regulations: In the world of blockchain transactions, government agencies may slow down the adoption by introducing new laws to monitor and regulate the industry for compliance. In the Netherlands for example, this may increase customer trust and helps with adoption. In more controlled economies like in China, the adoption will face significant headwind (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanaraman, 2015).

4.2. Added value for LWM's supply-chain

In this paragraph, the potential added value of BCT in the supply-chain of LWM will be discussed. The added value is based upon the objectives: Transparency, Security, Sustainability and Traceability. For each objective the added value, application in their cold chain and effect on future risks and will be formulated.

4.2.1. Transparency

Added value | BCT would create reliable identity management in the supply chain of LWM by enabling all parties involved to know what actions are taken at what time and where. Which improves collaboration, workflow and trust. LWM assumes that in the near future potential disputes will arise due to the lack of transparency, meaning blockchain in a way can be used as preventative mechanism in their supply chain.

Application in their cold chain

- The location and handling of the fries can be made visible for all parties. Not all parties know what kind of processes the other executes. BCT will make processes of LWM, DLG and Lineage more transparent for each other;
- What actions were taken that could influence the quality of the product by measuring temperature levels and timestamping;
- Transparency in inventory levels will make it easier for LWM to create forecasts which can be communicated to production.

4.2.2. Security

Added value | BCT would enhance the overall security of LWM's supply chain. The information stored on the blockchain platform is protected by data encryption and hashing. Furthermore, only those authorized can access the platform. LWM can also add digital solutions to their supply chain, increasing data integrity and accuracy.

Application in their cold chain

- LWM could aim for a private permissioned blockchain (paragraph 3.2), meaning that only authorized participants can join and read the data contained. This type of blockchain has a more enhanced security environment and keeps unapproved parties excluded;
- A technicality aspect of BCT (paragraph 3.3), zero-knowledge proof would be a beneficial application. Zero-knowledge proof would safeguard the private information of LWM by showing to the other parties, for example, only the temperature of the fries and no other measurements;
- Application of BCT would increase LWM's cybersecurity and could act as a preventative mechanism regarding hacking.

4.2.3. Sustainability

Added value | The sustainability created by BCT would connect greatly with the strategy of LWM (paragraph 2.1.1). Being a relatively young technology, blockchain provides an edge for LWM over their competitors that do not make use of this technology. Current transactions between partners flow through an intermediary, blockchain can replace that tasks, economizing the chain overall costs.

Application in their cold chain

- A technicality aspect of BCT (paragraph 3.3), Smart contracts would be a beneficial application. Smart contracts can automate LWM's workflows and economize transactions fees;
- BCT could map excessive use of cooling in their cold chain, pointing out where to unnecessary cooling occurs and aligning the electricity usage to the minimum necessity for adequate quality maintenance, making electricity usage more sustainable;
- BCT would also stimulate collaboration for LWM and its partners. In the future LWM seeks to scale their current activities. A sustainable foundation of collaboration will make process less costly and activity integrating more beneficial.

4.2.4. Traceability

Added Value | Traceability will be an important objective for LWM's supply chain. BCT offers advanced traceability. IoT devices and RFID technology could also be used in LWM's supply chain to create visibility, combined with BCT, item-level data can be collected, documented and stored. However, the essential added value for LWM's supply chain would be Timestamps.

Application in their cold chain

- BCT will enable LWM to find the sources of issue faster in the event of a comprised product. For example when and where suddenly the rise in temperature occurred. These issues can then be identified and solved. The timestamps of the blocks could also be traced back in order to prevent dispute between LWM and partners;
- Digital solutions (paragraph 4.1.2), when combined with BCT, can offer LWM item-level traceability. They will know where their fries are in the warehouse or during transportation, what their conditions are and other data history;
- Blockchain would enable LWM and its partners to share data without integrating systems, meaning that the fries and its conditions can be traced and monitored further than just warehousing and transportation, increasing the extension of traceability.

4.2.5. Effect on future risks

If LWM's supply chain would become blockchain enabled, the Transparency, Security, Traceability and Traceability the technology creates will have an effect on the future risks (paragraph 2.3.1) The effect on the risks are mentioned in the table below:

Bottleneck	Risk	How a blockchain-enabled cold chain could relieve the risk
Manual temperature processing	(R1) Non-confidential processing	BCT in combination with IoT devices and RFID technology could make measurement processing automated and the opportunity for alteration will be dismissed do to data encryption.
	(R2) The necessity of quality checks	There will always be quality checks. However, due to this process being automated because of BCT the overall costs for audits will be lessened.
	(R3) Higher error rate	Automation decreases the error rate relatively compared to manual processing. However, possibilities of malfunctions exists as well.
Temperature checks	(R4) Lack of frequent checks	The concern regarding the lack of check points and frequency of checks can be brought out of the picture due to the traceability opportunities of BCT which can identify the source of issues in LWM's supply chain faster and extend traceability capacity.
	(R5) Lack of checkpoints	
Energy cost dispersion	(R6) Unfair additional energy costs	Smart contracts would enable specific temperature delivery by stating that if the temperature is not at a certain temperature during production (at least when it gets loading) the pallet will be either cooled further or is set to return (from lineage) without need for inspection, saving costs.
Process inefficiencies	(R7) Lack of occupation machines	Machines could be integrated with the digital solution devices and the data can be analysed for what different purposes these inactive machines can be made active.
	(R8) Inaccurate measuring	Instead of measuring beginning and end BCT in combination with IoT devices, real-time data and monitoring. This eliminates the false image of the conditioned product in the current situation.
	(R9) Inefficient process overlap	BCT would create visibility and transparency in actives of LWM and its partners, given opportunity to collaborate on inefficient process overlap.

Table 12. Bottleneck and BCT effect on risks

Having formulated how a blockchain-enabled cold chain could relieve LWM and its partners on potential future risk, a table (table 13) for the new impact and probability has been established as well as a risk assessment chart.

Risk description	**Risk factor**	**Impact** (on cost)	**Probability** (of dispute)
Non-confidential processing	R1	1 (Low)	1 (Low)
The necessity of quality checks	R2	1 (Low)	1 (Low)
Higher error rate	R3	1 (Low)	1 (Low)
Lack of frequent checks	R4	2 (Medium)	1 (Low)
Lack of checkpoints	R5	2 (Medium)	1 (Low)
Unfair additional energy costs	R6	1 (Low)	2 (Medium)
Lack of occupation machines	R7	1 (Low)	2 (Medium)
Inaccurate measuring	R8	1 (Low)	1 (Low)
Inefficient process overlap	R9	1 (Low)	2 (Medium)

Table 13. New risk assessment table

New risk assessment chart

The new risk assessment chart only consists of a green section (Low risk) and yellow section (medium risk). Based upon the features of BCT, the risks compared the previous assessment (paragraph 2.3.2) has decreased significantly. All risks, except for **R7** have moved a segment in either risk of impact (costs) or probability (of dispute) because of what BCT could improve or act preventative for LWM's supply chain. In the visual below the new risk assessment chart is shown, where the risks factors have moved segments:

