

THE ADDED VALUE OF BLOCKCHAIN FOR NIJKAMP RAALTE

FINAL REPORT

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Preface

This consultancy research report is part of the minor Innovative Logistics & IT from Rotterdam University of Applied Sciences. Within a total of 20 weeks, five students from logistics management, logistics engineering and industrial engineering worked on this report to provide the client, Mr. Nijkamp from Nijkamp Raalte farm, a consultation about the possible implementation of blockchain technology.

The initiative to start this project came from a dairy and broilers farmer. He noticed how blockchain technology was used on a farm in China and the US and decided to find out whether it can also be a solution for his company.

The motivation from us, the students, started because we wanted to learn more about blockchain and think that blockchain technology is an innovation that will be widely used in the future.

This report is addressed to our supervisor Klara Paardenkooper and the client Robert Nijkamp.

We would like to thank Klara, Robert and also Josanne, Ilhan, Chris, Stefan and Jeroen for their help and interesting insights.

Rotterdam, 08-01-21

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Executive summary

The main goal of the project is to give advice on how to increase the negotiation power of Nijkamp Broiler Farm by improving transparency using Blockchain Technology within 20 weeks. The main question that helped to reach this goal is: ***In what way can blockchain technology improve data integration and add value to Nijkamp and its partners in the supply chain?***

This project focuses on the process from breeder to the consumer. The data from these processes will be integrated with the help of blockchain technology.

The problem in this research is the lack of data integration between the systems of the stakeholders. It is a problem because this shortcoming leads to inefficiency of the data output. Specifically the problem is between the sensors data (input) and the systems data (output). The problem lays with Robert Nijkamp, a dairy and broilers farmer. Mister Nijkamp works together with other farmers who have similar issues, but the focus of this research is on Nijkamp's company. The problem started when Mister Nijkamp realized how much time he spends on data analysis and mostly visualizing that data. The problem's context is the lack of a system or function that integrates data in a way that it could be inserted automatically, without human interference and keeping the data safe.

Outcomes

By analysing the current situation of the company, several bottlenecks came in sight. With the collaboration of a company who provides a digital quickscan for our client, the following bottlenecks were identified concerning the problem of automation and implementation of a possible solution:

- Current systems and automation do not support the process enough and do not work in an efficient way.
- Data analysis is not done in an efficient and user friendly way
- Hard to find which external party can help with digital solutions
- Hard to find partners in the supply chain to strategically participate in the common digital solution.
- Data quality issues regarding: reliability, completeness and accuracy.

Recommendations

On the basis of the bottlenecks that were identified, recommendation to improve digitalization were made. The most important recommendations are as follows:

- **Robotic Process Automation (RPA)**, to automate minor but time consuming and error-prone tasks. For example copy and paste data from one system to another or sending data to other parties.
- **Data Analysis improvements** using data from different sources that come together in a **dashboard**.
- **Plan for collaboration with other farmers** to create transparency, good internal relations and to implement and maintain the blockchain and organize all topics that come with it.

With the use of a blockchain technology – decision tree, the outcome was that Nijkamp Raalte is ready to explore the options to implement blockchain. By performing this research the choice of a **private permissionless or permissioned** blockchain is advised. The cost items are: hardware, software, bandwidth, energy, tech support and organisation. Depending on the complexity of the solution, options and tailoring of the blockchain, the costs range is around €5 000 – €200 000.

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1. Introduction

This is the final report of the blockchain project of our client Nijkamp Raalte. The first period consisted of setting up a plan of approach by selecting models that should be used during the research. Furthermore, several interviews have been taken, including the first meeting with the client as well as the second interview in which a quickscan was performed. This quickscan was to obtain a better insight of the company's processes. It was a comprehensive conversation in which a lot of information was received and processed.

The scope of project was slightly changed not long before handing in the midterm report. It was changed from a theoretical set up to a more practical implementation of blockchain technology for our client.

The second period existed of writing the final report. The quickscan was used as a basis of the project from which the bottlenecks and improvement areas were written. Furthermore, the new situation is sketched and a conclusion is given. This conclusion gives answer on our central question. The planning of his project is shown in appendix 1

1.1. Background

Nijkamp Raalte is a dairy and broilers farm, located in Raalte, The Netherlands. It was founded as a farm with cows, pigs and chickens in 1935 by Mr Nijkamp. Since then, the farm was passed on to the next generations, and currently Robert Nijkamp owns it. (Nijkamp, 2020)

A farm nowadays is not comparable to the farms of the past. For example, this farm prioritises the health of animals and sustainability. The health of animals can have an effect on the customers because in the today's society people care about animal wellbeing. Furthermore, the same priority is given to sustainability because of the climate change. The farm started using solar panels in 2011 and hot water panels in 2017 to maintain this responsibility. Mr Nijkamp also opened a part of the farm called Windstreek house in 2015. This house was a significant improvement in the area of integral sustainability (Nijkamp, 2020).

The distinctive feature of this farm is its focus on data. Mr Nijkamp implemented a system that can monitor each animal with the help of sensors and chips. Thanks to this system information can be gathered, for example, about where the broilers have been or how much they have eaten. This data generates added value at a higher level, because consumers have an interest in the welfare of broilers. Mr Nijkamp hopes that by the control of his data he could gain more power with this knowledge relative to the supermarkets, as they have an important position in the chain.

Furthermore, Mr. Nijkamp also started a corporation called Farmersnet. Farmersnet consist of a group of farmers and has been created to share data via a database. By storing shared reliable data, a group of farmers can gather all the shared data and approach other parties in the market, for example the slaughterhouse. This shared data allows the farmers to negotiate better prices and also gives them more power. (Nijkamp, 2020)

In order to successfully share data trust between the parties is crucial, because data is sensitive and can be used against the company. That is why Mr Nijkamp has started to cooperate with students of Rotterdam University of Applied Sciences. Mr Nijkamp requested the students to research how blockchain can help the company gain more power to negotiate.

1.2. Problem description

- **What** is the problem:
The problem is the lack of data integration between the systems of the stakeholders
- **Why** it is a problem:
The lack of data integration is reducing the efficiency of the data input.
- **Who** has the problem:

Robert Nijkamp has this specific problem. Nijkamp works together with other farmers who have a similar issue, but the focus is on Nijkamp.

- **Where** is the problem:
The problem is between the sensors(data input) and the system (data output).
- **When** did the problem start?
It started when Mr Nijkamp realized that a lot of time is lost in the process.
- **What is** the context of the problem?
The problem's context is the lack of a system that integrates data in a way that it can be inserted automatically, without human interference, furthermore, keeping the data safe.

There is a lack of a data integration system between output and input, increasing the time in which this data insertion. (RNi20)

1.3. Research question

The main research question is as followed:

“In what way can blockchain technology improve data integration and add value to Nijkamp and its partners in the supply chain?”

1.4. Objective

External Objective: The goal is to give advice on how to increase the negotiation power of Nijkamp Broiler Farm by improving data transparency concerning salmonella status of the broilers using Blockchain Technology within 20 weeks.

Internal Objective: For the students to gather and interpret the necessary information regarding blockchain technology, to evaluate if the information creates transparency and analyse how it affects the negotiation power within 20 weeks.

1.5. Sub-questions

In order to answer the research question and design the solution for Nijkamp, the following sub-questions will be addressed:

1. What does the current process of Nijkamp look like?
 - 1.1 In what way is the process being managed?
 - 1.2 In what way do information flows move in the process?
 - 1.3 How is salmonella information detected and shared in the process?
2. What are the bottlenecks of the current process?
 - 2.1 What kind of technology do Nijkamp and the stakeholders use?
 - 2.2 Which improvements can be made in the current process in order to achieve transparency and data integration?
3. In what way can blockchain add value in the form of transparency and data integration?
 - 3.1 What data needs to be shared among the stakeholders?
 - 3.2 In what way can the data of the stakeholders be integrated?
4. In what way can blockchain technology be implemented so that data integration and transparency between the parties can be achieved?
 - 4.1 What steps need to be made?
 - 4.2 What are the costs and benefits of the implementation?

4.3 What is the duration of the implementation?

4.4 What are the risks of the implementation?

5. In what way will the solution be evaluated?

5.1 What criteria will be used for the evaluation?

5.2 What results are expected by the client?

1.6. Scope

Inside the Scope

This project focuses on the process from breeder to the consumer (see figure below).

The data from these processes will be integrated with the help of blockchain technology.

Outside the scope (clarification)

The focus lies on Nijkamp Broiler Farm, and on their partners, they will only be involved as stakeholders.

The researchers will gather and analyse information regarding blockchain technology. The whole supply chain of Nijlamp is showed in Figure 1 The implementation itself will not be included in the research but the desired solution will be described in detail.

To prepare the ground for transparency, the current situation will be analysed. Other innovative actions involving Nijkamp Broiler Farm that do not regard blockchain technology will not be researched.

As for the type of data this research focuses on chicken health data, especially salmonella and possibly more aspects like use of antibiotics. This focus has been chosen in accordance with the client's requirements.

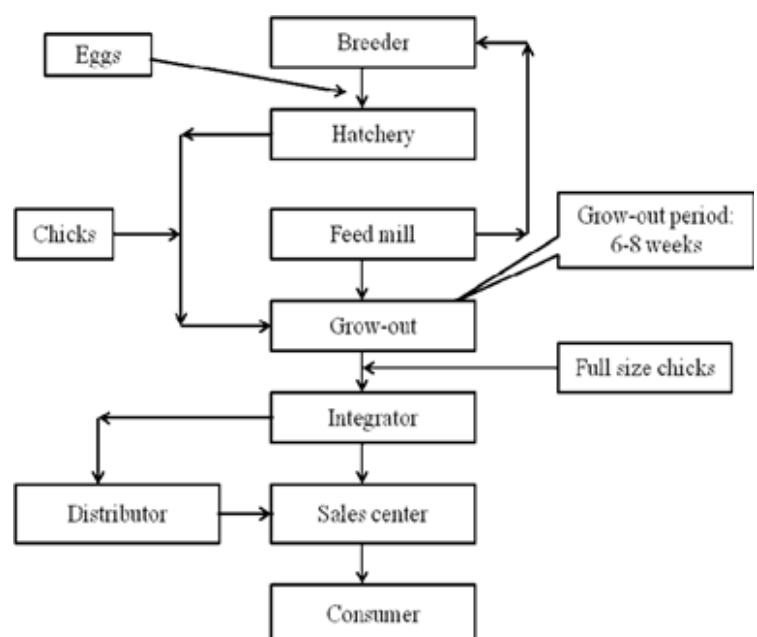


Figure 1: Scope of project

(Nijkamp, 2020)

1.7. Reading guide

The chapters of this report are divided over three phases: orientation, research and solution, shown in Figure 2.

Chapter 1, Introduction: This is the part where the project assignment is introduced and explained

Chapter 2, Theoretical framework: This chapter explains the main subjects of the project: blockchain technology, poultry industry and salmonella.

Chapter 3, Research design: Explains which certain models are chosen and why. Furthermore, it clarifies in what way the models are used in this project.

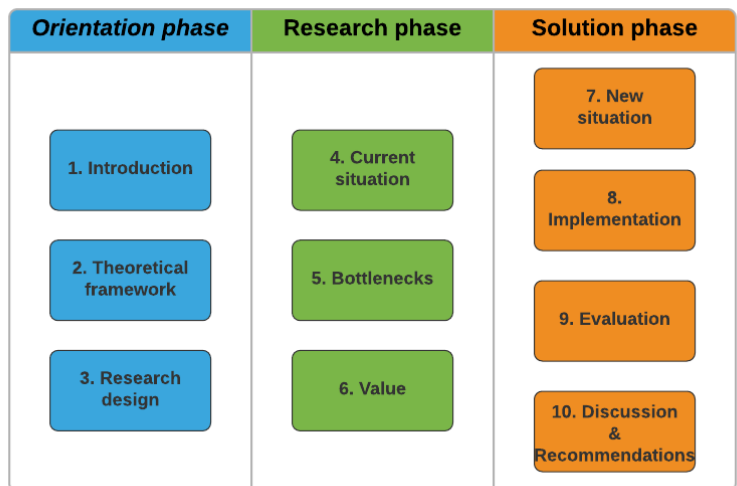


Figure 2: Reading guide

Chapter 4, Current situation: This chapter explains the current situation at Nijkamp on different levels: stakeholder, process and variables.

Chapter 5, Bottlenecks: The bottlenecks of the current situation are defined in this chapter. The research is done with the Digiscan and Olson criteria.

Chapter 6, Value: Value describes the added value of Nijkamp and also explains whether blockchain is needed in this case.

Chapter 7, New situation: The desired situation based on the bottlenecks is defined in the new situation. This chapter is divided into digital solution, process optimization, collaboration stakeholders and data quality and analysis.

Chapter 8, Implementation: In this chapter an implementation plan is written together with a cost and benefit- and risk analysis.

Chapter 9, Evaluation: The solution is evaluated by the client and tells if the outcome is a success or not.

Chapter 10, Conclusion, Discussion, Recommendations: A brief all-encompassing conclusion is written, together with some discussions and internal- and external recommendations.

2. Theoretical framework

In this chapter, the structure of the research will be explained. All the literature that is already available is listed, and all the models that will be used in the final report are elaborated. The last part of this paragraph consists of the conceptual model, with a schematic overview of the research.

2.1. Literature

Before gathering information, literature is needed, such as books, research papers, case studies, and interviews. This literature can be used as an inspiration source as well as an information source. The source must be reliable; therefore, only scientific and trustworthy literature will be used, meaning that research will be done on, for example, the university catalogues, library, and Google Scholar. The author will be traced in case of any doubt of the source to guarantee reliability. The used sources will be formulated in APA style.

The following sources will be helpful to finalize our research on blockchain technology:

- A systematic literature review of blockchain-based applications: The Current status, classification and open issues - (Casino , Dasaklis, & Patsakis, 2018)
- Waar is blockchain toepasbaar in de logistiek en wat doet dat met de waardepropositie? - (Katen, Duin, Lont, & Paardenkooper, 2020)
- Business analytics techniques - (Cadle, Paul, & Turner, 2014)

2.2. Conceptual framework

Figure 3 shows that data integration creates value for the company and that value consists of transparency and power that this data integration facilitates.

The methods and models for this report have been selected based on the previous research, namely the article *“Waar is blockchain toepasbaar in de logistiek en wat doet dat met de waardepropositie? Een basis voor een business scan voor het mkb”* by J.Heeroma-ten Katen, R. van Duin, Y. Lont and K. Paardenkoper.

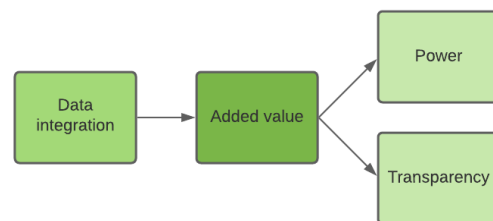


Figure 3: Conceptual framework

2.3. Poultry industry. What needs does it have?

This section gives an insight into the poultry industry. It explains the power factors, stakeholders, current collaborations, transparency, validity of data and chances for improvements.

2.3.1. Power factors in the poultry industry

In this section, the stakeholders of poultry industry will be introduced and it will be explained what kind of power they have and what it depends on. Besides, it will be shown what role product quality, sustainability and data sharing play in the industry. In the end, a conclusion will be made about how this power balance can benefit from implementing a data sharing technology like blockchain.

2.3.2. Interaction of the parties: who makes the rules

Nijkamp broiler farm is not the strongest player in this chain. The farm is largely influenced by the slaughterhouse rules. Another strong player and the most wealthy party are retailers (e.g. supermarkets). It could seem that Nijkamp as a farm would be influenced by the consumers' preferences who care about the quality of meat and sustainability. But it is not so. The consumer is disconnected from the farm and choices of consumers are in the retailer's territory. In the future Robert Nijkamp would like to see it change and have a more direct interaction with the consumer and therefore a shorter chain. Some farmers can for example sell chicken directly to the consumer, without the other parties (Nijkamp, 2020).