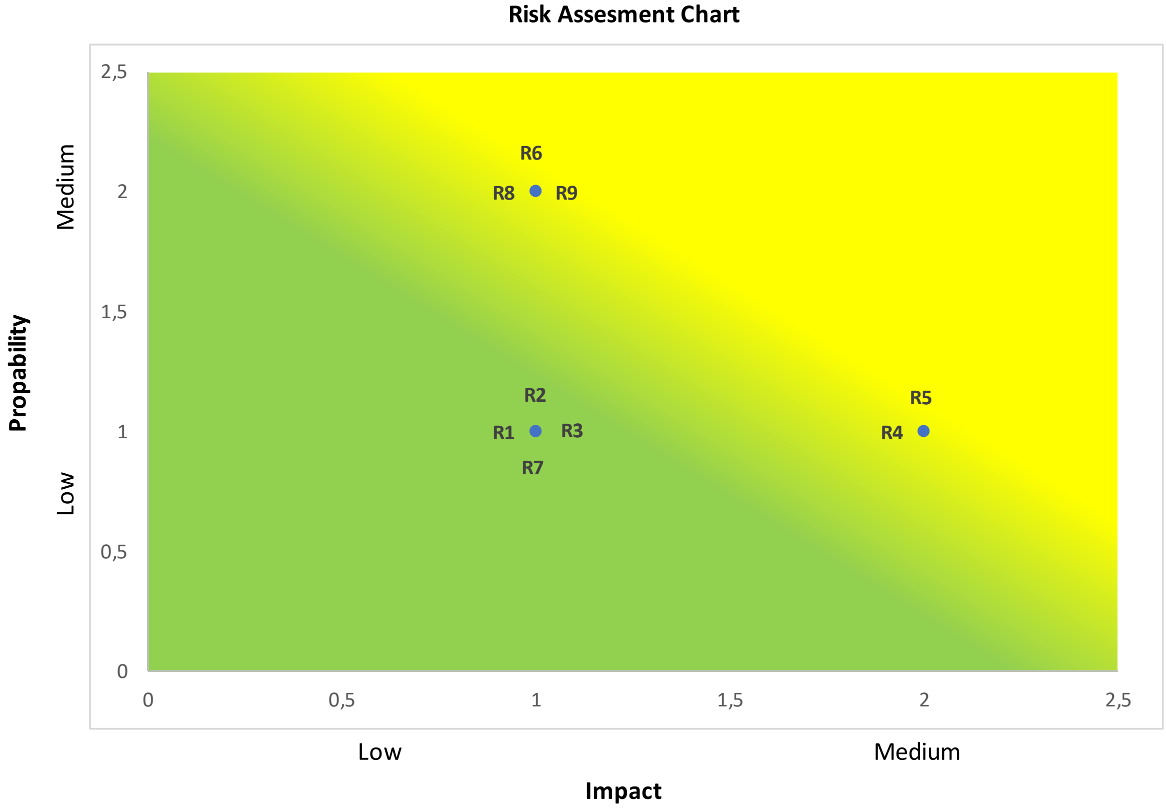

Figure 10. New risk assessment chart

4.3. Conclusion

Having established how the application of blockchain technology would add value to the supply chain of LWM with regards to the main objectives; traceability, transparency, security and sustainability. It can be concluded that for each respective objective, the application of BCT will add value, especially in combination with IoT devices such as Saas and RFID, which could complement the application of BCT.

Furthermore, having assessed the potential risks in the previous paragraph (2.3.2.), it can also be concluded that the potential risks can be mitigated through the application of BCT. Every risk has been formulated with the reasoning of how the risk can be combated based on the added values of each objective. In the new risk assessment chart, it can be concluded that the probability and impact of almost all risks have been reduced compared to that of the first risk assessment chart.

5. Generalisation of blockchain for SME's

In this chapter, the generalisation of blockchain technology for Small- to Medium-sized Enterprises regarding the applicability for SME's with similar branches, Blockchain decision tree, risk of adaptation solutions and evaluation method will be discussed. The topic of this chapter derives from the fifth sub-question "How can the current potential proposals be generalised so that Small- to Medium-sized Enterprises can use these findings for their cold-storage cooperation?"

5.1. BCT applicability for SME's with similar branches

In this paragraph, the applicability of BCT for SME's with similar branches will be discussed. BCT, as discussed in previous chapters, can be applicable for multiple branches. In this research the branch of discussion was mostly related towards conditioned -production, -transportation and -storage of potato's and how BCT could improve on a few main objectives; transparency, traceability, security and sustainability.

Having assessed the feasibility of these objectives through the applicability of BCT, the possible solutions on the bottlenecks, advantages and disadvantages, added values and implementation plan can be used for other branches that are similar to LWM. LWM main goal in essence is practically to safeguard the quality of their product that is produced, transported and stored until it reaches the customer. The quality is safeguarded by keeping it at a predefined condition. Branches with a similar goal like LWM are:

- **Pharmaceutical branch**: BCT can be used to give more of an insight of the medicines produced, for example, what is contained in the product, where does it come from. It can also be used to safeguard the temperature of the medicine, as some medicines are required to be transported and stored similar to the French fries of LWM;
- **Floristry and Floriculture branch:** BCT can used for transparency purposes for the various suppliers in the industry. Data processing would more efficient and authentic due to the trust less environment;
- **Fruit and vegetable branch:** BCT can used to meet requirements better and faster towards independent regulators. These regulators being certification institutes and officials.

For the SME's in these branches the applicability of BCT could be suitable for them as it can be for LWM. Its main benefit/usage however, as explained above, can differ between branches/organisations. However, the fundamentals of each issue can be related from one branch/organisation to another, making the applicability of BCT in different circumstances still a promising concept for SME's.

5.1.2. Risk of adaptation – SME's solutions

in this paragraph the solutions for the risk of BCT adaption will be discussed. The risks mentioned in the previous paragraph (paragraph 4.3) for the adaptions of BCT are the same for LWM and for SME's. in the table below the solutions for these risks are formulated:

Risk	Solution for adaptation risks
Behaviour change	As mentioned in the implementation plan (paragraph 4.4), the announcement and effort for involvement would increase the acceptance rate for the blockchain project. On a smaller scale this can be done for SME's by involving customers from the first moment as well;
Bootstrapping	This can be solved by planning ahead and installing buffer periods because no project can be executed successfully on the exact planned date without rushing;
Government regulations	Depending on which country the SME is in hiring a lawyer or consulted could safe trouble regarding countries that provide headwind against adoption;

Table 14. Adaptation solutions

5.2. When should SME's apply blockchain

In this paragraph, the assessment of when BCT should be applied for SME's will be discussed. In the current case of LWM, the organisation wanted to apply BCT into its supply chain. Even though, the organisation has assessed in its own way the reason why LWM wants to conduct the feasibility study and therefore conduct this research. It is important to understand when blockchain should be applied especially for SME's.

According to the Dutch blockchain coalition there are a some important questions an organisation has to ask themselves in order to determine if they should explore the concept of BCT in the first place. These questions are:

- Is there a need for a shared administration?
- Do multiple people need to have writing rights?
- Do these people have similar interest, can we trust them and do we know them?
- Do we want to use a third party or make use of legislation?

In the figure below a visual regarding the decision tree (made by the Dutch Blockchain Coalition) is shown, indicating when blockchain should be explored and when it is not needed at all.

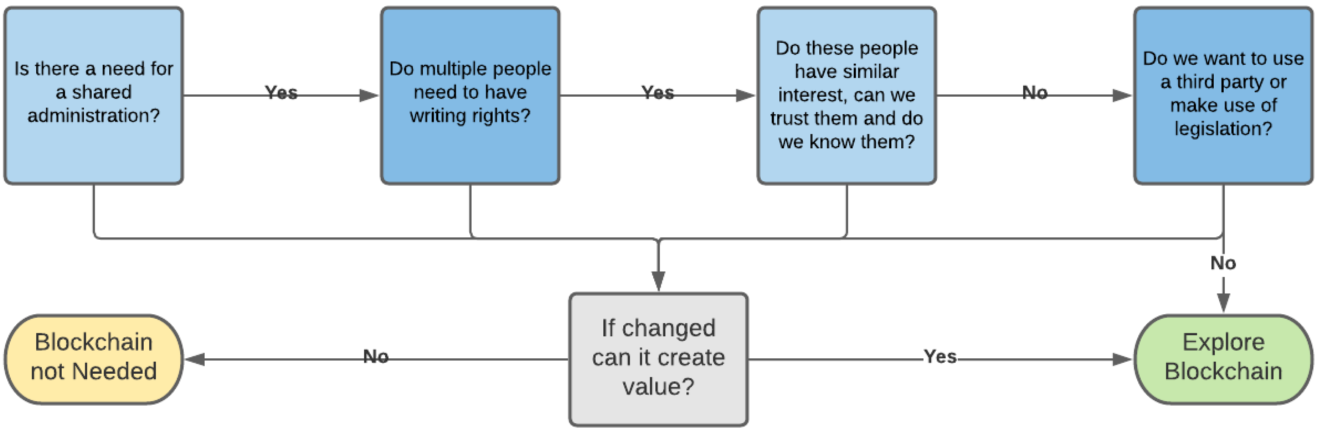

Figure 11. Blockchain decision tree

SME's should also asses what kind of blockchain they want to use based on the different types of blockchain discussed earlier (paragraph 3.2) and conduct a cost benefit analyses based on their own financial situation (paragraph 6.2).

5.3. Conclusion

BCT offers SME's to flourish better in their respective activities and processes. Also, there are branches whose actives are similar to that of LWM. These branches regard the pharmaceutical, floristry & floriculture and Fruit & vegetable branch. These branches can make use of the research conducted in the previous chapter because their accordance with cold chain logistics.

However, the adaptation of blockchain can also carry risks. Therefore, solutions towards those risks have been formulated in order to mitigated them. SME's should also considers assessing if they should apply BCT at all which is in accordance with the questions formulated, what type of blockchain the respective SME might need and its financial situation.

6. Blockchain implementation and costs

In this chapter, the implementation plan and costs- and benefit analyses will be formulated and conducted with a project management approach.

6.1. Implementation plan

In this paragraph the implementation plan will be conducted. The implementation plan paves the way for the introduction of the blockchain platform. Budget, available resources and time are taken into account. The entire implementation is set up through a critical path.

The implementation takes about three years before all stakeholders are correctly integrated into the blockchain platform. The implementation plan is divided into different phases: preparation phase, development phase, analysis phase, implementation and evaluation phase. During the project, everything must also be documented and archived at every stage.

Preparation phase: | Period regards 4 months | LWM will enter into consultations with the various facilities and departments in the Netherlands (possibly other countries). The team of experts will be introduced along with other staff members. Subsequently, all interested parties (customers and investors) and especially the staff must be informed. The sooner the interested parties are disclosed about the blockchain platform project, the higher their acceptance rate.

Development phase: | Period regards 2 months | Within the organization, the staff members and the team of experts are busy with how the platform should be developed. Different methods will be discussed. Furthermore, there will be a lot of different meetings, short and long sessions, in order to maintain involvement as effectively as possible. The current alignment of the technology will be examined. There will be speculation on other aspects as to what the technology could add/contribute further and whether this can be included in the project.

Analysis phase: | Period regards 3 months | The functionality of the platform is tested, does it work in the desired way, if that is the case, it can be considered possible training for staff to ensure that the technology is in line with current working methods as well as possible. LWM will be more affluent in information gained during the development of the project and look at possible further connections of the technology in the organization. Deficiencies regarding materialistic elements for the project are also taken into account at this stage.

Implementation phase: | Period regards 2 years | This phase will take the longest. There will be several implementations to be undertaken for the platform to function as successfully as possible. During this period, the platform will also be used. LWM and its partners will have already become acquainted with the technology.

Evaluation phase: | Period regards 3 months | The partners of LWM can also bring long-term criteria to the table. In turn, LWM can turn into a technical objective, thereby striving for continuous improvement. Furthermore, in this phase, the performance of the technology is examined, how it can be improved, and there is also talk with the interested party and their wishes. Finally, we will look at the cost savings, the platform's effectiveness, and untreated findings that can be used for future projects of LWM.

To illustrate how the implementation plan can follow through a Gantt-chart visual has been made, each phase with separate main actions to successfully execute a blockchain platform project. Each phase also has a mile stone derived from the implementation roadmap (paragraph 4.1). The Gantt-chart can be seen in the visual below:

	Taaknaam	Duur	Begindatum	Einddatum	Voorafgaande taken
1	**Blockchain platform project**	**760 dagen**	**woe 1-9-21**	**din 30-7-24**	
2	**Preparation phase**	**16 wkn**	**woe 1-9-21**	**din 21-12-21**	
3	Consultation with various facilities and departments	8 wkn	woe 1-9-21	din 26-10-21	
4	Selecting and recruiting team of experts	8 wkn	woe 27-10-21	din 21-12-21	3
5	Informing staff members, customers and investors	8 wkn	woe 27-10-21	din 21-12-21	3
6	*Proof of Concept*	0 dagen	din 21-12-21	din 21-12-21	
7	**Development phase**	**8 wkn**	**woe 22-12-21**	**din 15-2-22**	**2**
8	Meetings between experts, directors and staff	8 wkn	woe 22-12-21	din 15-2-22	
9	Methods and technology assesment	5 wkn	woe 22-12-21	din 25-1-22	
10	Selection for project includment	3 wkn	woe 26-1-22	din 15-2-22	9
11	*Defined viable ecosystem*	0 dagen	din 15-2-22	din 15-2-22	
12	**Analyses phase**	**12 wkn**	**woe 16-2-22**	**din 10-5-22**	**7**
13	Functionality assesment	4 wkn	woe 16-2-22	din 15-3-22	
14	Integration with current technology analyses	7 wkn	woe 16-3-22	din 3-5-22	13
15	Deficiencies defined	1 wk	woe 4-5-22	din 10-5-22	14
16	*Defined functional and technical architecture*	0 dagen	din 10-5-22	din 10-5-22	
17	**Implemantation phase**	**104 wkn**	**woe 11-5-22**	**din 7-5-24**	**12**
18	Building the blockchain platform	42 wkn	woe 11-5-22	din 28-2-23	
19	Implemantation of the blockchain platform	28 wkn	woe 1-3-23	din 12-9-23	18
20	Testing of the blockchain platform	34 wkn	woe 13-9-23	din 7-5-24	19
21	*Blockchain platform build, implemented and tested*	0 dagen	din 7-5-24	din 7-5-24	
22	**Evaluation phase**	**12 wkn**	**woe 8-5-24**	**din 30-7-24**	**17**
23	Blockchain platform evaluated	2 wkn	woe 8-5-24	din 21-5-24	
24	Challenges identified	2 wkn	woe 22-5-24	din 4-6-24	23
25	Challenges solved and improved	8 wkn	woe 5-6-24	din 30-7-24	24
26	*New identified challenges improved*	0 dagen	din 30-7-24	din 30-7-24	

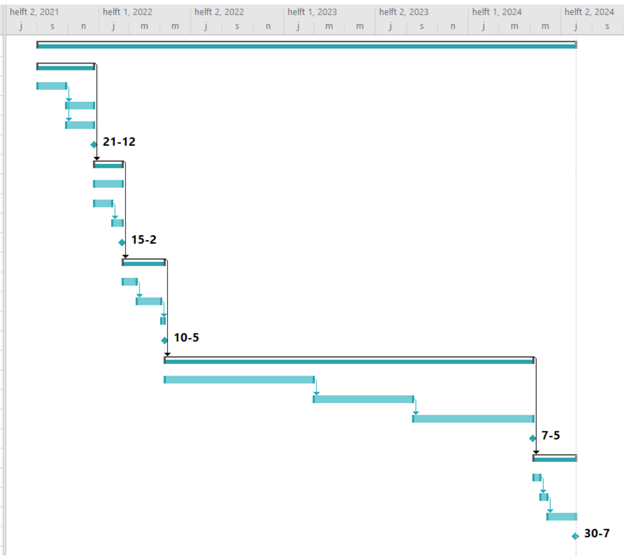

Figure 12. Gantt-chart blockchain project visual

6.2. Cost- and Benefit analyses

In this paragraph, the cost and benefit analyses will be conducted. There are multiple costs and benefit factors in play when it comes to implementing a blockchain-related project. The costs for implementing blockchain in the supply chain of LWM is mainly related to how complex the organisations involved want the platform to be. In general the costs for a blockchain project is ranged between € 5000,- and € 200.000,- in total.