Slaughterhouse. Nijkamp Raalte is competing with the slaughterhouse for the control over the price and the number of birds. Slaughterhouses have a strong power position because of their network of retailers and other farmers.

Retailers are also quite powerful in the supply chain. They can even have their own supply chain and be able to cooperate with another company only to copy the product and replace it with their home brand afterwards. So other companies have to protect their chain against being taken over by the retailers (Verhoef, 2020)

As for **feeding company**, Nijkamp cannot choose the company or the feed themselves. The slaughter company assigns Nijkamp to a specific feeding company and decides on the amount and timing of feeding. If Nijkamp deviates from this norm, the slaughter company will find another farm. (Nijkamp, 2020)

The **government** is responsible for setting up regulations and restrictions regarding chickens and can influence all parties of the supply chain. Food safety is the most burdening regulation for the companies in the whole chain to comply with (Verhoef, 2020).

Other **farmer companies** can be competitors or not but can also cooperate to achieve more power together (Nijkamp, 2020).

2.3.3. Factors in the industry

Trust and quality

Most of the time the parties have to assume that their supplier tells the truth and delivers a quality product (good chicken meat) without special verifications. The evaluation of meat products is largely based on the experience of the farmer. They can tell what meat is good based on its smell and texture. It is possible to do tests using syringe, but they are rarely used, the workers find it inconvenient and unnecessary. The relations of suppliers and clients are often long and based on trust, so there is a tendency to accept the product from a trusted supplier and skip some "unnecessary" checks (Verhoef, 2020).

Sustainability

It could seem that sustainability is in demand, is hard to achieve and can give businesses power. It is indeed a trend from a consumers' perspective, but not for the other parties. The slaughterhouse is actually not interested in Nijkamp getting more "Better Life" (NL: "Beter Leven") stars, they are more focused on their own specific standards to be fulfilled. Some of these standards are related to sustainability, but the rest not.

On the other hand, parties with controlling authority, like the **government** and **licensing parties** do have interest in sustainability. They have an important role in promoting sustainability and animal welfare by approving or banning the methods of work and setting standards. They are in contact with every company in the supply chain and put emphasis on ethics and quality.(Chris) If Nijkamp meets these requirements then they can continue existing as a company and get the needed certificates and licenses. (Nijkamp, 2020)

Data validity and sharing

By using data Robert Nijkamp would like to gain more power for his company and other farmers. He hopes to work together with the slaughter company, not against them. (Nijkamp, 2020)

Where data can help

Proper exchange of data can be very valuable for the companies in the poultry industry for several reasons. The gathering of data can help establish the cause of a problem fast or even prevent disasters like salmonella outbreak. If necessary measurements are done regularly, it would be easy to localize where something started going wrong. This is very important for food safety and the stability of the industry.(Verhoef, 2020)

Exchanging data helps maintain the good quality of the product (chicken meat) itself. For example, communicating information regarding the temperature and humidity of the truck that is supplying unhatched eggs, Nijkamp Broiler Farm can adjust their temperature and humidity levels to create the perfect hatch environment, so that the chickens can have better health and the quality of meat is then also better. Also Nijkamp farm works with batches now, the quantities however are not very convenient for Robert. By exchanging data agreements about more optimal quantities can be made (Nijkamp 2020).

Other parties like retailers can help farmers too. The retailers like Albert Heijn can provide information about consumer trends (what kind product is/will be in demand) and the farmers can grow their product accordingly.(Chris, 2020)

2.3.4. Current collaborations

Nijkamp Raalte works together with a few other farmers to optimize data overview and exchange, at the moment they are testing a dashboard for it. The most important measurements for the dashboard and the future blockchain need to look simple. Not everything has to be in it. They use a lot of sensors to report the health of the chickens so this data is the most important. There are now 30-35 farmers involved in his project.. In one or three years, Robert would like more than half of the farmers in the Netherlands involved. There are 600 broiler companies in Holland in total.

The slaughter company is already involved in a new IT project at the farm which includes all the data flows in the company, to exchange data from the farm to the slaughter company and the other way around. It is not sure if they want to be involved in blockchain, but if they do, other parties might join too, like the hatchery. If the slaughter company says they have to, they probably will.(Nijkamp, 2020)

2.3.5. Transparency

Even though sharing data between the parties can be of great value, in this industry it is not desirable to have transparency. It needs to be chosen strategically which data can be shared with whom. Many companies don't want to share data because often it is sensitive or competitive information which can be used in a wrong way and even ruin the business. Also slaughterhouses don't want to be transparent and be known because of competition (Verhoef, 2020).

2.3.6. Validity of data

Data sharing is a task in itself, but whether the data is true is also an issue. Blockchain helps keeping the data intact and authentic after it is put there. But before data enters blockchain it could already be unreliable. Robert says that his biggest concern about data sharing is about the origin of it. Some of the data is not generated automatically, so a third person has to type it into the system. The data can be

altered during this process. Everything would have to be digital, without people interacting and directing with it. (Nijkamp, 2020)

On the other hand, when the data is already in the blockchain, the question is, what data will be seen by who and what consequences it could bring.

2.3.7. Chances for the solution to improve the power balance

The vision of the industry for the future is how it was in the past that chicken meat was a luxury product. Now there is movement towards reducing the quantity in favor of quality and better life for the chickens. Companies would like to be able to prove they are really organic and to know their suppliers are telling the truth. This would help the companies to diversify from the ones that just claim to do so and gain consumer trust.

There are possibilities for farmers to get the certificate faster or get a preliminary document which makes improve the quality and make sustainable decisions easier. Many farmers would find it attractive to use a free tool catered to their needs that would help them earn more money. But the problem is also to make it fair for all stakeholders.

The chance for solutions is to make it easy for the parties to comply with the rules. The companies do not want to expose their vulnerable internal information. But they all need to pass audits and remain in business, so there will be interest in solutions which bring them value and helps avoid problems. They do not want to get fines or be shut down. Therefore for sharing data it would be interesting to store encrypted data and make it available on request.

The sector is conservative and many parties would be resistant to change such as digitalization, but the fear to remain outside will ultimately persuade them consider new technology too (Nijkamp, 2020).

2.4. Blockchain technology

This paragraph explains what blockchain is and how it can be useful. It also describes the technical aspects of blockchain, such as zero-knowledge proof and smart contracts.

2.5.1. What is blockchain?

Blockchain is a technology of distributed ledger (DLT) category, which essentially means an accounting book where all the participants save their records. The technology of blockchain became widely known due to bitcoin digital currency which allowed for payment transactions via an open network without exposing the users' identities.

It is considered to be one of the safest technologies existing nowadays. It is almost impossible to hack which makes it very interesting for applications like storage of financial transactions or healthcare 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 decentralized, 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).

2.5.2. How blockchain works

When a block stores new data it is added to the blockchain. Blockchain consists of multiple blocks strung together. In order for a block to be added to the blockchain, four things must happen:

- First of all, a transaction must occur. In many cases a block will group together with other transactions, also known as the chain of blockchain.
- Secondly, a transaction must be verified. A transaction must be verified with other public records of information. Normally this is done by a third party, however, with blockchain that job is left up to a network of computers.
- Thirdly, a transaction must be stored in a block. The information of that transaction, for example, dollar amount, digital signature and users information will be stored in a block.
- Fourthly, that block must be given a hash. Once all of a block's transaction has been verified, it must be given a unique, identifying code called hash. The block is also given the hash of the most recent block added to the blockchain.

When the new block is added to the blockchain, it becomes available for everyone in that blockchain. (Reiff, 2020)

2.5.3. Advantages & disadvantages

The creation of blockchain technology brought up many advantages in a variety of industries, providing increased security in trustless environments. However, blockchain does also have some disadvantages. The advantages and disadvantages of blockchain are summed up in Table 1 (Golosova & Romonovs, 2018)

Advantages	Disadvantages
No third party needed	High energy consumption
Avoid database security	Signature verification
Each action is recorded	Opportunity to split the chain (the fork)
Increases trust	Balance between node's quantity and costs
Increases transparency	Not all nodes can provide the necessary capacity

Unalterable and indestructible data	High costs
Data is traceable	

Table 1: Blockchain pro's & con's

Advantages

Blockchain technology is known of its decentralized system. In this way it is not necessary to work with a third party anymore. It means that the system works without intermediary and all participants of this blockchain make the decisions. By using blockchain the process of database security can be avoided, because the transactions of the blockchain have own proof of validity and authorization to enforce the constraints. And it means that the transactions can be verified and processes independently.

Each action is recorded to the blockchain and the data records are available to every participant of this blockchain and cannot be changed or deleted. The result of this recording gives transparency, immutability and trust. Transparency is also given due to every participant can look all transactions, also it means, that each action is showed to participants of the blockchain. Nobody cannot do anything insensibly

When the transactions will be connected to the blockchain, it is not possible to change or delete data if the system is decentralized. Each transaction is copied to each computer on this blockchain network. This makes it unalterable and indestructible. Furthermore, data in the blockchain can be traced from start to end.

(Golosova & Romonovs, 2018)

Disadvantages

A significant disadvantage of blockchain is the consumption of energy. The consumption of power is needed for keeping a real-time ledger. The minors are using substantial amounts of computer power. The signature verification is the challenge of the blockchain, because each transaction must be signed with cryptographic scheme, the big computing power is necessary for the calculation process to the sign. It is one of the reasons to the high energy consumption.

Another problem of the blockchain is the opportunity to split the chain. The nodes, which are operating to the old software, will not accept the transactions 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.

The next problem of blockchain is the balance between the nodes' quantity and 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 intensive. However, not all nodes can provide the necessary capacity. Because of this it breaks the immutability and transparency, and blockchain becomes more centralized system.

The high costs are a big disadvantage of the blockchain. The average cost of a transaction lies between 75 and 160 dollars and most of it covers the energy consumption.

(Golosova & Romonovs, 2018)

2.5.4. Kinds of blockchain

There are many different types of blockchain technologies, however in general four types can be distinguished: public versus private and permissioned versus permissionless. Public versus private is generally used to describe whether a blockchain is open to literally anyone with an internet connection. Permissioned versus permissionless is about whether someone needs an approval before using. (hperretta, 2017) A brief overview is shown in Figure 4. (Kapur, Blockchain: What it is and How it Works, 2019)

Public versus private

Anyone can join the network and participate within a public blockchain. A public blockchain is mostly decentralized and does not have a single entity which controls the network. Data on a public blockchain are secure as it is not possible to modify or alter data once they have been validated on the blockchain. Bitcoin and Ethereum are well-known examples of a public blockchain.

Pros: Public blockchains are completely transparent, which is great for building trust in the blockchain. It also incentivizes participants to participate in the network by rewarding

cryptocurrency for work done on the blockchain. It's also good to use in nearly every industry, making it a great option for anyone looking to start using blockchain technology.

Cons: Organizations who are looking to have some semblance of control over their blockchain will not find public blockchain to be an efficient solution.

Private blockchains work based on access control which restrict the people who can participate in the network. There are one or more entities which control the network and this 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 the others will not be able to access it. Hyperledger Fabric of Linus Foundation is an example of a private blockchain.

Pros: Private blockchain networks allow control for administrators, and lets them be more selective with who gets access to the network. In this way, it makes private blockchain a much more secure and reliable option. It is great for organizational blockchain implementation as they require total control over the workflow.

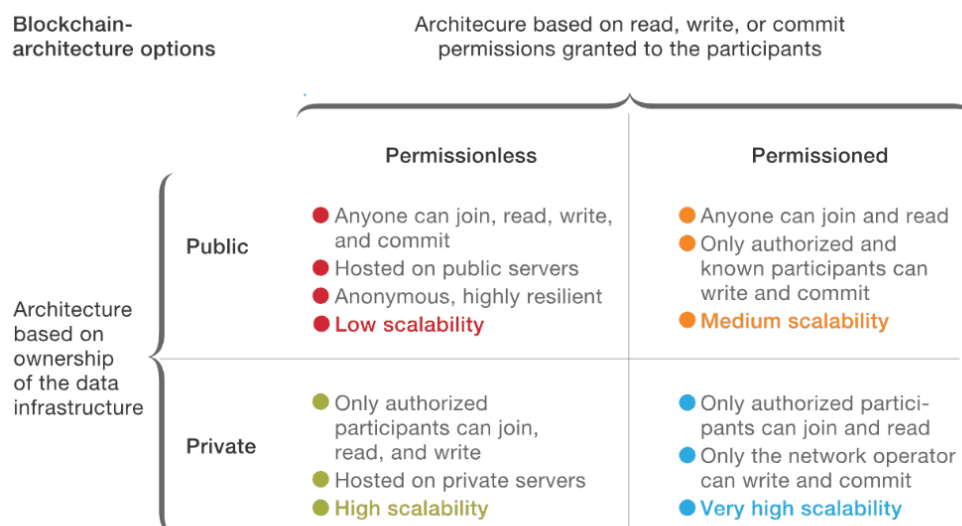
Cons: Unlike public blockchain, there isn't any similar incentive in private networks to have users grow the network. The main goal is not to have more and more people join the network and maintain it, as it is up to the managing authority of the private blockchain network to do that.

Hybrid blockchain aims to combine the best of both public and private blockchain. It still allows administrators to be selective with who gets access while still having features like transparency and security. There is a high level of customization available, as members of the hybrid blockchain can decide who can participate, and which transactions are publicly displayed. The fusion of different features from public and private blockchain systems ensures that companies can work with their stakeholders in an optimal fashion. Dragonchain is an example of a hybrid blockchain.

Pros: It has the benefit of the combination of the best parts of the former types of blockchain. Hybrid blockchains can be as selective or open as they want, and that also feeds into how much they want to incentivize users on the network.

Cons: Not everyone is in a position to be able to implement hybrid blockchain, at least not efficiently. Public blockchain is more affordable and open for most people and organizations, but the payoff of using hybrid blockchain is worth it.

(Readbtc, 2020) (SHARMA, PUBLIC VS. PRIVATE BLOCKCHAIN : A COMPREHENSIVE COMPARISON, 2020)



McKinsey&Company

Figure 4: Kinds of blockchain

(Kapur, 2019)

Permissioned versus permissionless

Anyone who is interested in validating transactions on the network of Permissioned blockchain needs to get approval from a central authority. This can be useful for companies, banks and institutions that are comfortable to comply with the regulations and are very concerned about having complete control of their data. Most permissioned blockchains are also private blockchains but there are exceptions. Ripple is an example of a permissioned blockchain.

The characteristics of a permissioned blockchain are as followed:

- Transparency & anonymity: Permissioned blockchains need not be transparent, but they can choose to be, depending on the inner organization of businesses. In terms of privacy, these are not needed on a central level and can be determined on a user-case basis. These blockchains store an extensive amount of data relating to the operations and transactions carried out by users.
- Varying decentralization: Members of a permissioned blockchain are free to negotiate and come to a decision about the level of decentralization the network can have. Private blockchains can be fully centralized or partially decentralized. These are free to choose the consensus algorithms they wish to employ.
- Governance: For permissioned blockchains, governance is decided by members of the business network. There are various dynamics to determine how decisions are made on a central level. But here, there is no need for consensus-based mechanisms where the entire network must agree to a change.

Permissionless blockchain allows every user to create a personal address and. Begin interacting with the network, by submitting transactions, and hence adding entries to the ledger. Additionally, all parties have the choice of running a node on the system, or employing the mining protocols to help verify transactions. Permissionless blockchain is mostly a public blockchain. Bitcoin and Ethereum are both examples of permissionless blockchains.

The characteristics of a permissionless blockchain are as followed:

- Decentralization: permissionless networks need to be decentralized, which means that no central entity has the authority to edit the ledger, shut down the network, or change its protocols. Many permissionless networks are based on consensus protocols, which means that network changes of any type can be achieved as long as 50% + 1 of the users agree to it.
- Digital assets: In a permissionless network, there is a user-incentivizing token that can increase or decrease in value based on the relevancy and state of the blockchain they belong to. Depending on the purpose, these blockchains either employ monetary or utility tokens.
- Anonymity: Many permissionless networks do not require users to submit personal information prior to being able to create an address, or submit transactions. However, in certain cases, personal information is required for legal purposes. Bitcoin, for instance, does not offer full anonymity, as user identity is indirectly tied to the addresses they have the private keys of.
- Transparency: blockchain networks are bound to be transparent by design. This is a required characteristic, given the fact that users who get involved must be incentivized to trust the network. Therefore, a transparent network needs to freely give users access to all information apart from the private keys – from addresses, to how transactions are processed into blocks, and the freedom to see all transactions processed by the network.