Costs analyses | The costs for the blockchain project can be separated in the following categories: Consulting (10%), Designing costs (15%), Development costs (50%), Quality assurance cost (25%) and Maintenance cost (15% - 20% of the overall project costs) (Takyar, 2018). For LWM the development costs will be calculated in order to understand the range of the other categories and afterwards a totalling can formulated.

The development of a successful platform requires a team of developers and experts with a lot of experience. Developing a platform will take approximately two months according to the implementation plan (paragraph 4.4). During the two months, the team will work under LWM and its partners. The personnel costs are calculated by means of FTE and will represent the development costs. Per FTE is equal to 40 hours per week and 320 hours over two months. The team of experts and developers consists of the following members:

- 2 Blockchain Developers | Hourly rate – €75,00, (Blockchaindeveloper, 2020);
- 1 Supply-Chain Manager | Hourly rate – €45,00, (SC-manager , 2020);
- 1 Innovation Specialist | Hourly rate – €30,00, (Innovationspecialist, 2019);
- 2 IT Specialist | Hourly rate – €35,00, (IT-specialist, 2021);
- 1 Public Relation Managers | Hourly rate – €40,00, (PR-Manager, 2018);
- 1 Lawyer | Hourly rate – €32,50 (Juristen, 2021).

In addition, according to TNO (TNO, 2018) the tech support, hardware, software and additional organisational costs will total a one-off fee of around €17.500,- (based on 'worldwide permissioned' architecture, should LWM in the future aspire towards that) totalling the development cost to around **€131.500,-**.

Knowing the total estimated development costs (€131.500). for the blockchain project the other categories can be calculated as well. In visual below the proportions of every category is shown:

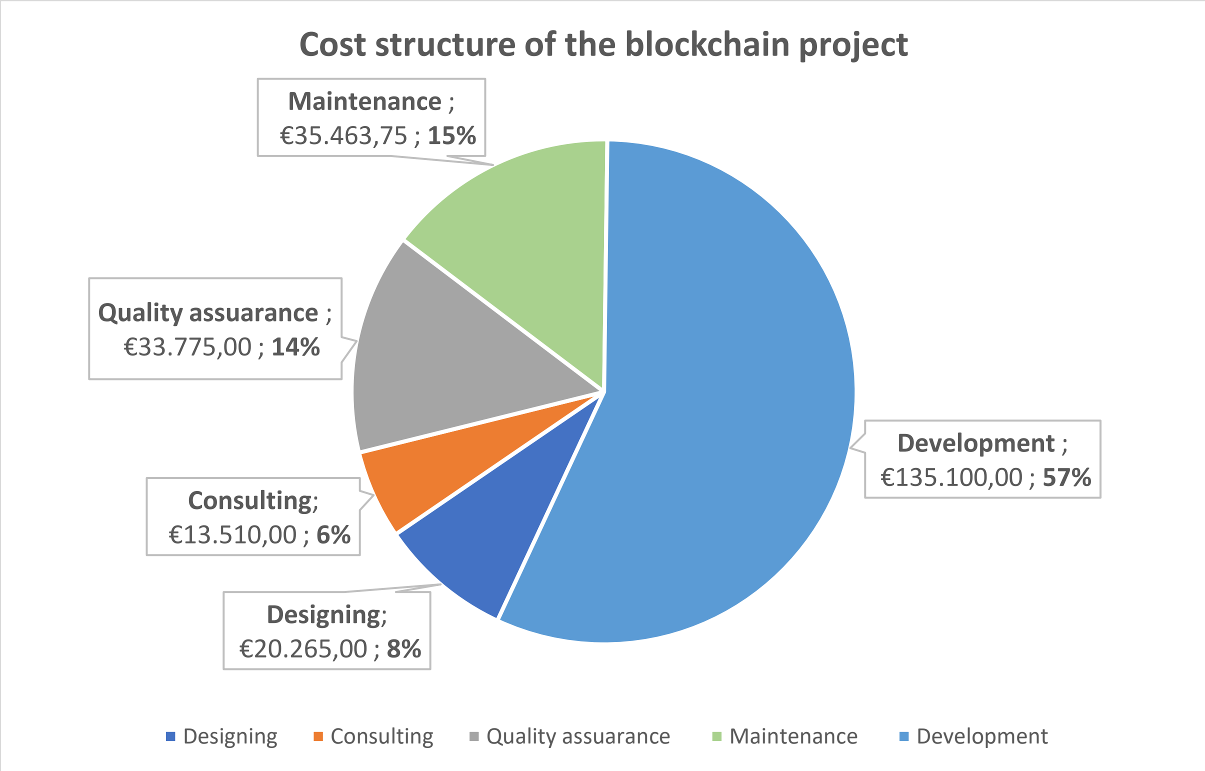

Figure 13. The cost structure of the blockchain project

These costs are directly derived from the hourly rate of the team of experts that would participate in the hypothetical project. Based on their expertise's on the activities correlated with the overall development of a blockchain platform, the costs can be reversed calculated (plus a €17.500,- one-off fee for technical and organisational costs). Afterwards, the other categories were calculated using the rule of thumb (Takyar, 2018).

Digital solutions (paragraph 4.1.2) can also compliment the blockchain project, The costs for implementing RFID in the warehouse of LWM can range from an additional €8.000 – €16.000 in total for hardware, installation and configuration (Watson, 2015).

Finally, every category was added up and an estimated 17,5% of the overall cost would be necessary for maintenance. Totalling the blockchain project costs to be **€250.113,75**.

The road to implementation of BCT can take various of paths which can have various of costs. Each organisation would take its approach differently compared to another, meaning that the costs for the implementation of blockchain is has no exact fixed costs.

Benefit analyses | In order to understand the financial benefit of BCT for LWM the return on investment (ROI) will be calculated. The ROI calculation will take the following factors into account for a better comprehension of the BCT influence on LWMs existing market. These factors are:

- **The market growth**: The market growth forecast for the potato production industry is according to the organisation "Mondor Intelligence" (Mondor Intelligence , 2016) to be around 1% per year from 2016 until 2026:
- **The revenue of LWM**: The total revenue of LWM in the year 2020 was around €693 million euros, a 16% decrease compared to the year before due to Covid-19 (Kloosterman, 2020):
- **Cost saving through BCT**: The costs savings through BCT would be around 12% per year in the logistic sector annually according to blockchain and IT experts (Pals, 2019). However, in the case LWM, the cost saving through BCT will be around 5% (based on the added value discussed in paragraph 4.2).

Having formulated the main factors to calculated the ROI of BCT, a few assumptions need to be added as well. Eventually, it will be up to the organisation itself how it wants to allocate its finances. However in the following situation, the next assumptions for LWM are made:

- The profit of margin amounts to 5% of the overall revenue;
- An investment budget of 3% annual profit will be released for the implementation of BCT;
- For maintenance and other extra costs an estimated €23.000,- per month (€23.000 x 12) will be taken into account. This will directly subtracted from the investment budget;
    - The cost for maintenance p.m. will be slightly lower during the implementation than during development;
- The implementation phase will take around two years and will be finished around halfway through 2024, meaning that its economization can truly start around that same year.