(Dob, 2020) (SHARMA, 2020)

2.5.5. Risks for adoption

There are vast array of applications or problems that can be solved using blockchain technology. However, the adoption of blockchain does not come without any risks. Few of the risks are; behaviour change, bootstrapping, government regulations, Fraudulent activities.

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 USA for example, this may increase customer trust and helps with adoption. In more controlled economies like in China, the adoption will face significant headwind.

Fraudulent activities: The bad guys may misuse blockchain for fraudulent activities like money trafficking given the pseudonymous nature of blockchain transactions and its ease of moving valuables (Crosby, Nachiappan, Pattanayak, Verma, & Kalyanaraman, 2015).

2.5.6. Technical aspects

The technical aspects of blockchain technology can be quite complex and not all knowledge is needed for this project. Below are a few aspects which can be helpful to understand blockchain technology.

Zero-knowledge proof

Also known as zero-knowledge protocol, the zero-knowledge proof is a method is an encryption method that proves to one party that a given statement from a third-party is true. It is useful because one organization can, for example, prove that has specific information without revealing it, keeping their internal privacy. It is secure and straightforward, however, limited, in a sense that the protocol demands the “secret” to be a numerical value, so the other side will have to translate this value to the actual meaning.

- It is mostly used for the following applications:
 - Messaging;
 - Authentication;
 - Storage protection;
 - Sending private blockchain transactions;
 - File system control;
 - Security for sensitive information.

(Bhardwaj, 2020)

Furthermore, a visual example can be studied below, Figure 5:

Zero-knowledge Protocol: Data Exchange

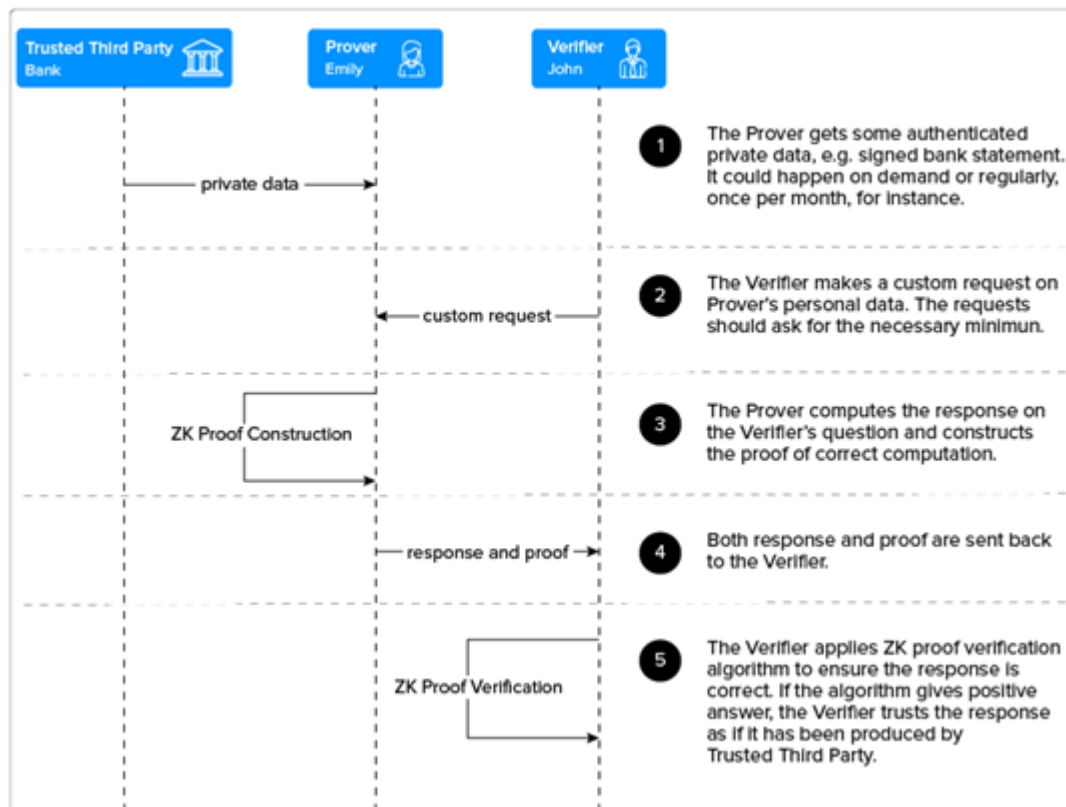


Figure 5: Zero-knowledge protocol

(Bhardwaj, 2020)

Smart contracts

A smart contract is a code that runs on top of the blockchain to facilitate, execute and enforce an agreement between untrusted parties without the involvement of a trusted third party. Smart contracts could help the exchange of money, property, shares, or anything of value in a transparent, conflict-free way, without the intervention of a middleman.

A smart contract has an account balance, a private storage and executable code. The contract's state comprises the storage and the balance of the contract. The state is stored on the blockchain and it is updated each time the contract is invoked.

The added value of a smart contract is that it automatically executes the terms of an agreement once the specified conditions are met. This means that smart contracts have lower transaction fees compared to traditional systems that require a trusted third party to enforce and execute the terms of an agreement. It can be thought of as a system that releases digital assets to all or some of the involved parties once arbitrary pre-defined rules have been met. Smart contracts work on the If-Then principle. If I give you the key, I'm sure to be paid. If you send a certain amount in bitcoins, you receive this specific value. The rules by which a smart contract work are also strict, when the deadline of an agreement is overdue, there is no possible way to exchange the value in the blockchain. Also the code of the contract cannot be changed without all participants of the blockchain knowing it.

Smart contract technology can be compared with vending machines. Using a smart contract, you drop a digital currency into the vending machine and the machine gives you your wanted and agreed value. Smart contracts essentially work the same as traditional agreements, but also use automatic execution and enforcement of the agreement. (Rosic, 2020)

There are two types of smart contracts, namely, deterministic and non-deterministic smart contracts. A deterministic smart contract is a smart contract that when it is run, it does not require any information from an external party (from outside the blockchain). A non-deterministic smart contract is a contract that depends on information (called oracles or data feeds) from an external party. (Alharby & Moorsel, 2017)

2.5.7. Blockchain applications in the supply chain: case studies

This subparagraph contains three examples of companies that are using blockchain technology. These companies have more or less the same goal for using BCT as the goal for this project; to use blockchain to integrate data and data sharing for the company itself and other stakeholders.

Provenance

This company helps brands and other companies to make data behind their products transparent. It includes presenting information about the products and their supply chains, with verified data. For example they show consumers in a store the origin, journey and the impact on the environment of the products. Provenance is not claiming to be ethical or sustainable, but is striving for these ideals. They want to reach it through a commitment to open, accessible information.

Provenance uses blockchain to prove authenticity and origin by creating an auditable record of the journey. The tools they use for it are QR codes and NFC for example.

The company offers many services, like additional promoting of a brand, but their core business runs on blockchain (Provenance, 2020).

Origintrail

Origintrail provides companies a universal data exchange with their supply chain, by connecting their IT systems and make data unchangeable using blockchain technology. They use an open-sources protocol for trusted data exchange and are providing this protocol to different sectors. According to Origintrail there are technical challenges to overcome for IT providers that want to build collaborative applications to establish end-to-end supply chain transparency. The current way of using databases can also be improved, because there is a lack of adequate functionalities and companies are not neutral, because there is no permission inserting the data for example at the moment (Origintrail, 2020).

Minehub

Minehub is a technology company that is digitalizing the paper-heavy and costly processes of the mining & metals supply chain. It is a platform that connects the industry participants into a network, with the goal to have efficiency, security and transparency through the whole supply chain. Minehub uses blockchain technology that will ensure privacy but also provides transparency and traceability of the data, especially the real-time flow of information and products. The parties that are involved are producers, trading houses, logistics service providers and financial institutes (Minehub, 2020).

These three use case could be interesting for Nijkamp Raalte. It could be used as an example to look at when investigating the implementation of a blockchain, to see how these companies are doing. The three are quite big players, so contact with these companies will be difficult. Further research after this project could be done to see what good aspects of these companies can be used for Nijkamp Raalte.

2.6. Why blockchain could be relevant for Nijkamp Raalte case

In the supply chain, blockchain technology is being used for example for checking the authenticity of the goods, tracking them down to the origin and excluding defect products by applying "smart contracts". Nijkamp Raalte is a broiler farm. In the poultry industry, the health safety of the chicken meat and its attractiveness as a meal are the most crucial values. Recently, animal welfare became the third important factor. Unfortunately, companies in the sector often do not have a proof their partners supply a good quality product for them. The decisions are often based on trust and experience. As a result, tragic situations happen, like a disease is spread or poor quality meat gets delivered to the consumer. (Verhoef, 2020) Of course there are certificates and licenses that give guarantees about the farmer, but daily operations often happen in a closed environment and nobody knows for sure what really happens there.

This situation can be improved by implementing a data platform which stores the records of all participants and gives the guarantee of true information. This information needs to be up-to-date and available at least for the audits and possibly to other partners in the chain.

Implementing a new technology in the farmers sector has the following **challenges**:

- Many parties are unwilling to share their data with others as it exposes their vulnerabilities
- The value of the technology to the company activities may seem unclear or low
- Implementing a technology can require a big investment

However, there are also **drivers** that could persuade the parties to still opt for such a technology:

- Fear of not passing quality checks and going out of business
- Big value (increase of competitive advantage and power) for the company combined with low cost (Verhoef, 2020)

All these aspects need to be taken into account while deciding whether or not a certain technology will help.

2.7. Salmonella detection

Salmonella is a bacteria that settles in the intestines of chickens. Many different types of salmonella are known, most of those types can also infect other animals and a few can only infect poultry. Salmonella Enteritidis and Typhimurium can also infect humans when consuming chicken, eggs or meat and lead to food poisoning. (Kippenziekten, 2020)

2.7.1. Salmonella sources

Chickens can become infected with salmonella quite easily. The bacteria can survive on many surfaces and subsequently infect a chicken. An infection occurs mostly by touching or picking up a contaminated object. This can be for example contaminated food, soil, dust or manure. The salmonella bacteria can easily travel with people on dust, on clothes, in the hair or manure under the shoes. The bacteria can also be on tools, crates or food trays. Another important source of infection is vermin such as mice, rats and beetles. Furthermore, a mother hen can transmit the bacteria on its eggs. (Kippenziekten, 2020)

2.7.2. Detection methods in general

Salmonella infection in poultry can be detected by both bacteriological and serological tests. **Bacteriological research** means that salmonella bacteria is detected via samples, for example overshoes, manure samples, swabs and feed samples. This process takes approximately 5 days because several selective and non-selective steps must be performed.

Serological tests can detect antibodies against salmonella in blood samples. Such research has little use for broilers, but it can be useful to prove an infection in older animals. The chance of detecting antibodies in broilers is very small because the infection is often limited to the intestine. Moreover, it takes at least 10 days for sufficient antibodies to be formed to detect them. (Peeters, 2016)

2.7.3. Salmonella detection at Nijkamp

In Table 2 is shown when Nijkamp has to take a sample for salmonella detection. A flow chart showing salmonella data movements can be found in appendix 9.1. However, if the results of the salmonella tests at Nijkamp is negative twice, but positive at the slaughterhouse then Nijkamp will be given a penalty. (Nijkamp, 2020)

Age / time of sampling	Number of samples per house	Research	Sampler
One day old chickens / Upon arrival	1 sample of 40 pieces of insert per truck or trailer	Regular	Poultry farmer / third party / Transporter
Max 21 days before removal to slaughter*	At least 2 pairs of shoe covers	Regular	Veterinarian or veterinary assistant paraveterinarian
Random check at 10% of the farms with more than 5000 broilers: 1x per year from 1 house	2 pairs of shoe covers	Official	Competent authority

Table 2: Salmonella detection policy at Nijkamp

Regular sampling

This refers to the research that must be carried out on each batch during the round. Furthermore, it is important that the farmer or veterinarian / veterinary assistant paraveterinarian provide the following information on the submission form:

- Name and address details
- Sampler
- Number chicken
- KIP-number (Koppel informatiesysteem pluimvee)
- Date of sampling
- Stable number
- Date of birth batch
- Activity / business type
- Sample type
- Name and signature sender

An example of salmonella submission form can be found in appendix 9.2.

Official sampling

All EU member states are required by the regulations to carry out the so called official investigation. In the Netherlands, the NVWA is responsible for the annual official sampling. The NVWA has given the responsibility of execution to C-mark B.V. and Eurofins KBBL laboratory. The sampling is provided by C-mark B.V. and the costs of this research are covered by dierengezondheidsfonds (DGF) (Avined, 2020)

3. Research design

For the data collection, the qualitative approach will be used. The use of the following can do this:

- Interviews
- Observation
- Case studies

Using a qualitative analysis will help us to understand the stakeholders involved, help us see the problem in a broader view, and highlight the possible solutions and drawbacks. The quantitative method, however, will not be used for this plan of approach since there is no measurable data available for analysis. (Cadle, Paul, & Turner, 2014)

3.1. Chosen analytical methods

The methods focus on main issues brought about by the sub questions: stakeholders, process, bottlenecks, value, implementation and evaluation. These form the basis for the whole research. The methods were selected during a brainstorm session where everyone had to provide pros and cons per method. Some of the methods are from an article about business scan. (Katen, Duin, Lont, & Paardenkooper, 2020) Table 3 below gives an explanation why certain models are chosen.

Main issue sub-questions	Methods	Reason
Stakeholders	Stakeholder Wheel	It gives a clear overview who the stakeholders are.
	Mendelow Matrix	This method is chosen because it divides stakeholders in high/low power and interest. Based on the positions of stakeholder, different approach can be chosen.
	RACI Model	It helps to provide a clear view what the roles are of certain stakeholders are.
Process	Integral Logistics Concept	This method helps to describe the current process of Nijkamp and identify bottlenecks based on the aspects of process management and the flows of physical goods and information.
	Order Penetration Point	It shows who has the power in the chain by giving a signal to produce stock.
	BPMN level 2	This model is chosen because it gives a high-level overview of the process and includes relevant stakeholders.
	Data Flow diagram	This diagram is chosen because it shows which data flows through the process and in what way.
Bottlenecks	Digiscan	It gives information about the maturity of digitalization within the company and also which steps have to be taken.
	Olson criteria for information	This method is chosen because it tests the quality of information.

Value	VRIO Model	It shows Nijkamp's position on the market relative to his competitors.
	Slack & Lewis	This model helps to define KPI's on three different levels: societal, strategic and operational.
Choice	Decision tree blockchain	This decision tree gives information on whether blockchain is needed or not and which blockchain is advised.
Implementation	Cost and benefit analysis	This analysis gives information on whether the tradeoffs are reasonable enough in order to implement the project.
	Roadmap of digiscan	The roadmap gives the steps necessary to improve the digital state of the company, in this case it is blockchain implementation.
	Risk analysis	This analysis gives information on potential risks, which have to be taken into account.
Evaluation	V-diagram	The diagram evaluates whether all the requirements have been met.

Table 3: Chosen methods

3.2. Research method per sub-question

The nature of the given research is qualitative because it is focused on the improvement of communication systems and not the analysis of the data itself. The research can be categorized as applied because the goal is to design a solution for the company. The researchers will use a top down approach (deductive research) first getting the general idea of the situation and then tackle the specific aspects of it.

Table 4 below gives an overview of the methods that will be used and sources that will be consulted to answer the sub-questions. The methods are preliminary and might change if more suitable methods are found during the literature research.

Sub question	Research method	Source of information
1. What does the current process of Nijkamp look like?	stakeholders: stakeholder wheel, Mendelow matrix, RACI model; process: integral logistics concept, order penetration point, BPMN flowchart level 1+, dataflow diagram interviews, observation	employees, work process
2. What are the bottlenecks of the current process?	Technology: Digiscan by Evofenedex; Information: Olson criteria; observation, interviews	employees, work process
3. In what way can blockchain add value in the form of transparency and data integration?	VRIO model, 3 levels of Slack & Lewis; blockchain decision tree, literature research	employees, literature

4. In what way can blockchain technology be implemented so that data integration and transparency between the parties can be achieved?	Digiscan roadmap, business plan, costs & benefits analysis, risk analysis	Analysis of bottlenecks, gathered information, employees, company documentation
5. In what way will the solution be evaluated?	Control of requirements: V-diagram, VRIO model, Feedback from client	employees, gathered information

Table 4: Methods per sub-question

3.2.1. Stakeholders

This subparagraph is related to the first sub question: 'What does the current process of Nijkamp look like?'.

Mendelow matrix

The Mendelow matrix, showed in Figure 6, suggests that stakeholders should be analyzed in four quadrants, based on Power and Interest.

- **Power** (the ability to influence our organization strategy or project resources).
- **Interest** (how interested they are in the organization or project succeeding).

Based on the High and Low of Power/Interest, stakeholders can be assigned to these four quadrants: *managed closely, keep satisfied, keep informed and monitor*. Stakeholders can also switch between quadrants when there is a shift in power/interest.

This model will be interesting for Nijkamp Boiler Farm, because based on the position of the stakeholders, different methods of approach can be made. This will result in efficient time-management, more resources, money and a better position in the market because of the acquired knowledge (Oxfordcollege, 2019).

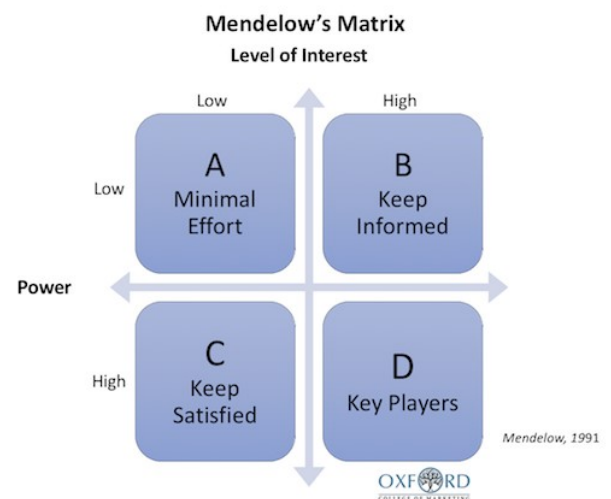


Figure 6: Mendelow matrix

(Oxford, 2021)

Stakeholder Wheel

The stakeholder wheel, showed in Figure 7, is used to identify the stakeholders that are internal to the organization as well as external. This model would complement the Mendelow matrix as it helps as a checklist to identify and categorize the stakeholders, under eight generic categories (Analyst-zone, 2019).

The categories being: Owners, Manager, Employees, Competitors, Customers, Partners, Suppliers and Regulators.



Figure 7: Stakeholder wheel

(Unknown, 2021)

	Project Sponsor	Project Manager	Business Analyst	Operations Manager	Sales Clerk
Record Customer Orders			I	A/S	R/C
Document Requirements	A		R		C
Plan Stage	S/C	A/R	I	I	
Approve Request for Change	A	S	R	C/I	C/I

Figure 8: RACI model

(Unknown, 2021)

3.2.2. Process

This subparagraph is related to the first sub question: 'What does the current process of Nijkamp look like?'.

Data flow diagram

The Data flow diagram (DFD) is used to graphically represent the flow of data through a process. DFD describes the processes that are involved in a system to transfer data from the input to the file storage and reports generation.

DFD can be divided into logical and physical. The logical data flow diagram describes flow of data through a system to perform certain functionality of a business, The physical data flow diagram describes the implementation of the local data flow. In this case DFD will be used to describe Nijkamp's general flow of data and salmonella data sharing. (Unknown, 2020)

BPMN model

Business Process Modelling Notation (BPMN) is a flow diagram method to display all the process steps in a company. It gives a visual overview of the working methods and information flows that are essential to complete the processes of a company. The BPMN helps companies to become more efficient and anticipate better in new circumstances and to look for unique competitive advantages.

Integral Logistic Framework

An integral logistic framework is used for embedding of the logistic concepts within the strategy and operational policy of a company. The framework is showed in Figure 9.

The framework provides a common thread for a change plan, in which the management can work from step by step. An integrated approach means that all decisions about the flow of goods, planning and control, support and IT and the organization are properly coordinated. However, before the logistics concept can be properly fleshed out, the objectives of the company, the chosen strategy and the logistical objectives that can be derived from it must be clear (Noordhoff, 2016).

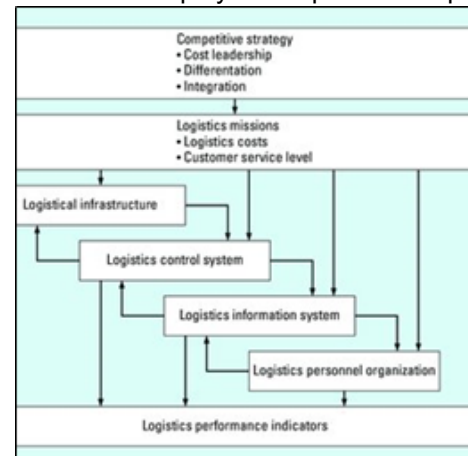


Figure 9: Integral Logistics Framework

(Amstel, 2015)

Order Penetration Point

The order penetration point (OPP), showed in Figure 10, defines where in the production value chain, the customers gets linked to the product with a some form of influence. These are the OPPs from least to most influence on the product: make-to-stock (MTS), assemble-to-order (ATO), make-to-order (MTO) and engineer-to-order (ETO). The products go from more demand driven to more customer driven. The OPP gives an indication on how production objectives are managed for the particular product like customer service, efficiency and inventory management. One company can also have different types of products and thus OPPs. Major factors for the OPP are demand volume, volatility and production lead times (Olhager, Strategic positioning of the order penetration point, 2003).

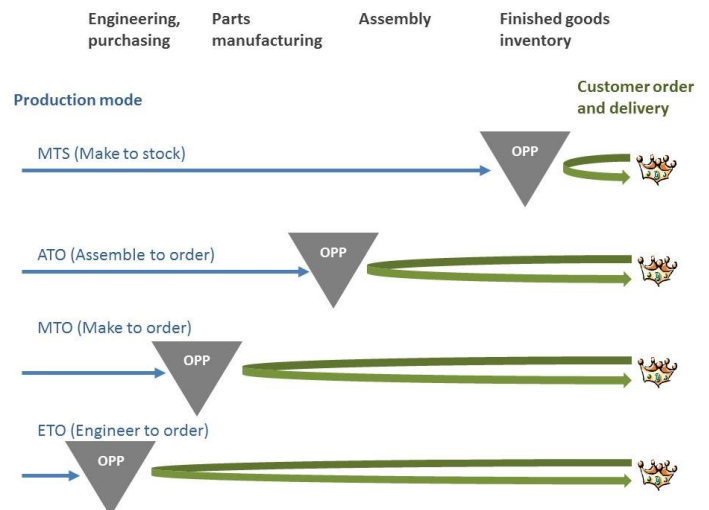


Figure 10: Order Penetration Point

(Unknown, 2020)

3.2.3. Bottlenecks

This subparagraph belongs to the second sub question: 'What are the bottlenecks of the current process?'. The aspects of bottlenecks will be divided in two groups: **quality of technology** and **quality of information**. For the information quality Olson criteria will be used. For the state of technology digiscan by Evofenedex will be used.

Digiscan

This quickscan is made by Evofenedex and helps companies to know where they are in digitalisation and innovation and gives the company a roadmap as an advise with the next steps in innovating their company. This level gives an indication on which new technology the company can implement in the near future.

The quickscan will help with this project to analyse the Nijkamp Raalte company. The scan is a proven tool and suitable for SMEs, like Nijkamp Raalte is, and that is why the tool will be used in this research. It is an online survey of 30 questions and only takes 7 minutes. The quickscan will be executed during a dedicated online meeting. In an additional process analysis and questions asked to Mr Nijkamp, most of the bottlenecks in the company will be identified.

Olson criteria for information

The Olson criteria has to do with the quality of information and data. It means that information must comply with the following aspects to be of good quality:

- Accuracy: representation the data from actual events
- Relevancy: speed with which data is updated
- Completeness: is there missing data?
- Comprehensibility: is the function of the data clear?
- Reliability: is the data correct?

(Katen, Duin, Lont, & Paardenkooper, 2020)

3.2.4. Value

This dimension is related to the third sub question: 'In what way can blockchain add value in the form of transparency and data integration?'. The value blockchain technology can offer to the company will be described with the help of VRIO model and three levels of Slack and Lewis will be used.

Competitive position: VRIO model

VRIO model, showed in Figure 11, was chosen to diagnose the competitive position of the company and to identify its strengths and weaknesses. It stands for Valuable, Rare, Inimitable and Organized. (Barney, 1991) Each of the aspects will be evaluated by asking questions (see appendix 3). The answers to these questions will give an idea of possible improvement points for the company.

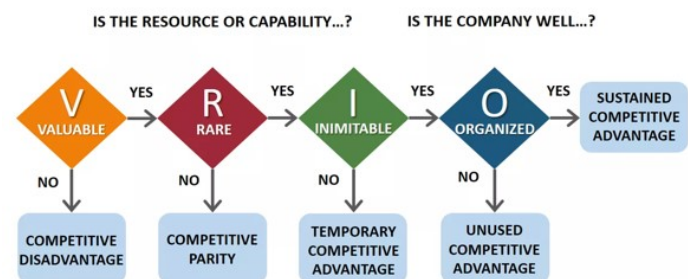


Figure 11: VRIO model

Performance: levels of Slack and Lewis

With the help of this model the current and desirable KPI's of the company will be categorized based on three levels: societal, strategic and operational (Slack&Lewis, (Barney, 1991) p. 48), see Figure 12. It will illustrate the current performance metrics of the company and show how they will be affected by implementing blockchain technology. The questions asked to identify the metrics can be found in appendix 3.

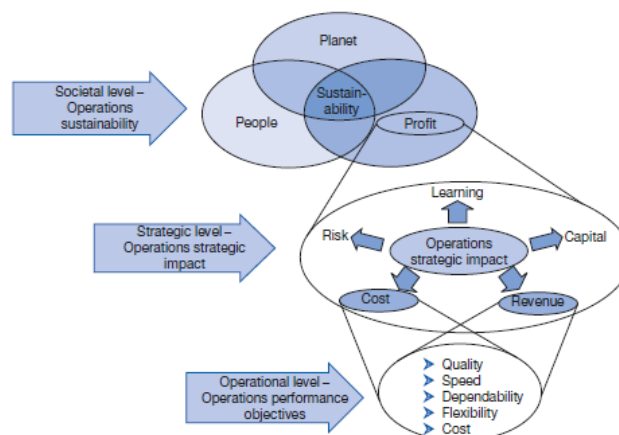


Figure 12: Three levels of operations performance

(Slack & Lewis)

3.2.5. Decision tree

In order to decide whether blockchain is the right solution, it is important to analyze how the company works with its information, how the parties exchange data with each other and what part of administration is useful and realistic to transfer to a digital system. Figure 13 shows a scheme which helps to decide whether blockchain is relevant for a company's needs.

Wanneer blockchain?

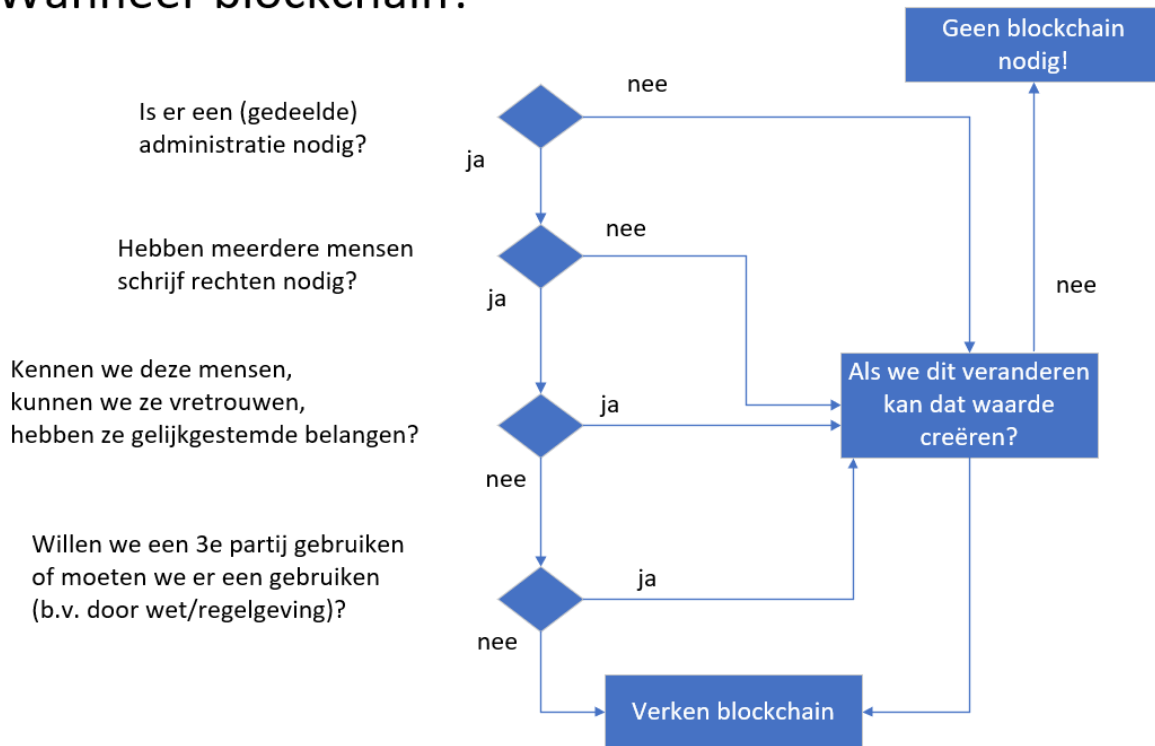


Figure 13: Decision tree

Source: Dutch Blockchain Coalition

The scheme above contains the following questions:

- Is (shared) administration needed?
- Do more people need to have writing rights?
- Do we know these people, can we trust them and do they have similar interests?
- Do we want to use a third party? Or do we have to (e.g. through legislation)?

In case Nijkamp is ready for blockchain technology, the final result of answering the decision tree will be "explore blockchain" (middle bottom box). In that case, the next phase begins, namely choosing the suitable kind of blockchain. The other options are "no blockchain needed!" (top right corner) and "If we change this, could it add value?" (middle right).

If the decision is to explore blockchain solutions, it is followed up by the next question: What kind of blockchain will be used? Figure 14 below gives an example on what blockchain protocols can be used, like Bitcoin, Hyperledger and Ripple.