Year	Revenue(31-12)	Markt Growth	C.S. % through BCT	Profit Margin	Investment budget	Annual costs	Investment Cum.
2020	€ 693.000.000,00	-16%	0%	€ 34.650.000,00	€ 70.500,00	€ 276.000,00	€ 70.500,00
2021	€ 582.120.000,00	1%	0%	€ 29.106.000,00	€ 15.060,00	€ 276.000,00	€ 85.560,00
2022	€ 587.941.200,00	1%	0%	€ 29.397.060,00	€ 17.970,60	€ 276.000,00	€ 103.530,60
2023	€ 593.820.612,00	1%	0%	€ 29.691.030,60	€ 20.910,31	€ 276.000,00	€ 124.440,91
2024	€ 629.449.848,72	1%	5%	€ 31.472.492,44	€ 38.724,92	€ 276.000,00	€ 163.165,83
2025	€ 667.216.839,64	1%	5%	€ 33.360.841,98	€ 57.608,42	€ 276.000,00	€ 220.774,25
2026	€ 707.249.850,02	1%	5%	€ 35.362.492,50	€ 77.624,93	€ 276.000,00	**€ 298.399,18**

Total return on investment period is approximately **Six Years**

Figure 14. Return on Investment BCT

Having established the return of investment of BCT for LWM in the visual above. It can be concluded that the return on investment period will take approximately **six years**.

6.3. Conclusion

Having established the implementation plan it can be concluded that the project will have a duration of three years, with two years dedicated to the implementation of the platform. Communication has to be direct and effective at the same time in order to avoid setbacks and misunderstandings.

Financially wise the application of BCT in the supply chain of LWM proves to be a real benefit with these realistic factors and assumptions. The cost savings especially would make the organisation more financially sustainable In the future. The ROI period is also relatively short compared to other expensive assets such as machines that can take 10-20 years in order to have the investment returned. Finally, the application of BCT can be financially seen as a revenue boost potential due to the different work applications it can offer but as off today are not yet used.

7. Discussion and Recommendation

In this chapter, the discussion and recommendation regarding this research will be discussed.

7.1. Discussion

This research was aimed at how the application of BCT could improve the cold chain of LWM and translate its findings into an universal format for SME's to use.

First of all, LWM approached Spark! Living Lab to conduct a feasibility study regarding the application of BCT. The current situation of LWM was researched and analysed from which the conclusion could made that at current moment of time BCT would not be necessary. Afterwards the company gave its concern regarding their desire to expand their activities meaning that safeguarding their product would become more difficult. In regards to that situation, what could the application of BCT add to the current and potential future bottlenecks of LWM. Therefore, the bottlenecks where identified and risks formulated and a risks assessment chart has been established.

To understand how BCT could add value to LWMs supply-chain the principles of the technology where further elaborated upon, with main focus towards the objectives; transparency, traceability, security and sustainability. Their added value and applicability opportunities where discussed and crossed against the current and potential bottlenecks of LWM. Therefore, a new risk assessment chart could be established and the risks formulated where reduced due to the value that BCT brings.

BCT also offers SME's to flourish better in their respective activities and processes. Also, there are branches whose actives are similar to that of LWM, meaning that improvements/added value findings made through BCT on cold chain related actives for LWM can be used for SME's as well. These branches have been formulated in addition to the risk that comes with adaptation of BCT.

However, blockchain is a very complex technology and requires carefully planning and a relatively high investment when implementing the technology. Each of these aspects where formulated. Regarding planning, an implementation plan was established, emphasising how LWM could continue this research further from its proof of concept. Financially, a cost- and benefit analyses was developed in order to understand how fast the promising technology would be able to return its investment.

7.2. Recommendation

The recommendation are divided into internal and external recommendations. The internal recommendations are related to LWM and its supply chain and the external recommendations are related to the SME's.

Internal | LWMs current situation would not require BCT related solutions. However, scaling/expansion in the near future, BCT can play an important role in providing improved transparency, traceability, security and sustainability. However, further digitalisation of current activities could improve these aspects as well and minimize potential bottlenecks that comes with scaling/expansion.

LWM can also make use IoT devices such as Saas and RFID technology that would complement the application of BCT.

In order to implement BCT successfully, communication and collaboration plays an important role. LWM could make use of change management methods in order to pursue effective change in activities.

External | BCT would significantly improve current activities of LWM and its partners. It can be recommended for SME's to make use of this technology and using the findings in this report as a foundation towards their yet conducted research.

Another recommendation is to look into how blockchain may be replicated in a database. When it comes to blockchain, no one knows who is accountable if something goes wrong, making it difficult to cover legally. If the fundamentals of blockchain can be duplicated in a database, it is easier to hold someone accountable.

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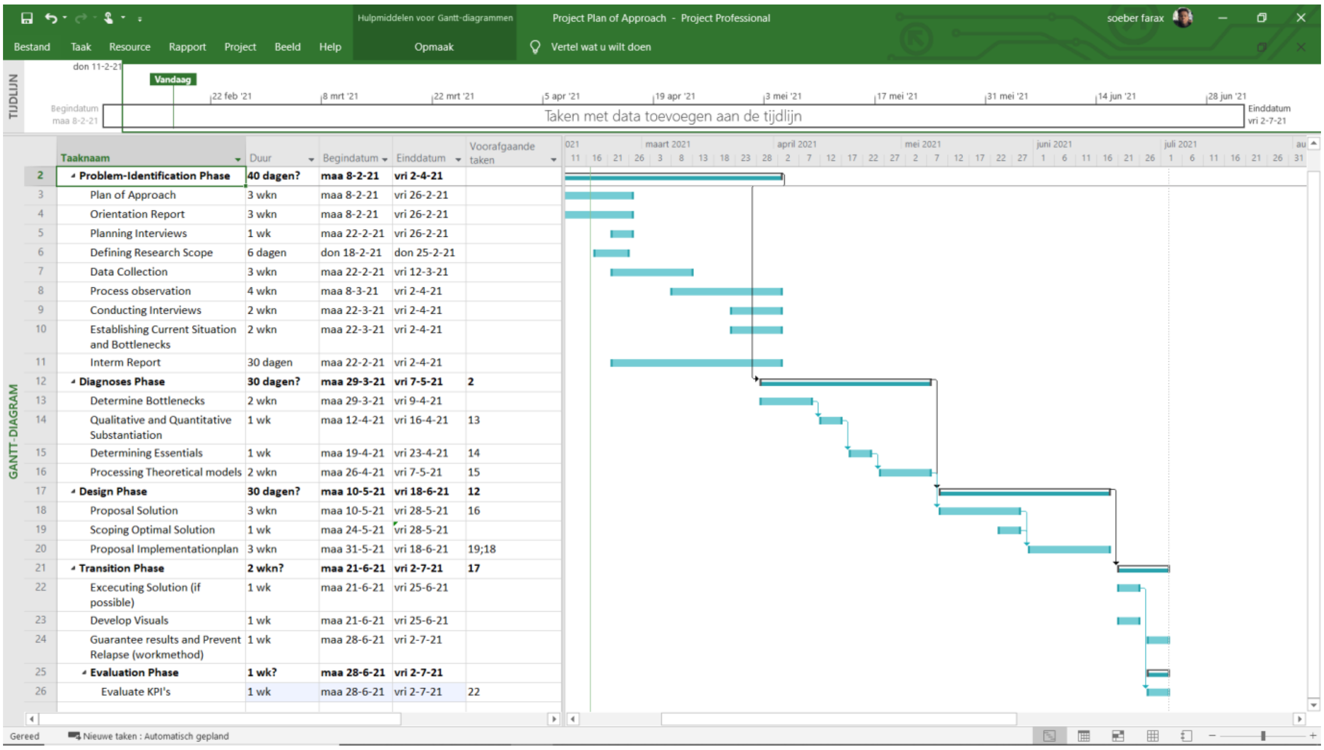
Appendices