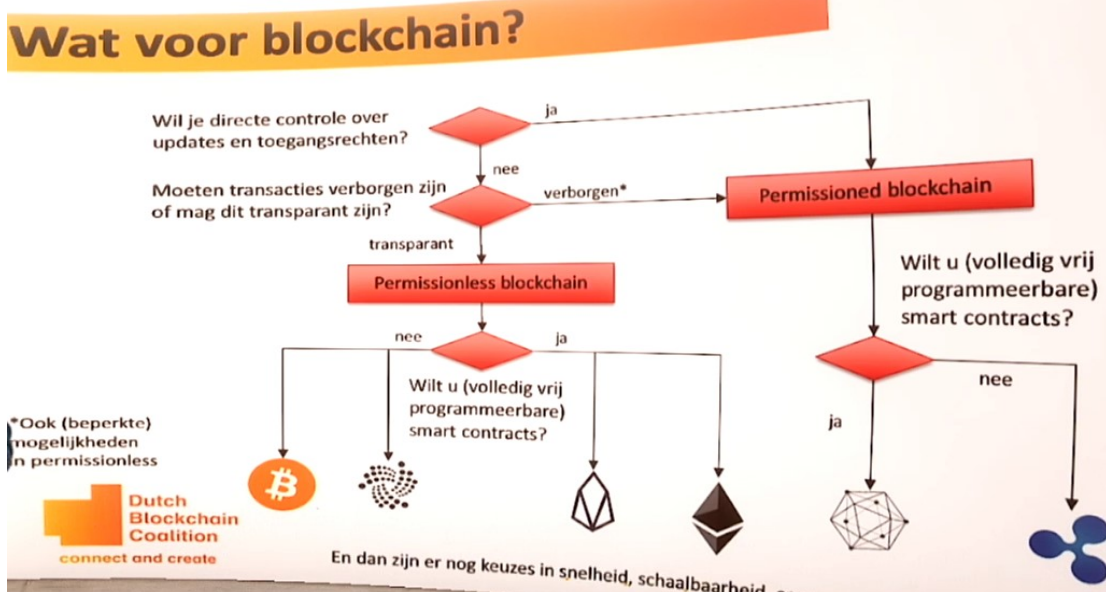


Figure 14: Which blockchain technology

Source: Dutch Blockchain Coalition

The questions from the scheme above are as follows:

- Do you want direct control on updates and access rights?
- Do transactions need to be hidden or can they be transparent?
- Do you want (completely programmable) smart contracts?

The outcomes from left to right are: Bitcoin, IOTA, EOS, Ethereum, Hyperledger and ripple.

(Dutch Blockchain Coalition, 2020)

3.2.6. Implementation

This paragraph is related to the fourth sub question: 'In what way can blockchain technology be implemented so that data integration and transparency between the parties can be achieved?'.

Cost and benefit analysis

This analysis can be defined as an economic technique whether the project should be undertaken or not. It attempts to quantify the advantages and disadvantages associated with a particular project. (Alberini, 2020) (Rus, 2020)

To make such an analysis the following steps have to be undertaken:

- *Objective of the project and examination of the relevant alternatives:*
The objective should be clarified and the alternatives should be identified.
- *Identification of costs and benefits:*
It is necessary to identify the benefits and costs derived from this implementation
- *The counterfactual*
The situation without the project should be considered as well, also known as the counterfactual.
- *Measurement of costs and benefits*
The costs and benefits have to be measured
- *Benefits and costs aggregation*
Add a discount rate greater than zero in order to compare. For example, A matter which weights more receives a higher discount rate.
- *Interpretation of results and decision criteria*
This represents the net present value of the project and helps with the decision to accept or reject.
- *Economic return and financial feasibility*

Describe the economic return of the project and the financial return or commercial feasibility of the project.
(Rus, 2020)

Roadmap

This implementation plan, shown in Figure 15, is to implement blockchain and is based on the digiscan roadmap of Evofenedex. Two checkpoints have been added in order to control the process.

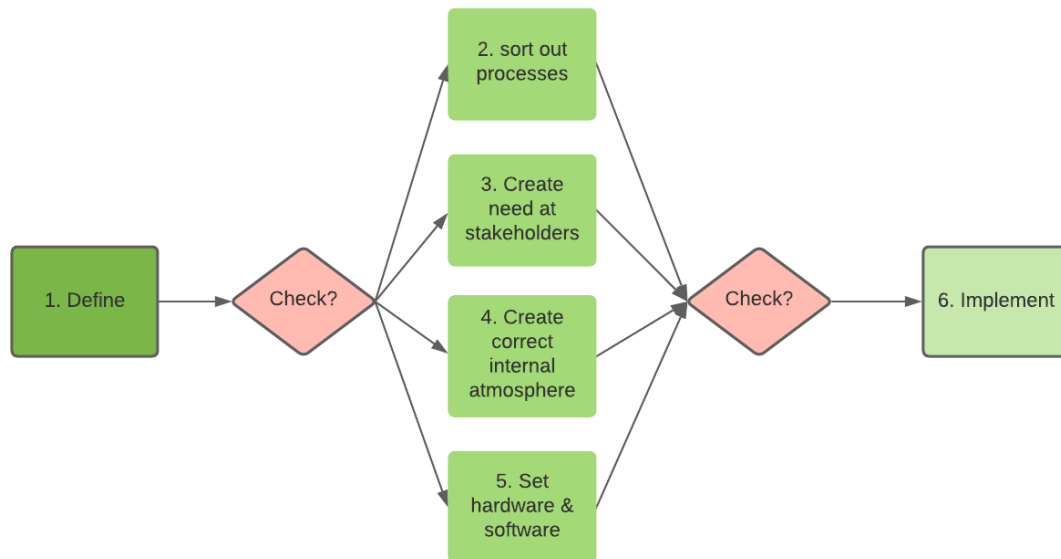


Figure 15: Digitalization roadmap

1. *Define*: First of all, the requirements, digital & HR strategy, budget and customer value need to be clear in order to proceed.
2. *Sort out processes*: Study the current processes, as well as internal and external
3. *Create need at stakeholders*: In order to succeed, stakeholders must apply blockchain as well.
4. *Create the correct internal atmosphere*: inform and teach employees how to deal with blockchain.
5. *Set hardware and software*: Make sure of the right hardware and software
6. *Implement*: Rollout

(Heeringa, 2020)

Risk analysis

The risks of the implementation should be taken into account. This analyses the possibility of a hazardous event occurring that will have an impact on the achievement of objectives. Risk is measured in terms of consequence and likelihood of the event. (Misra, 2008)

3.2.7. Evaluation

The evaluation of the designed solution is related to the fifth sub question: 'In what way will the solution be evaluated?'. Here the connection will be made between the solution and the client requirements gathered in the beginning. Basically the solution needs to solve the stated problem and satisfy the client. The evaluation criteria can be found in the appendix.

The V-diagram helps to evaluate if our designed solution meets the requirements of the client. From origin the V-model comes from system engineering and is used as a development process, see Figure 16. It demonstrates the relationships between each phase of the development life cycle and its associated phase of testing. The V-model focusses on a waterfall method that follows strict, step by step stages. While initial stages are broad design stages, progress proceeds down through more and more granular stages, leading into implementation and coding, and finally back through all testing stages prior to completion of the project. (Elm, et al., 2008)

The diagram is adjusted in order to be useful in this project, because system design and implementation is beyond the scope. Figure 17 will be used in this project. On the left hand side the requirements of the client and on the right our designed solution. The arrow pointed to the left shows that our solution will be evaluated.

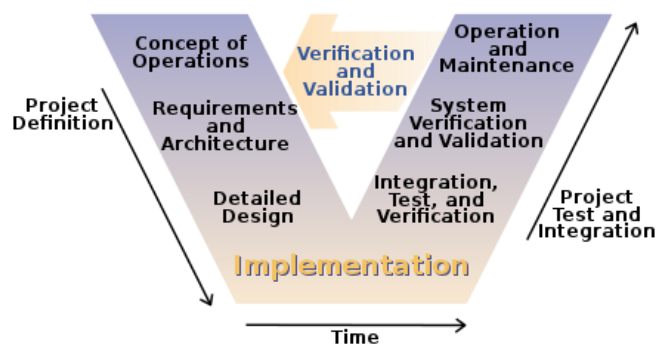


Figure 16: Original V model

(Turck, 2016)

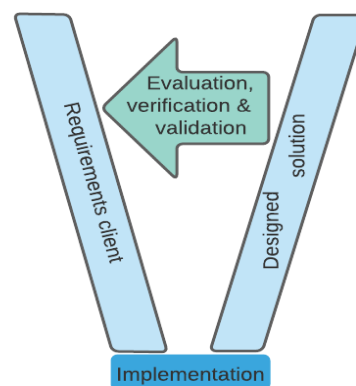


Figure 17: Adjusted V model

3.2 Research quality

In order to ensure the trustworthiness of the research, the researchers will be guided by the principles of transparency, validity, reliability, triangulation, and generalizability.

Transparency. The steps of this research will be described and explained to ensure that the outcomes are traceable and verifiable. Not only positive results but also the challenges will be documented to give an honest overview.

Validity. Before answering the central question, it is crucial to ask the right questions. The research group will regularly meet with their supervisor and the client and receive feedback on the chosen approach.

Reliability. Before gathering the information correctly, first, the relevant research methods will be listed and then reviewed based on several criteria for this research. In the end, the most optimal methods will be chosen and described how exactly they would be conducted.

Triangulation. To make sure the gathered information is correct, the researchers will cross-check the same facts in different sources and then compare the outcomes. Only the facts proven to be accurate by several sources will be used.

Generalizability. This research is a solution design for Nijkamp farm, but it can also be useful for similar companies in the sector, for example, other farms or agricultural companies. The applicability will be ensured by working not only on the detail level but also on the high level of processes and explaining the choices made in the research.

Sensor measurements. What concerns measurements from the sensors for the purpose of this research it is assumed that the measurements are reliable and valid and the stakeholders use it in the correct way. Later this security aspect can be improved further.

4. Current situation at Nijkamp broiler farm

The current situation at Nijkamp is described in this chapter. This chapter is written with the help of the quickscan shown in appendix 3: questions and appendix 4: summary. Several models were used to clarify who are the stakeholders involved in the process as well as the process flow and data flow.

4.1. Stakeholders

In this paragraph the outcome of the quickscan regarding the current situation in Nijkamp Boiler Raalte Farm will be discussed using the theory of the of the Mendelow matrix and the Stakeholders (paragraph 1.2.1) wheel to identify the different stakeholders, their involvement, power of alteration, interest and what should be the advised approach of the discussed stakeholders.

4.1.1. Who are the Stakeholders

In the matrix seven different stakeholders are known to have a direct involvement with Nijkamp Boiler Raalte Farm (Figure 17). The opportunity for the following paragraph will be to highlight the most important stakeholders in the matrix.

4.1.2. What impact do the stakeholders have?

This paragraph is written on the hand of the Mendelow Matrix showed in appendix 7

- **The slaughter company** – In the context of the stakeholder's wheel, the stakeholder is categorized as a Customer. Once chickens become 8 weeks old, they will be sent to the slaughter company which will chop the chicken in pieces. The company holds a strong position of power because of its network with retailers and other farmers. The slaughter company is already involved in a new IT project at the farm which includes all the data flows in the company, to exchange data from the farm to the slaughter company and the other way around. It is not sure if they want to be involved in blockchain, but if they do, other parties might join too, like the hatchery. This results in the combination of High-High which puts the slaughter company in the Key player quadrant.
- **The Government** – In the context of the stakeholder's wheel, the stakeholder is categorized as a Regulator. The Government is responsible for setting up regulations and restrictions regarding chickens. They are in contact with every company in the supply-chain and put emphasis on ethicality & quality. They also decide the regulations and restrictions. If BCT requires to deviate from the norm. Nijkamp could get fined. Regarding the BCT project, the government is not as interested relative to other parties in the supply-chain. If Nijkamp meets the regulations, then the method does not matter as much. This results in the combination of High-Low which puts the government in the Keep Satisfied quadrant.
- **The Licensing parties** - In the context of the stakeholder's wheel, the stakeholder is categorized as a Regulator. The licencing parties can approve methods of work that can stimulate animal welfare. he licencing parties then need to control this and if Nijkamp meets these requirements then they are qualified for a label. In other to prove that the chickens Nijkamp provides are breed ethical, an independent licencing party decides if Nijkamp meets the required requirements. Licencing parties are interested in BCT, in order to track the origin of products. This can be used then for working out a pre-label or other methods that can accelerate proof of ethicality. This results in combination of High-High which puts the licencing parties in the Key player quadrant.
- **Hatchery farms** - In the context of the stakeholder's wheel, the stakeholder is categorized as a Supplier. These farms Breed chickens and supply Nijkamp boiler farm of unhatched chickens. Ones hatched they stay in the farm for eight weeks and then go to the slaughter company. There is a broad offer of chicken eggs. Because of the competition, Breeders do not have a strong position in the supply-chain. The chickens are transported by truck and held under a specific temperature that could affect the health and therefore the quality of the chicken. This

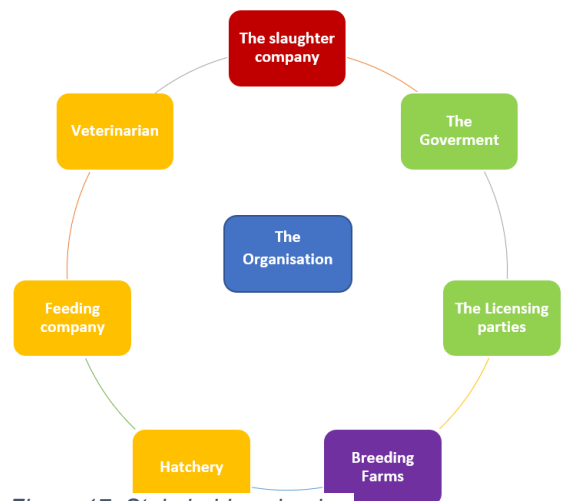


Figure 17: Stakeholder wheel

results in the combination of Low-High which puts the Breeder farms in the Keep Informed quadrant.

4.1.3. Who is responsible for what in the process?

Stakeholders	Role
Slaughter company	Responsible & Accountable
Feeding Company	Consulted
Government	Informed
Controlling authorities	Informed
Veterinarian	Consulted
Breeding farms (other broiler farms)	Consulted
Hatchery	Consulted

Table 5: Filled in RACI model

The table shows who is responsible for what in the process according to the RACI-model (paragraph 3.1). In the previous paragraph the stakeholders were discussed, in this table different roles are assigned to the stakeholders based on their level of responsibility in the whole process (table 5).

4.2. Process

This paragraph gives an overview of the current processes and how it is organized at Nijkamp. It also explains the general information flows as well as the salmonella information flow. Furthermore, the most important variables are mentioned. The documents received by Nijkamp in appendix 8 helped by writing this paragraph.

4.2.1. How is the process organized?

In this paragraph the integral logistics concept will be used to show how the processes in the company are currently organized. The integral logistic concepts consists of the logistical infrastructure, control system, information system and personnel organization (paragraph 3.2.2).

Infrastructure

The logistical infrastructure focuses on two main points, order penetration point and contract logistics. The order penetration point in Nijkamp is a Make to Order strategy (figure 18). The chicks arrive at the farm with a maximum of 1 year old, where they are grown up and cared for until they have the enough weight to be sold. Also, the whole supply chain is considered a pull system, since the original request comes from the consumer or retailer.

The contract logistics regards multiple aspects, such as transport, storage and distribution. These aspects are in essence shown in the BPMN (paragraph 4.2.2).

Control System

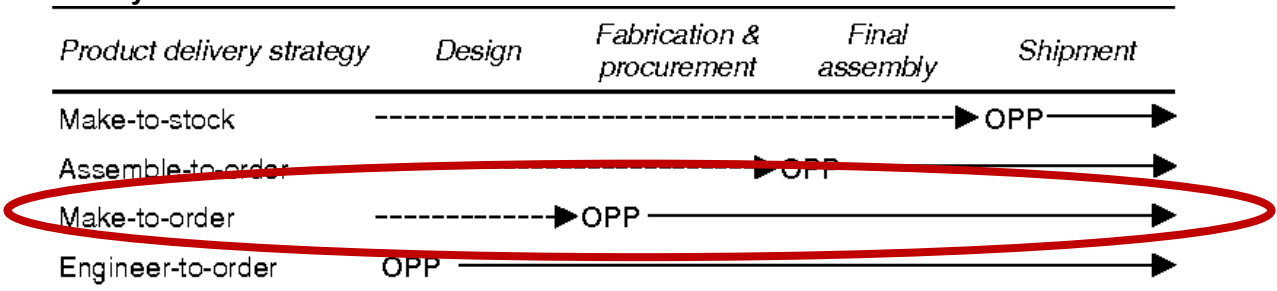


Figure 18: Order Penetration Point

(Olhager, 2003)

The logistical Control systems puts emphasis on how the activities are controlled and the goals are achieved in the supply chain. Nijkamp grows chickens until they are ready for the slaughter houses, in between this process, quality control is being done to ensure and improve the quality of the chickens, for instance, by using of sensors and other sorts of measurement instruments.