Appendix I: Project Time Schedule



	Taaknaam	Duur	Begindatum	Einddatum	Voorafgaande taken
2	**Problem-Identification Phase**	**40 dagen?**	**maa 8-2-21**	**vri 2-4-21**	
3	Plan of Approach	3 wkn	maa 8-2-21	vri 26-2-21	
4	Orientation Report	3 wkn	maa 8-2-21	vri 26-2-21	
5	Planning Interviews	1 wk	maa 22-2-21	vri 26-2-21	
6	Defining Research Scope	6 dagen	don 18-2-21	don 25-2-21	
7	Data Collection	3 wkn	maa 22-2-21	vri 12-3-21	
8	Process observation	4 wkn	maa 8-3-21	vri 2-4-21	
9	Conducting Interviews	2 wkn	maa 22-3-21	vri 2-4-21	
10	Establishing Current Situation and Bottlenecks	2 wkn	maa 22-3-21	vri 2-4-21	
11	Interm Report	30 dagen	maa 22-2-21	vri 2-4-21	
12	**Diagnoses Phase**	**30 dagen?**	**maa 29-3-21**	**vri 7-5-21**	**2**
13	Determine Bottlenecks	2 wkn	maa 29-3-21	vri 9-4-21	
14	Qualitative and Quantitative Substantiation	1 wk	maa 12-4-21	vri 16-4-21	13
15	Determining Essentials	1 wk	maa 19-4-21	vri 23-4-21	14
16	Processing Theoretical models	2 wkn	maa 26-4-21	vri 7-5-21	15
17	**Design Phase**	**30 dagen?**	**maa 10-5-21**	**vri 18-6-21**	**12**
18	Proposal Solution	3 wkn	maa 10-5-21	vri 28-5-21	16
19	Scoping Optimal Solution	1 wk	maa 24-5-21	vri 28-5-21	
20	Proposal Implementationplan	3 wkn	maa 31-5-21	vri 18-6-21	19;18
21	**Transition Phase**	**2 wkn?**	**maa 21-6-21**	**vri 2-7-21**	**17**
22	Excecuting Solution (if possible)	1 wk	maa 21-6-21	vri 25-6-21	
23	Develop Visuals	1 wk	maa 21-6-21	vri 25-6-21	
24	Guarantee results and Prevent Relapse (workmethod)	1 wk	maa 28-6-21	vri 2-7-21	
25	**Evaluation Phase**	**1 wk?**	**maa 28-6-21**	**vri 2-7-21**	
26	Evaluate KPI's	1 wk	maa 28-6-21	vri 2-7-21	22

Appendix II: Research Question (SMART)

In this paragraph the central question is decomposed into five aspects, these aspects are each bound to their own term.

- **Specific:** The central question is specifically focused on these main objectives, these objectives are *Transparency, Traceability, Security and Sustainability.*
- **Measurable:** In this project the potential solutions will be crossed against the current situation, quantitative and qualitative. Thus, making the central question measurable.
- **Acceptable:** The central question is accepted by all of those involved in the use-case.
- **Realistic:** The project will be conducted with the help of professionals in all sorts of areas, meaning that not only one perception. Also, the scope will be demarcated.
- **Time-bound:** The Project has been ongoing for multiple months now and is nearing its ends phase, the feasibility study. After that the project will go into a prototype phase, if everything goes well. The feasibility study will take approximately twenty weeks.

Appendix II: Problem analyses – 6W-Analyses

In the 6W-analyes, the following questions are asked to clarify the problem analyses of the Report.

1. **What is the problem?**

The problem is that the conditioned goods are experiencing a loss in temperature. The products need to be transported and stored at agreed temperature. For the companies involved it is unknown where the loss in temperature occurs, which causes a dispute between parties involved in cold chain.

2. **Who has the problem?**

Lamb Weston-Meijer (LWM): The company produces the French fries at a certain temperature and represent the products they make. The loss in temperature causes the products to decrease in quality which will affect the company's image and can cause an end-result on the overall revenue.

Lineage Logistics: The company is specialised in cold storage of conditioned goods. It stores the French fries of Lamb Weston-Meijer and cools it down to a certain temperature so that it is ready to be transported to clients. If the company receive the products warmer than expected it will cost more energy to cool it down, which can be directly translated to unnecessary costs.

Daily Logistics Group: The company is specialised in cold chain transport. For them the lack of transparency is a problem, the lack of trust and uncertainty creates dispute for the logistics service provider. Therefore, the extra handling it needs to take in order to be trusted creates inefficiency in transport.

Spark! Living Lab wants to create sustainability and appointed students to work on this use-case.

Consumer: Potential decrease of quality arises from the loss of temperature during the whole process and consumers are on the receiving end of it.

3. **When is it a problem?**

When the quality of the product is affected in a negative manner, that is when the problem occurs for the whole chain and those involved.

4. **Why is it a problem?**

- There is a lack of trust between partners, dispute can occur.
- Decrease in the products quality.
- It requires more energy which generates costs.
- Extra handlings are necessary in order to be transparent which causes inefficiency in transport
- It has an impact on the whole chain overall and those involved.

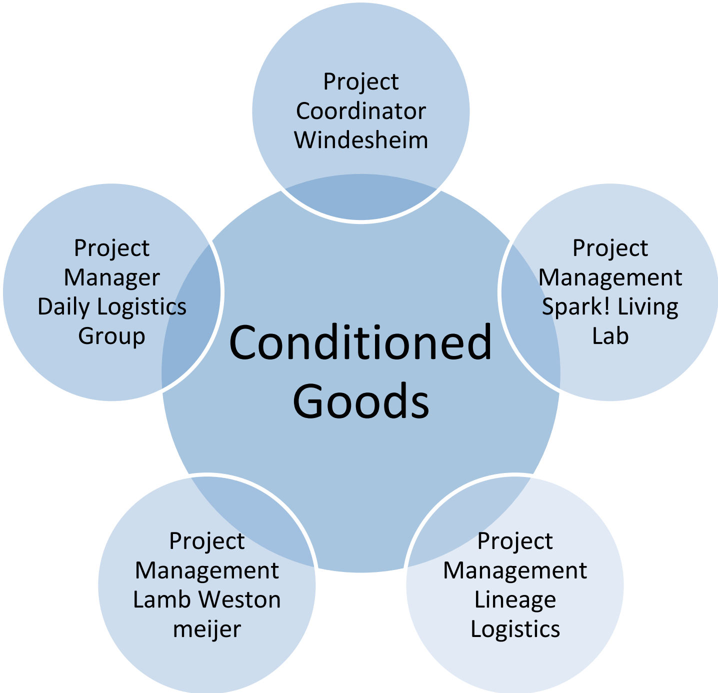
5. **Where does the problem occur?**

The problem of temperature loss occurs when the French fries leave the production site and get transported to the cold storage in Bergen op Zoom.

6. **What is the reason it's a problem?**

As stated before, the world changes at a rapid pace, companies want to create sustainability. In order for that to happen, companies need to be transparent with their partners and trust them completely so that they can compete in the market. Certain technologies are able to provide that.

Appendix III: Project organisation



Project Coordinator Windesheim

The project coordinator of Windesheim provides students to participate in this project.

Project Management Spark! Living Lab

Maxime Bouillon is responsible for students who are participating in the Conditioned Goods project, some of the students work on preparations and developing. The results of the students will have an impact on this project.

Project Management Lamb Weston-Meijer

Jos Gommers and Matthijs Tomeij are responsible for providing the use-case. They work in service of Lamb Weston-Meijer and are very present in this project. The company wants to improve their current supply-chain and see possibilities in the application of Blockchain Technology.