Information System

The logistics Information system follows up on the data generated from the measurement instruments of different activities (illustration dataflow diagram paragraph 4.2.3). This data is then stored and communicated to different stakeholders. Most of the data is manually written, stored on the computer and transported by either mail or specific forum (government forum or licensing forum).

Personnel organization

The logistical personnel organization will be quite difficult to describe in terms of Nijkamp's current situation. At the moment there is only one person responsible for almost the whole process. The personal organization is currently centralized.

4.2.2. What does the process look like?

To analyse the process, the BPMN level 2 model is created on Nijkamp Raalte. The model can be found in appendix 5. It shows all the tasks related to the process and who is responsible for that given task as a stakeholder. The whole process within Nijkamp and the main stakeholders involved in it are visualised (Unknown, What is business process modeling notation?, 2020).

4.2.3. Information flows.

The information flow in general and about salmonella are explained below. The general information flow is about Nijkamp its overall information sharing with stakeholders. The salmonella information flow is specifically about salmonella information sharing with stakeholders.

General data flow

In Figure 19 is the general flow of data showed. This flow is not necessarily the same as the actual process flow, since data “doesn't end”, meaning that it will always be stored in a server, accumulating more and more by each process cycle.

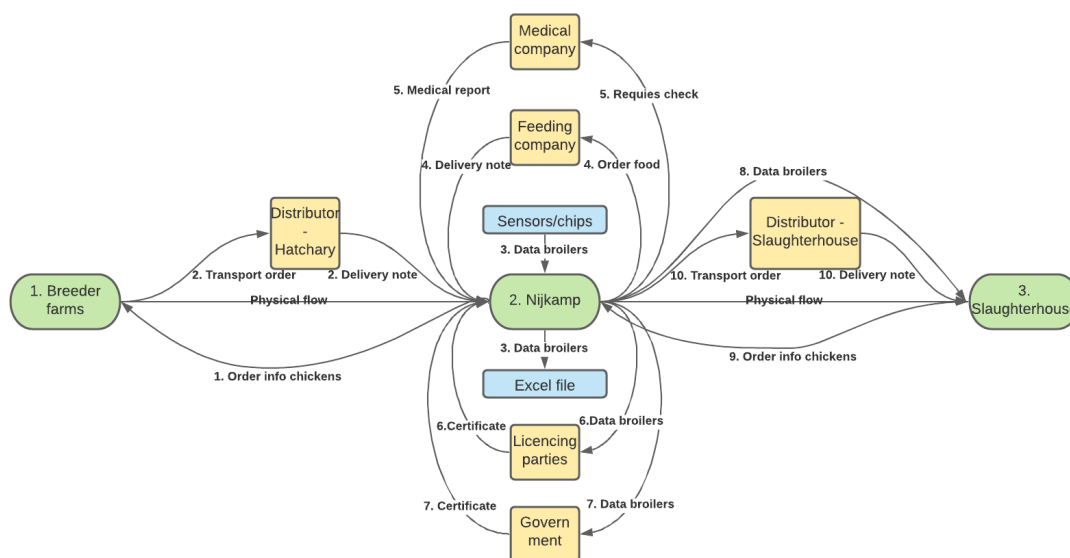


Figure 19: General data flow diagram

The data flow diagram helps to understand how data is shared, within the supply chain and where it is stored. Also, it allows to understand more the characteristics of it and how it behaves.

The flow in the middle is also known as the physical flow of chickens, and the other flows are more related to data and documents. So, as an example, Nijkamp orders chickens at a breeder farm (1). This breeder farm makes a transport order at a distributor, and this distributor delivers the ordered chickens, but also a delivery note (2).

In the meantime, Nijkamp gathers data via sensors and chips and stores this in an excel file (3). Furthermore, Nijkamp orders food at a feeding company and receives a delivery note in return (4). Nijkamp does also request a medical check, and in exchange, Nijkamp receives a medical report (5). To receive certificates, Nijkamp needs to send data about the broilers to licencing parties (6) and the government (7).

After the broilers have grown to their right size and after receiving a shipment order (9), they will be transported to the slaughterhouse by making a transport order and delivering a delivery note (10). The slaughterhouse does also demand data of the broilers to check the quality (8).

Salmonella data flow

Salmonella is tested multiple times in the chain, as shown in Figure 20. It is tested at the hatchery, Nijkamp and the slaughterhouse. The results on the salmonella tests are shared between stakeholders,

for example hatchery needs to share their results with Nijkamp and Nijkamp with the slaughterhouse. This is in order to know who is responsible for an eventual outbreak. Furthermore, Nijkamp has to share the information on salmonella with the government and licencing parties as well.

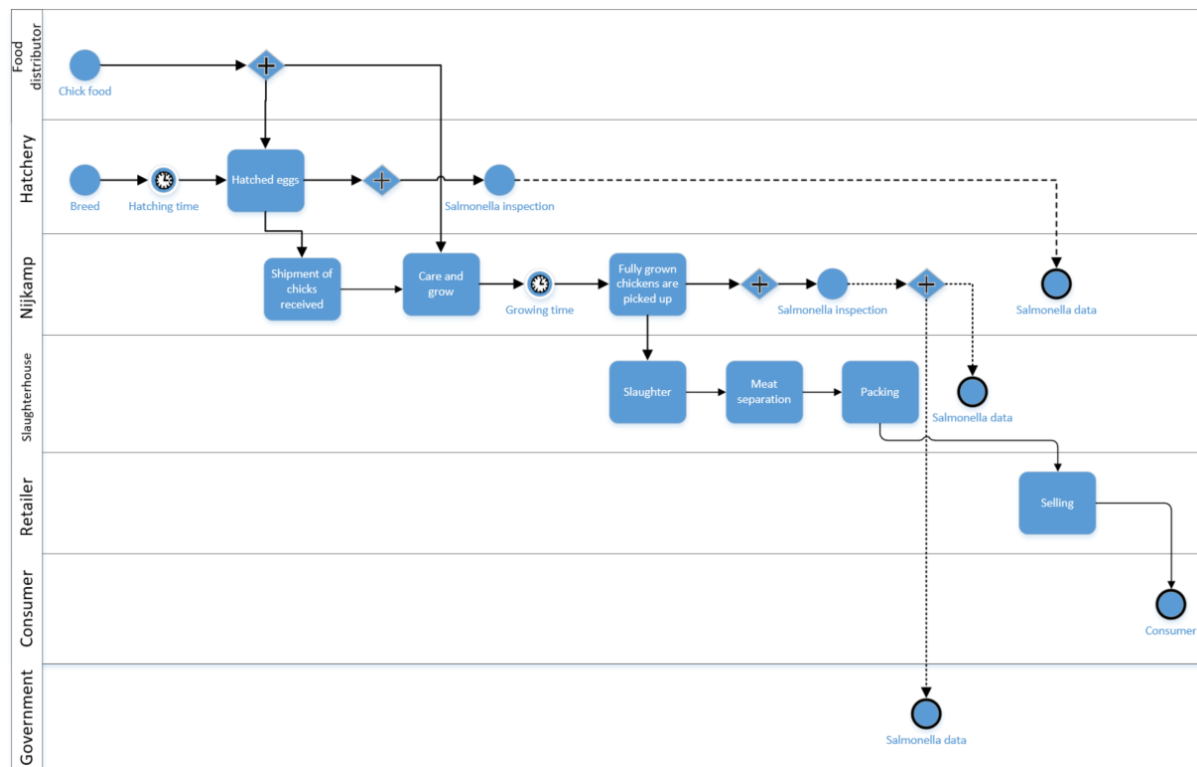


Figure 20: Process flow incl salmonella

4.3. What aspects of chicken health are being measured?

Our client provided an Excel file with around 60 variables, and he explained in detail five of them that are the most important for the company. In Table 6 the five variables are visualised with an explanation, the sources of that data, the purpose of the data and which stakeholder also needs that data.

Variable	Explanation	Sources of the data	Purpose of the data	Which stakeholder needs it
Animal weight	Question retailer	Weighing slaughter company	For good filet weight retailer	Slaughter house
Feeding Total	Vet. risks	Farm computer	Feed brand and feed additives used	Slaughter house
Present (chicken)	Number slaughtered	Farm computer	Number of birds slaughtered	Slaughter house
Declined Today (chicken)	Number slaughtered	Farm computer	Number of birds slaughtered	Slaughter house
Outburst Total (Chicken)	Number slaughtered	Farm computer	Number of birds slaughtered	Slaughter house

Table 6: Variables filled in by the client

The variables in the table above are not the only indicators for Nijkamp. The company also uses other variables as so called key performance indicators (KPIs). These KPIs have more or less two purposes: to keep track of animal's health and to measure the company's performance. Some variables in these KPIs are also required to report to the slaughter house and controlling companies.

The three main factors that our client uses and sends to the slaughterhouse and controlling authorities are:

- Average body weight per house
- Mortality rate per house
- Number of birds per house

So as it is required to report these KPIs to other parties, Nijkamp also uses these indicators for the company itself. This way he can make decisions that will satisfy the other parties more and his revenue will increase.

The following KPIs are used by Nijkamp to measure company's performance, which is related to our client's own activities, strategic goals and sustainability. So these indicators are used by the company alone:

- Feed conversion rate (FCR)
- Mortality percentage
- Kg broiler per m2
- Profit per bird delivered
- Chicken's feet lesions
- Percentage declined meat per broilers (by NVWA veterinarian at the slaughterer)

In the future our client wants to improve the animal's health. Therefore other KPIs could be more important than the current. For example external environmental factors could be measured and used for analysis and improvements. These potential indicators can be used to indicate the animals health:

- Density (by measuring the amount of chickens in an area)
- Inside and Outside Temperature
- Ventilation (the flow of clean air)
- RV-sensor (humidity level)

All the information about the variables and KPIs are important for the implementation phase of this research. Because now we know which data and information is important to the company and has to be integrated in the blockchain for own use or for data exchange with other parties.

4.4. Conclusion

The processes of Nijkamp can be divided into two, the physical flow and the information flow. The physical flow consist of broilers and has a make to order strategy. The information flow consist of data sharing with Nijkamp closest stakeholders, the breeder and slaughterhouse. Furthermore, the salmonella data flow shows how the salmonella information is shared between stakeholders in the chain. Sensors and chips measuring many variables which Nijkamp has to provide to the slaughterhouse.

5. Bottlenecks

This chapter is all about finding the bottleneck(s) in Nijkamp's current processes. This is done via a Digiscan to measure Nijkamp's digital maturity and via the Olson criteria. On the basis of the outcomes of mentioned methods some main improvement areas are described.

5.1. Quality of technology: Digiscan

Digiscan conclusion

The Digiscan questions showed quite a good result, as you can see in appendix 6. However it also brought some problems to the sight. The results of the Digiscan are analysis and discussed with Stefan Heeringa, an employee of EvoFenedex.

At which digital phase is Nijkamp now

Nijkamp is somewhere between stage 1 and 2 and blockchain is stage 3 (Figure 21).



Figure 21: Digiscan phases

Source: EvoFenedex

According to EvoFenedex, to progress from this phase to the next ones there are two crucial elements needed: good data analysis and process automation. The other technologies from further stages like AI and blockchain can be most effective when these two elements are achieved.

It has been advised to look into techniques which precede blockchain, namely RPA (Robotic process automation).

RPA caught eye as relevant since one of the Nijkamp bigger problems is having to retype received data in different systems and that is exactly what RPA solves.

In the Digiscan tool there are also extra questions for specific digital topic which can be used

For blockchain it is further away so steps in the middle are needed. However with extra help this can still get going, which means advise how to get blockchain running and additional advice what to improve in the current situation to prepare the company better. It is important that the first improvement steps do not require large investments but are more about getting the process in order.

RPA automation process

RPA is an automation process technology which simulates the human input. The software will act as the employee, so it will not influence the process and will give room for the employee to focus on more important tasks or tasks which requires human skills, as for example reasoning, judgment, interaction with customer, between more. The advantages of using this automation process is that it makes possible the integration of any software and it can be implemented in a short amount of time. However, RPA is considered a temporary solution and it is only suitable for processes which are repetitive and routine-based.

What is needed to get to next stage

There is internal and external part of this project, internal is Nijkamp processes and external is the network of stakeholders. Also important to find out about stakeholders if they are willing to cooperate in the blockchain project. For this the researchers have been advised to look into the approaches that are used for starting the collaboration of parties (a case study from Tilburg University).

Digiscan advantages

The effectiveness of Digiscan is that it is a good tool for preliminary generic questions to identify possible weak areas at the company. The questions are quite broad and in principle follow Integral Logistics Framework and the answers to the questions give a good overview of the company. The minus in this

research was that the authors have already made up based their own questions based on the chosen methodology and these questions were already quite specific which made the Digiscan tool a bit excessive. It could have been better used at the very beginning of the research.

Digiscan disadvantages

The drawback however was that the client company was supposed to evaluate their activity on their own and

Describe it in one word, for example: Are you processes well structured? And the answer is that they are alright, quite good. This kind of answer could be not very helpful to diagnose the problems and the client might not have expertise to know exactly whether his process is good or not in a particular area. So the questions can better be more related to the client's own expertise and ask about the ways he runs the farm and require a more specific answer, like a number or a KPI. To which Stefan from EvoFenedex replied that the idea is to do a follow up on unclear answers and dig deeper into those areas. From the general overview of all answers a logistic consultant can spot where potential problems can be.

Bottlenecks of digital topic

- Current systems and automation do not support the process enough and do not work in an efficient way.
- Data analysis is not done in an efficient and user friendly way
- Possibly not everywhere relevant KPIs are present to monitor progress
- Data exchange with partners need to improve, with some partners the data is not connected
- Hard to find which external party can help with digital solutions (knowledge)
- Hard to find partners in the supply chain to strategically participate in the common digital solution (cooperation)

5.2. Information quality: Olson criteria

When working with data, the quality of information and data is very important. Decisions or evaluation on performance can only be made when that data that is worked with is of good quality. As mentioned in the models, the Olson criteria is used to know the quality of data and to set requirements for the data that might be used in the blockchain. The criteria were *accuracy*, *relevancy*, *completeness*, *comprehensibility* and *reliability*. During the quick scan interview with the client we asked him about his data flows and concerns about all data sharing, now and in a possible blockchain, and the Olson criteria. The criteria is used in this research to identify bottlenecks at the client's company. These are taken into account and will be used in the implementation phase of the research.

According to Robert Nijkamp the Olson criteria can be accomplished. Only if there are multiple parties involved. The more sources, the more reliable the data is. Another concern is the input of data, because at this time data is not always put in the systems via sensors. Some of the data Mr. Nijkamp has to put in manually and can easily be manipulated in his opinion. The completeness of the data can also be a concern because our client wants to use the solution for animal health, and it is not clear if there is enough data available regarding animal health to make a value added solution. There is no concern about the reliability of the sensors, because the company pays for an audit by the manufacturer of the sensors to see if they are still working right and the data coming from the sensors is reliable. But maybe not all farmers are doing sensor audits, so the accuracy of the data could be an issue for other users of the solution. So the Olson criteria bottlenecks according to the client are (Heeringa, 2020)

5.3. Improvement areas

Based on the information we gathered from Nijkamp, Olson and Digiscan we conclude that the data, for the implementation of the given programs, has to be more computerized to fulfil the requirements.

The result of the Digiscan showed the current digitalization of Nijkamp. Nijkamp should improve in the following aspects in relation to digitalization:

- Nijkamp does not transfer information efficient between the stakeholders. for example, the company stores data in an excel sheet and must rewrite the data manually according to the desired format of the stakeholder,
- The lack of connections with other parties that are more professionalised in digitalization.
- Inefficient data analyses and lack of system support.

The result of the Olson criteria showed the quality of information. For this we concluded the following aspects that should be improved:

- Nijkamp audits its sensors (paragraph 4.3). However, not all farmers audit there sensors as Nijkamp, questioning the accuracy of the data.
- According to Nijkamp, the Olson criteria can be met by involving more parties, more sources and having more reliable data.
- Nijkamp has to store data manually, meaning that the data input should be improved.

5.4. Conclusion

To conclude, the digital stage of Nijkamp Raalte is average. Topic that still have to be improved to make a possible blockchain solution a success are data analysis and process automation, in form of robotic process automation. The improvements towards the solution should not have to be big of costs, but must be minor and effective and the core process should not be faded.

Bottlenecks regarding the data quality that is used within the company are accuracy, reliability and completeness. When these aspects of data quality are sufficient, the data that is used by Nijkamp Raalte can be of good quality.

6. Value

In this section, the value of Nijkamp is discussed based on its competitive position. Furthermore, the correct KPI's are selected that should be in use in order to validate the process.

6.1. Competitive position: VRIO model

Nijkamps competitive position is defined by the VRIO model. During the quickscan, shown in appendix 3.3, questions related to VRIO were asked to determine each element.

Valuable

Nijkamps value lies mainly in his new Windstreek house with good conditions for his chickens. This farmhouse helps him achieve more power to negotiate more effectively with stakeholders. Therefore his added value is sustainability. Furthermore, Nijkamp is also active in data sharing projects among stakeholders and this can be seen as added value to his farm.

Rare

Despite some farmers trying out new innovative ideas such as blockchain and sustainable chicken houses, the traditional farms remain unchanged. In general, it is hard for farmers to change as the slaughterhouses and controlling parties do not typically demand for new ideas. For them it is interesting to share certain data, however, in sustainability they have limited interest.

Many of sustainable initiatives came from Nijkamp and not because of specific demands from stakeholders. The consumers are interested in sustainability but they do not have direct influence on Nijkamp, only slaughterhouses and controlling parties have.

Inimitable

The current strategy of Nijkamp is not easily copied for other farmers. Firstly, it is expensive to build such a Windstreek house and to invest in new and existing technology like sensors and blockchain. Secondly, it brings a lot of risks along to invest in those ideas. Thirdly, it takes a lot of effort to transform a traditional farm to a more sustainable and data driven farm.

Organized

The physical flow of goods of Nijkamp is well organized. The processes of the chickens, food and medicines are clear without significant disturbing's. However, there is space for improvements on the information flow side. For example, Robert has to retype data from his system to an Excel file and he has to send data twice which is not efficient.

6.2. Performance: levels of Slack & Lewis;

This subparagraph highlights the most important KPI's on three different levels.

Operational

The operational KPI's are related to his day to day activities and are mostly determined by the slaughterhouse and controlling authorities. The three main variables Nijkamp has to measure are:

- Average body weight per house
- Mortality rate per house
- Numbers of birds per house

These variables together can be seen as a KPI: performance per chicken house. To create a measurable KPI it is important that variables are given a weight in percentage.

Strategic

Strategic KPI's are related to his long term objective and decides if an objective is achieved. In this case strategic KPI's are linked to the digitalization of Nijkamp as he wants to improve his data sharing process to gain more transparency and data integration.

Societal

Societal KPI's are related to the welfare of broilers and his overall footprint. The welfare of broilers can be measured by air quality, amount of sun per day, space per broiler, and so on. Welfare broilers could also be measured by the number of stars 'beter leven label', however, Nijkamp specifically chose for

one star “beter leven” because the markets for two and three stars are relatively small and costs a lot of effort.

His overall footprint is also known as sustainability. It is known that he has a sustainable Winstreek house where the barn is ventilated via neutral ventilation and a substantial energy saving is possible. Possible KPIs related to this matter are: amount of water, amount of energy, amount of waste, and so on.

6.3. Decision tree “Do we need blockchain?”

In order to find out whether blockchain technology has value for Nijkamp the researchers used a decision tree model (see paragraph 3.2.5 for details). This model helps to find out whether blockchain is necessary at all and if yes, which kind.

- **Is (shared) administration needed?**

Yes, the Nijkamp wants an administration of the broiler health data. The goal is to share data with the whole chain to optimize their internal process as well as collaboration with other farmers and gain more negotiation power towards bigger parties like the slaughter house.

- **Do more people need to have writing rights?**

Yes, there are multiple parties that will put data in the blockchain. One of the goals is to use more data sources for strategic decisions. So indeed more people need to have writing rights in this administration.

- **Do we know these people, can we trust them and do they have similar interests?**

Yes, the stakeholders of the process are known, they are links in the broiler supply chain, namely the breeder, other farmers and the slaughter company. The interest is to deliver a good quality product to the end consumer, but there are also conflicting interests due to different aspects like convenience and price. Because of these conflicting interests trust is not always easy to achieve and it is better not to rely on it.

- **Do we want to use a third party? Or do we need it (e.g. because of legislation)?**

No, a third party is not needed. A necessary party however is the one related to legislation since there are boundaries about the way in which data should be managed, but it still leaves many opportunities. One of limiting cases is when the government has to interfere in the form of quality control and legal aspects company (Dutch Blockchain Coalition, 2020).

As a result Dutch Blockchain Coalition decision tree shows that blockchain is a logical choice for Nijkamp, so the next step is to explore which sort of blockchain is the most suitable one.

6.3.1. What kind of blockchain is applicable in this case

The blockchain decision tree is used in order to find out which blockchain is applicable for Nijkamp. Additional questions were added to create a more specific conclusion, as the decision tree combines public/permissionless and private/permissioned, but there is a slight difference. Various questions are answered to select the best blockchain (provider).

- **Do you want direct control on updates and access rights?**

Yes and no are both possible. It is imaginable that Nijkamp or a selected group want to take responsibilities on updates and access rights. However, this will reduce transparency between stakeholders, so no would be more convenient, but is harder to set up legal frameworks since no one is responsible.

- **Do transactions need to be hidden or can they be transparent?**

Transactions need to be transparent within the chain. Nijkamp wants to create transparency between stakeholders, so stakeholders need to be able to see the transactions. However, transactions should be hidden from parties outside the chain.

- **Do you want (completely programmable) smart contracts?**

Yes. Smart contracts need to be made completely to Nijkamp and its stakeholders their wishes. This also create more flexibility in the setup of their potential blockchain.

- **Do you want information/transactions need to be visible for everyone?** (additional)

A private blockchain is advisable. Everyone can access a public blockchain and read every transaction, but not everyone has to see every transaction that has been made. For example, farmers do not want to share prices with their competitors and information can be misused if it gets in the wrong hands. The users of a private blockchain can select who can participate and who not.

- **Do you want everyone to be able to validate?** (additional)

Whether Nijkamp should use a permissioned or permissionless blockchain all depends on what Nijkamp and its stakeholders want. Either permissioned and permissionless blockchain can have a positive effect on the business.

A permissioned blockchain is advisable when parties want a third party involved. This party has the authority to validate transactions. This will probably be the situation if one or more parties do not trust the input of data. If this data can be validated by a third party, it can eliminate some of the trust issues.

A permissionless blockchain is recommended in the first place if all parties want full transparency. That is also the idea of blockchain to create transparency within a process. In this way all stakeholders and participants within this blockchain can validate transactions. However, parties need to trust each other that the data input is true.

Conclusion

Based on the decision tree Hyperledger is recommended for Nijkamp if Nijkamp wants direct control on updates and access rights. The following blockchains are advised If Nijkamp does not want control: Ethereum or EOSIO. Based on the additional questions a private permissioned or permissionless blockchain is advised.

6.3.2. Blockchain providers

There are many blockchain solution providers and each with different features. Based on the questions above certain solution providers were found listed below, Table 7. The providers below are mostly blockchain developers, but some of them are only the providers using a consisting blockchain. However, it is hard to tell which provider Nijkamp should select, as it depends on the right quality/price balance.

Provider	Public/private	Permissioned/-less	Info
Ethereum	Public & private	Permissioned(less)	– Can built own public permissionless or private blockchains – Own currency – Uses decentralized application – Able to use frameworks and pre-made stacks – Open source platform – (Ethereum, 2021)
Corda	Private	Permissioned	– Made especially for businesses – Offers two interoperable and fully compatible distributions of the corda platform – Open source platform – Transactions are confirmed immediately – Delivers scalable, private and secure blockchain for regulated businesses – Does not have own currency – (Corda, 2021)
Quorum	Private	Permissioned	– Uses Ethereum structure – Comes with full service support and a development landscape – Open source platform – Enterprise focused – Specialized in financial industries – (Consensys, 2021)

IBM Blockchain	Private	Permissioned	– Uses Hyperledger Fabric – Fully custom-managed – Open source platform – Also provide other services – Specialized in agriculture – (IBM, 2021)
VITAS blockchain	Public & private		– Dutch company – Customized blockchain – Blockchain consultant – Blockchain architect – (VITAS, 2021)
Oracle blockchain	Private	Permissioned	– Uses Hyperledger Fabric – On-premises solutions – Open source platform – (Oracle, 2021)

Table 7: Blockchain providers

6.3.3 Smart contracts

Smart contracts could help the exchange of money, property or anything of value in a transparent, conflict-free way, without the intervention of a middlemen. It more or less executes the terms of an agreement once the specified conditions are met.

The smart contract function of a blockchain is interesting for Nijkamp Raalte, because the company works together a lot with third parties. Like the veterinarian, government, feeding company, etc. These parties can not be eliminated from the chain, but their tasks could be reduced or made more easy. Also information exchange with their customer, the slaughter house, could be made more efficient with this function.

An example of the use of smart contracts for Nijkamp is the exchange of health information about the broilers to the government and the slaughter house. For example, when Nijkamp releases all required health papers in time in the blockchain, the government could automatically release an approval in some form, as well for the slaughter house. Now the broilers can be transported to the slaughter house more efficient. When the deadline is overdue, the agreement is deleted and the deal can not go on, only with human intervention.

Another example where smart contracts can be useful is when two parties exchange items with each other. In Nijkamp's case it will be exchanging broilers for money, or money for vaccinations. The smart contract can control such exchanges. If the broilers are received happy and well by the slaughterhouse, the money will automatically go to Nijkamp.

The code of the contract can also not be changed without all parties knowing it, so it is a very safe way of executing agreements. Possibly only some small, physical assessments should be done by the government. But that is less than they are assessing at the moment.

6.3.4 Zero knowledge proof

Zero knowledge proof can be used to provide information, but not the whole information. For example, a stakeholder asks if a specific serial number is infected with salmonella. Normally, that person shows a salmonella document from the veterinarian with a lot of extra information. With the zero knowledge proof, Nijkamp is able to just say no or yes via the blockchain without giving too much information. This answer via blockchain is just as reliable as the original way, because the information in on the blockchain should always be true.

This was just one example, but there are plenty other ideas where zero knowledge proof can be an asset. For example, providing information to licensing parties. They are only interested if the broiler has had a happy life and have been treated well enough. Without giving the whole picture, blockchain can just provide enough information to pass the 'beter leven' quality.

6.4. Conclusion

The position of Nijkamp is good. Nijkamp has a position others cannot copy easily, due to price and also technology. Despite Nijkamp's position is already good, blockchain can lift Nijkamp's position to a higher level. This is because blockchain is still relatively new in the farmers industry. The kind of blockchain advisable is private permissioned or permissionless with smart contracts and zero knowledge proof technology.

7. New situation

This chapter is about the new situation based on the improvement areas from chapter 6. The structure of this of this chapter is based from high to low level.

Collaboration with stakeholders can be seen as an external improvement and legal framework is also known as an overarching aspect. Blockchain is an internal as well as external improvement. RPA, data analysis, process optimization and data quality are all internal improvements.

7.1. Collaboration with stakeholders

An example of steps needed to initiate horizontal collaboration is shown in a roadmap by P.Mordvinova and Evofenedex how to set up horizontal collaboration, **Fout! Verwijzingsbron niet gevonden..** The scheme below shows five tasks to complete which initially require two foundations:

- 1) Build trust and good internal relations;
- 2) Create and review a collaboration and evaluation plan.

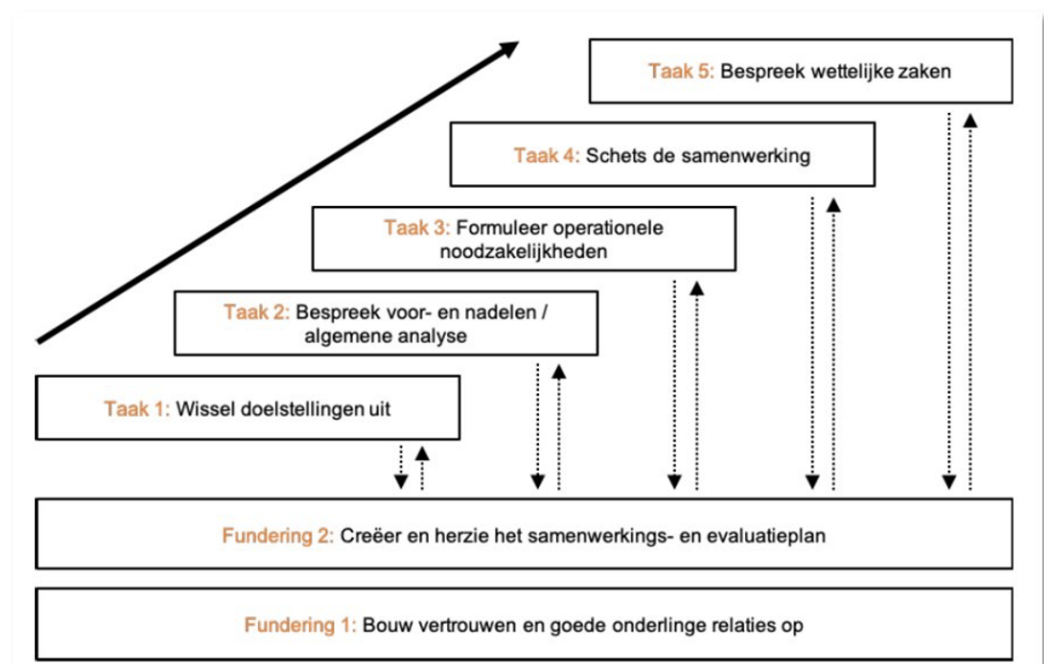


Figure 22: Roadmap for starting horizontal collaboration

Source: Evofenedex

It is important to note that in the case of blockchain implementation, the first foundation which is trust, will work in a different way. Blockchain technology is meant for the parties as a substitute of trust. So in this case the foundation of trust can be better replaced by being open about their interests and needs and not necessarily transparency in their internal activities. Also it is advised to find common identity with partners, for example based on common values and professional community (Evofenedex, pp. 38-45).

Based on the interviews with the client it can be concluded that the client and the key party slaughterhouse know each other quite well and there is potential to work together for mutual benefits. The slaughterhouse is one of the most powerful parties in this supply chain and could attract other parties to work together. Some of the farmers had interest in such a project, but often it is the fear of unknown and absence of common benefits that is holding such partners back. For that purpose discussing the mutual benefits and individual goals is crucial.

The logical next step for the slaughterhouse, Nijkamp and other close stakeholders like hatchery, feeding company and other farmers would be to have a meeting together and discuss the needs and possible improvements of each party, with a process scheme as a visual aid to see how the products

and data travels through it. Some of the possible improvements have already been noted in this research, like communicating the health of young broilers from the breeding company to the farmer. Potentially a lot of other improvements can still be discovered.

The proposed five steps to start collaboration are as follows (see Figure 22):

1. Exchange goals
2. Discuss advantages and disadvantages/conduct a general analysis
3. Formulate operational needs
4. Make a draft of the collaboration plan
5. Discuss legal aspects

In step three it is useful to discuss cases of other companies, formulate performance metrics and discuss which data is useful to which stakeholder. So this step is about process steps as well as information. Step five is especially important for blockchain because the division of responsibilities and rights decreases the risks.

7.2. Legal framework collaboration stakeholders regarding Blockchain-technology

Mapping the various legal aspects of blockchains requires a structure which can function as an ordering principle. To this end, criteria have been chosen acceptability of normative technology. Blockchain is normative technology. By her its purpose is to redefine the relationships between the parties involved. Moreover, it is chosen scheme of criteria sufficiently general to provide a broad picture of legal aspects. The three main criteria are discussed here.