Project Manager Daily Logistics Group

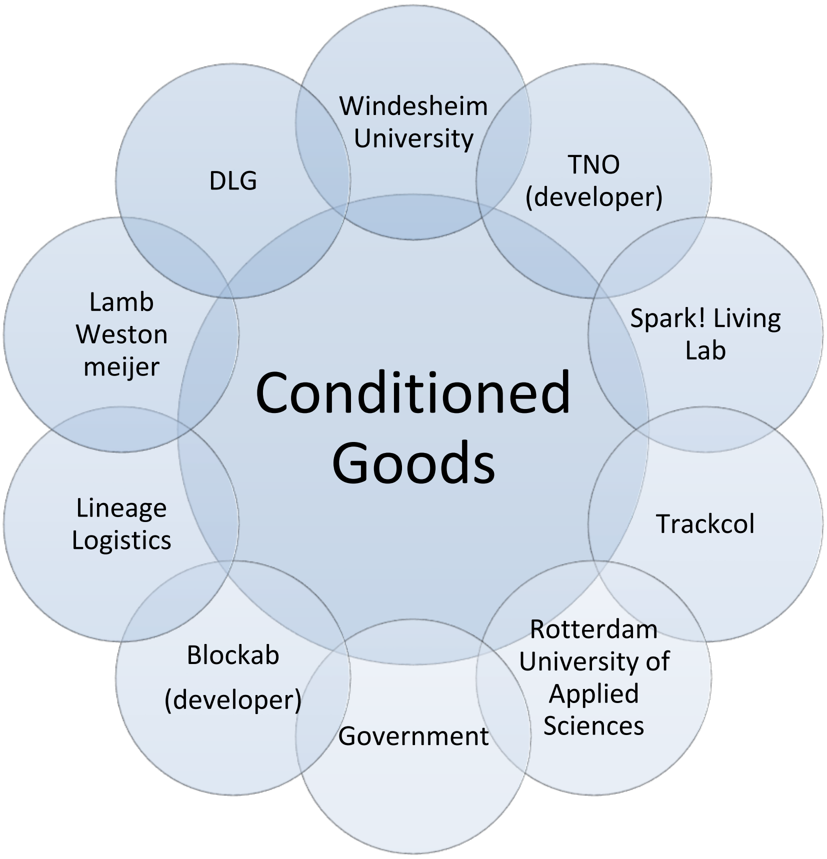
Daily Logistics Group is a Logistics Service Provider. They work with Lamb Weston-Meijer and also participate in this project. The field of significant importance for them concerns Track and Trace.

Project Management Lineage Logistics

Lineage Logistics is a storage faciality for food specialised in Conditioned Goods.

Appendix IV: Secondary Stakeholders

These are all the stakeholders and partners that are involved in the Conditioned Goods use-case. These stakeholders and partners all have an interest or impact on the Report to a certain extend.



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Appendix V: Conditioned Goods use case Spark! Living Lab Interview – New Scope

Date: *09-03-2021* **Time:** *15:00 – 15:50* **Absent:** *Diana van Zielst, DLG*

Attendees of the meeting:

Name	Company	Function/Role
Maxime Bouilon	Spark! Living Lab	Co-leader Conditioned Goods use case
Soeber Farax	Spark! Living Lab	Internship for the Conditioned Goods use case
Jos Gommers	Lamb Weston-Meijer	Strategic Supply-Chain
Mathijs To+--meij	Lamb Weston-Meijer	Innovation specialist
Martijn Timmermans	Lineage Logistics	Logistics improvement Manager
Luca Gelsomino	Windesheim University	Supply-Chain Finance/ Senior Researcher
Victor van der Hulst	Windesheim University	Co-leader Conditioned Goods use case

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"What do you think we should focus on during the Conditioned Goods Research, what is the area of application we should look at?"

We produce our French fries at a temperature of around minus 7 or 8 degrees Celsius. Then the fries are transported to the cold store. It will stay in the cold store for a couple of days in order to get could enough for delivery towards final customers.

In order to deliver/start delivery the product has to be minus 18 degrees Celsius or colder. There are a couple of challenges. first of all, when the product arrives at the cold storage warmer than the agreed temperature:

- it will require more energy to get the product colder.
- It could also cause a moment of disputed between partners.
- The product will decrease in quality because it doesn't have the required temperature.

Because of sustainability, we are also looking at other ways of transporting the product from production to the cold storage. Currently, it is loading the products into the truck and then unloading the products into the cold storage. However, we are looking for other modalities such as train and ships to use for transport to cold storages. knowing that there will also be a case of potential dispute regarding temperature.

We want to be able to measure and monitor the temperature from loading the truck at the production site until the cold storage. The last step in the production process is the cold storage.

"Assuming that you are looking at other modalities to transport products to the cold storage must imply that it is located relatively far away?"

We have three main warehouses, biggest is with Lineage in *Bergen op Zoom.* The cold storage is managed by Lineage. To improve our sustainability we look at other modalities to transport the products towards this particular cold storage.

"What is your perspective of the previous asked questions, (Martijn Timmermans (Lineage))?"

The whole process of transportation is fully automated. We also believe that during transport that the loss of temperature does not occur. However, we speculate that the loss of temperature occurs at the moment we accept the goods, when we receive the goods and when we start with certain handlings (the checkpoints are loading and unloading).

Timmermans also stated that he is not aware of problems related to temperature at the moment. He also believes that the decrease in temperature of the goods (around minus 6 or 8) does not affect the customers ordering process. Because of QA stock-time which block the pallets for 3 to 5 days before the can get ordered. In the last two years he also never had issues with pallets that arrived to warm at customers. Jos Gommers made an important remark on this however by stating that the scope has been changed from outgoing to ingoing.

"From production to storage there are checkpoints at loading and unloading the goods, how often is that checked (Jos Gommers (LWM))?"

Checks of temperature are made at loading and unloading. However, LWM is a 24-hour business, meaning that it is uncertain if they company actually checks the products during at these checkpoints on every hour. The company believes its workers do it, but it is still uncertain. Furthermore, some more remarks regarding the process:

- The checks are conducted manually.
- The checks are registered on paper as well.
- The owner of the data is the truck driver.

After the truck driver arrives at the cold storage, he proceeds to give Lineage the paper regarding the temperature. Lineage stores the data on an Excel file.

"how the data gathering is actually being made in the current situation (Jos Gommers (LWM))?"

Jos and Mathijs have spoken to the production site in Oosterbierum. They said that they would like to participate in the research and are open to help, even offering to show their processes. In Oosterbierum there are two lanes:

- One lane goes into the storage part and afterwards get loaded.
- And there is one lane that directly goes to the loading dock.

The reason why one lane goes directly and the other doesn't is unknow, but it is speculated that it has to do with the capacity of trucks.

"Is there a boundary or limit to where the products can drop in temperature but not lose quality (Jos Gommers & Mathijs Tomeij (LWM))?

Internally I have asked that question already, currently research is being conducted to where the rise in temperature can be acceptable without affecting the quality of the French fries. However, the company assumes that the loss in quality occurs when the temperature goes above minus 8 degrees Celsius.

"How are the products checked on temperature (Martijn Timmermans (Lineage Logistics))?"

- The shuttle driver must temperature 1 pallet per load.
- The probe should be cleaned with an alcohol swab before inserting it into the product.
- After loading at the production site of LWM, the driver inserts the thermometer in between the nearest boxes.
- Upon arrival Lineage Logistics Bergen op Zoom, the driver opens his doors and reads the temperature of the thermometer and record the measured temperature on the "Shuttle trailer check form".

LWM: on the bottom corner of a box around the second or third stacked box (view from above).


If the temperature is found to be warmer than minus 8 degrees Celsius, the operational manager of Lineage Logistics (Bergen op Zoom) must be notified immediately and they will take further action towards LWM.


During loading, the temperature is measured between the boxes, as it is not possible to enter the core of the products. Validation of DFI has shown that the temperature between the boxes is warmer than the actual core temperature of the product. From the validation, the maximum temperature to charge is minus 9 degrees Celsius measured between the boxes. The measured temperature is noted on the CMR and the exit control forum from the customer. The hottest temperature is noted on the shuttle trailer control form.

Important remarks

- Lamb Weston-Meijer does not know where the loss of temperature takes place in the process from production to cold storage.
- Lamb Weston-Meijer wants to participate in this exercise in order to create a measurement situation that should act as a preventive mechanism for in the future, so that they can add (maybe) more steps in between the process (such as other modalities).
- The focus of Lamb Weston-Meijer is getting the measurements right, not solely problems that they are having right now.
- It only takes a couple of hours for the whole process of loading and unloading to occur.
- In the future Lamb Weston-Meijer wants to make use of other modalities which can increase the lead time from hours to days. However, they want to make sure that for all parties in the chain the products arrive cold enough.
- Legal requirement is that the product has to be minus 18 degrees in order to be delivered to the customer. However, there are no legal requirements, just agreements between partners when the products are produced at the production site. Because it requires more energy to get the products from minus 6 to minus 18 than minus 8 to minus 18, for that agreements are established.

Appendix VI: Current cases – Blockchain in the Supply-Chain

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 optimise 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 optimisation 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.

Appendix VII: Counsellors Roles and Responsibilities

In this appendix the roles and responsibilities of the counsellor from the university as well as the one from the company are mentioned for a successful result in cooperation concerning this research. The main goal is to create a healthy form accountability and responsibility (Hogeschool Rotterdam, 2021).

University Counsellor Rolls & Responsibilities:

- Act as the first point of contact during graduation on substantive matters;
- Conduct counselling discussions and comment on intermediate products;
- Monitoring the level of graduation; To this end, he will sometimes involve another teacher or the second reader in assessing intermediate products (action plan, interim Report, draft research report).
- Taking a company visit during graduation (usually during the interim nomination) and conducting a performance appraisal together with the company counsellor during that visit;
- Ensuring good coordination between the school and the graduation company
- Solving any problems;
- Assessing the final presentation and graduation work together with the second reader and the external examiner from the professional field.
- If necessary, formulate an additional assignment and supervise the student until graduation is completed.

Company Counsellor Rolls & Responsibilities:

- Taking care of your introduction to the organisation
- Help you learn in practice
- Maintaining contact with and being the point of contact for the teacher supervisor
- Conducting a weekly counselling conversation with the student (s) and commenting on intermediate products
- Attending the interim presentation in the company
- Conducting a performance appraisal together with the teacher counsellor during the company visit of the teacher counsellor
- Fill in the ‘LM Company Graduation Assessment Form’, see Chapter 6. The student ensures that this form is uploaded in PraktijkLink before the graduation session.
- Participate in the graduation session in the role of observer / advisor and explain the assessment of the student
- Complete the evaluation form that will be sent by e-mail after graduation

STAGEOVEREENKOMST

- Stichting Christelijke Hogeschool Windesheim, gevestigd te Zwolle, te dezen rechtsgeldig Vertegenwoordigd door Derk Jan Kiewiet, Directeur Kenniscentrum Strategisch Ondernemerschap, verder te noemen: Windesheim;

- Soeber Farax geboren 11-11-1998 te Hoogeveen, als student ingeschreven bij de opleiding Logistiek Management van de Hogeschool Rotterdam, hierna te noemen: de stagiair;

Verklaren de navolgende overeenkomst te zijn aangegaan:

Artikel 1 Duur en karakter overeenkomst

1. Windesheim stelt de stagiair in de gelegenheid in verband met zijn/haar opleiding praktische ervaring op te doen binnen het Lectoraat Supply Chain Finance/Spark! Living Lab (naam School/dienst) van Windesheim.

2. Deze overeenkomst is aangegaan voor bepaalde tijd en gaat in op 8-02-2021 en eindigt op 02-07-2021. De stagewerkzaamheden hebben voor de stagiair een omvang van 32 uur per week.

3. De dagelijkse werktijd voor de stagiair is in overleg waarbij rekening wordt gehouden met verplichtingen vanuit de opleiding.

4. Deze stageovereenkomst is geen arbeidsovereenkomst in de zin van artikel 7:610 van het Burgerlijk Wetboek en is ook niet als zodanig bedoeld.

Artikel 2 Uitvoering werkzaamheden en begeleider

De stage betreft een onderzoeksstage. De stagiair zal tijdens deze stage meewerken in het onderzoek

en kennismaken met het toekomstige werkveld. Specifieke werkzaamheden in het Spark! Living Lab project worden tijdens de stage met elkaar besproken.

Windesheim heeft de taak van begeleider van de stagiair toegewezen aan Maxime Bouillon.

Vanuit het Kenniscentrum Strategisch Ondernemerschap wordt de stagiair begeleid door Maxime Bouillon, onderzoeker Supply Chain Finance, die tevens optreedt als contactpersoon voor Windesheim.

Artikel 3 Stagevergoeding en vergoeding kosten

1. De stagiair heeft gedurende de tijd dat hij/zij als stagiair bij Windesheim in het kader van zijn/haar opleiding werkzaam is recht op een stagevergoeding van € 350 bruto per maand. Windesheim zal de verschuldigde wettelijke lasten (loonheffing en premies sociale verzekeringen) op deze stagevergoeding inhouden.

2. Windesheim vergoedt aan de stagiair de kosten die direct zijn verbonden aan de werkzaamheden in het kader van de stage als bedoeld in artikel 2. Tot deze kosten behoren in ieder geval:

a) een vergoeding van de door de stagiair daadwerkelijk gemaakte noodzakelijke kosten woon/werkverkeer op basis van de tarieven van het openbaar vervoer (trein tweede klas);

b) een vergoeding van de reis- en verblijfkosten die op uitdrukkelijk verzoek van Windesheim worden gemaakt ten behoeve van de werkzaamheden als bedoeld in artikel 2. Ook deze reiskosten worden vergoed op basis van de tarieven van het openbaar vervoer (trein tweede klas), tenzij anders wordt overeengekomen. Artikel 4 Verplichtingen bij verzuim wegens ziekte stagiair

In geval van verzuim wegens ziekte is de stagiair verplicht Windesheim direct van dit verzuim op de hoogte te stellen. De stagiair zal daarbij de procedurevoorschriften zoals deze gelden voor de medewerkers van Windesheim in acht nemen.

Artikel 5 Beëindiging overeenkomst

1. Deze overeenkomst eindigt door het verstrijken van de termijn waarvoor zij is aangegaan.

2. Tussentijdse beëindiging vindt plaats:

a. met wederzijds goedvinden;

b. door opzegging, bij niet of niet behoorlijke nakoming door de stagiair van de overeengekomen afspraken;

c. indien en vanaf het moment dat de stagiair tijdens de in artikel 1 lid 2 genoemde periode niet meer als student is ingeschreven bij Logistiek Management van de Hogeschool Rotterdam dan wel door Logistiek Management van de Hogeschool Rotterdam als student is geschorst.

Artikel 6 Aansprakelijkheid

Windesheim is niet aansprakelijk voor eventuele schade en/of letsel, die de stagiair in het kader van de stagewerkzaamheden heeft opgelopen, behoudens opzet of bewuste roekeloosheid van de zijde van Windesheim ter zake van het ontstaan van de schade en/of het letsel.

Artikel 7 Vertrouwelijkheid informatie en auteursrecht

1. Alle informatie die de stagiair in het kader van deze overeenkomst over Windesheim verneemt, zal als vertrouwelijk worden beschouwd en mag uitsluitend ten behoeve van de uitvoering van de in deze overeenkomst genoemde werkzaamheden worden aangewend.

2. Windesheim en de stagiair komen overeen dat aan Windesheim het auteursrecht toekomt op zowel de werken in hun geheel als op onderdelen daarvan, die de stagiair in het kader van de

stagewerkzaamheden voor Windesheim tot stand brengt.

Artikel 8 Geschillen

Geschillen die voortvloeien uit deze overeenkomst zullen zoveel mogelijk in onderling overleg tussen partijen tot een oplossing worden gebracht. Indien geen oplossing kan worden bereikt, is de rechtbank Zwolle / Lelystad de tot behandeling van het geschil bevoegde rechter.

Artikel 9 Slotbepaling

Alle partijen verklaren een afschrift van deze overeenkomst te hebben ontvangen

Aldus in tweevoud opgemaakt en overeengekomen op 17-02-2021

Derk Jan Kiewiet

Directeur Kenniscentrum Strategisch Ondernemerschap

Windesheim

De stagiair

Soeber Farax