- Human rights and moral values / protective function of the law

Which human rights and moral values are under pressure from the use of blockchain. Some come under pressure quite explicitly, in others it is more of an implicit process. Given the broad scope of blockchains, human rights and moral values can come under pressure.

- Legitimacy

It is often claimed that a blockchain would make trust obsolete. This is about the overlooked choices decided in the code for the blockchain. Instead of believing that trust has become redundant, people would be better off to ask what the legitimacy of the exercise of power by means of code is.

The legitimacy has a formal aspect (administrative action requires a legal basis, private parties are in principle to act freely), but also a safeguard aspect: there must be sufficient safeguards built in so as not to leave the simple user at the mercy of the builder of the technique. Care must be taken that blockchains in the name of innovation or efficiency promotion to safeguards and negate legitimacy.

- Democracy and transparency of rules

Blockchains have implications for many people who have not been involved in development of the code that bring about those implications. That raises the question of the democratic legitimation of blockchain: to what extent are those affected by blockchain involved in designing a blockchain or blockchain application? The most important permission less blockchains have a governance structure in which everyone can participate, but the decision-making power still rests with miners and core code developers. Especially if the social impact of blockchains increases, effective governance is an important point of attention.

7.3. Salmonella solution

At the moment salmonella is tested a lot in the chain as the hatchery is checking on salmonella, as well as Nijkamp and the slaughterhouse, explained in paragraph 4.2.3. Information flows. This amount of testing is necessary in order to prevent salmonella outbreaks and to find its source. Because there is no way to trace salmonella to its origin if only one stakeholder tests on salmonella. Despite all the testing

it is still hard to find the origin of salmonella and figure out who is responsible. It is a paper trail exercise to find out.

Blockchain is able to reduce the salmonella issue to a minimum. Still a lot of testing needs to be done, but the process of finding its source becomes easier. The broiler can be scanned and traced back with precision and accuracy to source in seconds, not days or weeks. Also, the information on salmonella can be shared immediately via the blockchain. No delay on paperwork and data entry is needed anymore. This creates a safer, smarter and more sustainable food system.

Blockchain can also be an asset to prove the quality of the broilers. For example, blockchain can provide trustworthy information of the farm that they have not had a salmonella outbreak for a long time. In this way the farmer can possibly receive a higher rating, less audits and easier certification.

7.4. Digital solutions

Various digital solutions about Robotic Process Automation, data analysis and blockchain are explained. By improving this area, the data flow within Nijkamp will be more fluent.

7.4.1. Blockchain

By implementing blockchain the transparency between stakeholders increases, which results in smoother processes and less trust issue problems. Parties can trust on blockchain technology that the data on that blockchain is true and is visible for everyone. In this way stakeholders will not receive misleading or false information. More important is that the information given via blockchain technology cannot be misused by a party for its own advantage.

It is recommended to use a private permissionless blockchain, as Nijkamp wants to create full transparency. With a private blockchain confidential information is protected for outsiders but is fully transparent between users. A permissionless blockchain is advisable, because it creates full transparency between stakeholders. However, if for any reason a party does not trust the system or data entry, a permissioned blockchain is recommended. In this way a third party can validate transactions

7.4.2. Robotic Process Automation (RPA)

RPA is an automation process technology which simulates the human input. The software will act as the employee, so it will not influence the process and will give room for the employee to focus on more important tasks or tasks which requires human skills, as for example reasoning, judgment, interaction with customer, between more.

RPA can be used in different ways, for example it can open emails and answer them, or copy and paste information. In Nijkamp's case RPA can be useful to automate the input of information whether the broilers were vaccinated and sending data to stakeholders. The doctor makes the prescription but does not vaccinate the broilers. Nijkamp has to vaccinate the broilers himself and has to update the system manually. This repetitive task can be replaced by RPA. Sending data to stakeholders is done manually by Nijkamp, but this could also be replaced by RPA. RPA is able to send data automatically to stakeholders. However, after implementing blockchain this will be obsolete.

No more time have to be wasted on these activities due to RPA, as it can replace repetitive and routine based tasks. No human is needed anymore. The replacement of a human activities results in more time for other activities, less transferring errors and always up to date data. Robotic Process Automation is a relatively small solution in ways of investments and implementation as well.

7.4.3. Data analysis

Data analysis plays a big part in the company. It helps our client by making and reflecting on important decisions. Analysis also give an insight in company performance. When data analysis for Nijkamp is improvement, logically decision making and overview on company performance will be improved as well.

Power BI

A tool to use for an efficient dashboard that show performances of the company and all kinds of data, is Power BI. It can be used to form an own dashboard with different types of data sources as well, and can also be automated. The problem that a Power BI dashboard solves is that there is no clear overview on all the different data from different sources, and analysis now are done inefficiently, according to our client. The advantage of a dashboard is that you can see in a blink of an eye how the company is doing this year, month, week and even day. The downside of this solution to improve data analysis is that it is time consuming to create a tailor made dashboard and align it well with the data sources. This could be a new project for the future, possibly executed by an IT (graduate) intern. The first steps that could be made is to clean and organise all of the data and make it more practical, so that every data that is seen is actually being used and there is no unnecessary data.

Further research

Power BI can be a great tool to use for data analysis. But to look at all possibilities and create such a tool, further research is needed. Mostly Power BI works with excel files, so the technical side of blockchain and the connection between excel, the blockchain and a data analysis tools like Power BI should be researched as well. The goal is to create a data analysis tool that aligns well with all data sources and is user friendly.

7.5. Process optimization

Infrastructure

Penetration point stays the same in the new situation, but a little but more to make to stock. Because with better analysis etc. forecasts will be better and its possible to delay the penetration point. the delay of the penetration point would improve the health of the chickens. Also for business it is better, because of standardization and delivering better quality to the slaughter house.

Control System

In the new situation Nijkamp Raalte will use its sensors and other sorts of measurement instruments to generate data and distribute the necessary information between its stakeholders. For example the slaughter house, the necessary information concerning the chicken's health, age and other important aspects will be shared in the blockchain. The blockchain will automatically ensure trust between the slaughterhouse and Nijkamp regarding the information of the chickens making other methods of validation obsolete.

Information System

In the new situation Nijkamp Raalte will use the generated data from the blockchain to make better decisions regarding the caretake of chickens, compliances of government regulations and organizational targets. Also, in the new situation Nijkamp will transit more from manually written data to computerized data. For example, not all information systems are aligning with each other, so the data has to be put in one Excel file to make a detailed well-constructed analysis.

Personnel organization

Nijkamp is a one-man company at the moment. Robert Nijkamp executes all daily tasks by himself and only hires external contractors for heavy jobs like mowing grass. When blockchain is implemented, more attendance will be needed for the IT side of the company. Maintenance and support is import to keep the system as optimal as possible. So an option is to hire an IT specialist for this job. But also the choice can be to hire external contractors for the IT side of the company. This depends on the complexity of the blockchain solution Nijkamp will choose.

7.6. Data quality: Olson Criteria

The Olson criteria is used to measure Nijkamp's current data quality. Current bottlenecks in data quality are data accuracy, completeness and reliability. The data quality will be good if all Olson criteria is satisfied, including relevancy, comprehensibility and the bottlenecks as mentioned in the previous phrase. So before implementing blockchain, the data quality of all participating companies has to be measured. And if one of the criteria is not satisfied, the company could not be allowed in the data sharing blockchain. The danger of wrong information, which leads to wrong decisions and analysis, will be too high if data quality is not guaranteed.

Data quality does not only have to be assessed on entering the blockchain, but maintaining quality is important as well. A periodic assessment on data quality of all participants that put in data could be a solution to remain good quality. For example certificates could be handed out after sensor calibrations are executed, just like elevator safety maintenance. You can find a maintenance sticker in nearly every elevator where you find the previous and next maintenance job.

As an addition to the Olson criterium of reliability, the number of computerized data should be one of the conditions of entering the blockchain. At least a particular number or percentage of the total put in data of one participant should be computerized via sensors for example. And maybe a small amount of additional data could be put in manually. This way in cooperation with sensor calibration, the chance of manipulation of the data will be minimised and the data is more reliable.

8. Implementation plan

In this chapter there will be described which steps the client can take to prepare for the blockchain implementation, the costs required and possible risks.

8.1. Steps

The future steps for Nijkamp are recommended in this paragraph. These steps are based on the outcomes of the Digiscan in order to implement blockchain as well as conclusions from other methods.

Involving stakeholders

To make blockchain fulfil its function, involving other parties for collaboration is essential. Without them, a regular database system would be good enough for the internal processes of the farm. Many stakeholders see this new technology as a threat and are unwilling to accept such an offer. Therefore it is crucial to show the mutual benefits of using this system together and have a discussion with possibly a software demo about it and naming other companies who had positive experiences with it, especially from the same sector.

Internal process improvement (optional but recommended)

As a solid foundation to start with blockchain it is advised to increase automation of current processes and improve data analytics. That will make daily work more efficient and decrease the chance of errors. According to the client, some improvements have already been made in this area, it is still recommended to implement RPA on a larger scale. For example, the input of information about whether the broilers were vaccinated and when can become automatic instead of manual. Another example is sending data to stakeholders. Nijkamp's Real Management System stores the data but the client still has to send the data to stakeholders manually, but that could also be replaced by RPA. However, after the blockchain is already in use, data sharing algorithm will already be there.

Relevant specialists

If all the parties in the chain are on the same page and recognize the potential of blockchain, the next step is to hire the experts who will facilitate the implementation. It is advisable not to do it too early as there is a chance the blockchain project cannot continue.

In order to implement blockchain, it is sensible to consult the following parties:

- **a lawyer** – to settle the agreements and officially and protect yourself from risks;
- **an IT specialist** – somebody who will build and maintain the system (there are variations what kind of specialist is possible);
- **other users** – companies who already implemented blockchain and can tell about their experience.

Lawyers are needed in order to make arrangements regarding smart contracts and the functionalities of blockchain, namely how the data of users will be treated and what are the restrictions to comply with. The agreements must be clear to all parties and properly documented.

IT specialists needs to be involved for dealing with the technical side of implementation as well as advising about strategic decisions for the companies. There are three ways to involve them:

- in house team – in this case the blockchain software will be developed according to the customer requirements;
- freelancers – this option includes a risk of the entrepreneur not being available;
- Agency – can bet he optimal balance of costs and quality.

To avoid high costs, it is possible to hire a remote offshore company from countries like India or Ukraine where specialists are well qualified but charger less than the local ones (Leewayhertz).

Community

It is advisable to find companies or unions of them that already implemented blockchain and can share their experience, especially other companies and companies from agriculture sector that had to resolve the problem of provenance and certification. Such connections can not only help to find out about the possibilities of the technology but also to find potential interested parties who could participate in the common blockchain project.

8.1.1. Duration implementation

The exact duration time to implement blockchain is hard to say, as it depends on a lot of factors. For example, how many stakeholders want to be part of the blockchain, how complex do they want the blockchain and how difficult is it to find a legal framework. The technical part does only take a few months, but the more customized the longer it will take. A not too complex blockchain with only four attendees will approximately take up to three to six months. (Unlu, 2020)

However, involving stakeholders to the blockchain project is probably more time consuming than actually developing the blockchain. It takes time to persuade and create support at stakeholders to participate in a blockchain. Once all parties are involved agreements can be made and legal framework can be set up. The duration of this part depends on how agreeing all stakeholders are with each other.

8.2. Costs and benefits

Although the cost categories may differ, in a nutshell the main type of costs for implementing blockchain are as follows:

- Setting up the network;
- Maintenance;
- Fees for software developers;
- Added functionality, like smart contracts.

The price range for a blockchain project is around €5 000 – €200 000 of total costs. Figure 23 shows what the proportion of these costs can be. It is visible from the pie chart that the biggest cost are developing the software and tailoring it to the needs of the organization (TNO, sd). The national means “a nation wide network” in this case.

The technical part of the implementation can take around several weeks to several months depending on the project complexity. Finding the partners and making legal arrangements is the more difficult part and could take quite some time at the beginning.

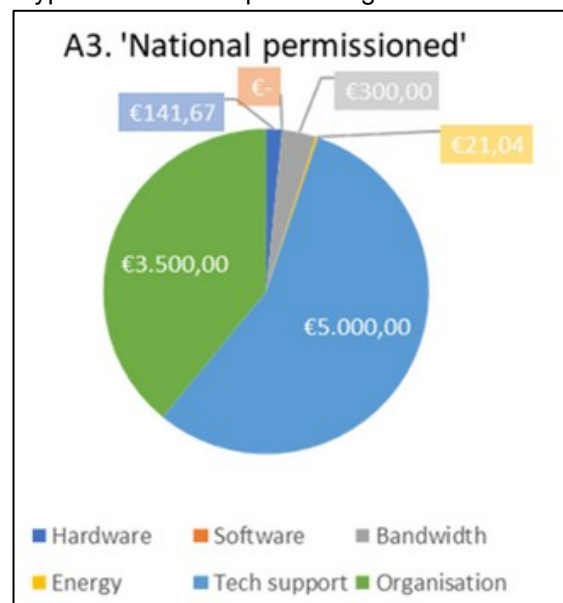


Figure 23: Cost structure for national permissioned blockchain

Source: TNO

8.3. Risks

In the table below, Table 8, the main risks of blockchain project are named and it is advised how to diminish these risks.

Risk	Action
High investment but useless	Start with small simple blockchain software and test it (e.g. open source software). If it works well, choose an existing platform with high rating.
Data leaks and abuse by users	Hire a lawyer and make detailed agreements with all participants
Not ready for implementation	Get to know other users, participate in a community initiative related to blockchain; improve internal processes (automation and data analysis) first
Not enough informed	Look at similar cases and how it was implemented there (e.g. provenance)
The parties are afraid of new technology and are not interested in collaboration.	Make an appointment and discuss together in person what the interest are and what benefits the parties can achieve together. Tell about examples of other successful companies.

Table 8: Risks

8.4. Conclusion

This project was aimed to show how blockchain can help to identify salmonella quicker and thus prevent outbreaks.

First of all, the current situation was analysed to decide how blockchain technology fits there and whether it can add value and what the improvement points are. To describe the current situation flowcharts of process steps have been made and apart from that a data flow diagram. A separate analysis has been done for information quality and quality of technology. The current digital stage was identified, to implement blockchain more improvements are recommended (but not compulsory) – internal process improvements, improvement of data analysis tools and more automation (RPA technology).

Blockchain is advisable for the company based on the decision tree. The preferable option is private permissioned or private permissionless, the usage of smart contracts is advised too, along with zero knowledge proof technology.

In order to start working with blockchain, the first essential step is to connect with the stakeholders, in this case especially the slaughter company and discuss together common goals and valuable data to be exchanged.

The biggest value blockchain can bring to Nijkamp farm is salmonella detection and prevention as well as possibility to trace and ensure the quality and sustainability of poultry products. It can make easier the process of getting quality certificates and can significantly reduce the needs for audit checks. Also the positive outcome is that if quality is proven to be better, it will be possible to increase the prices and be considered a high quality provider. It is true not only for consumers but partners in the chain, namely slaughter company who will value Nijkamp more because they will have definite proof of quality.

During the research some examples of mutually valuable data have already been discovered and there is likely to be much more of such data. It is beneficial for stakeholders to exchange it especially combined with limited access options (private blockchain and zero knowledge proof). In this way the data of stakeholders won't be in the wrong hands and sensitive data will not be shared without need and permission. In this report a number of cases is listed where it is shown how blockchain has already helped similar companies.

It is important to raise awareness in the agricultural sector that blockchain can significantly help daily operations. This can be improved when more farmers cooperate with each other and get the knowledge about the technology. Risks can be avoided by having conversations with technical specialists and other farmers who already implemented blockchain and by hiring a lawyer and putting the agreements in official form to define the responsibilities.

9. Evaluation of the solution

The evaluation consist of concluding which methods helped the most to come to the solution and afterwards the solution itself will be compared with the initial requirements of the client.

9.1. Evaluation of the methods

At the beginning of the project several models were selected that could be useful to apply in this research. Some models were experienced useful and handy, where other models were less useful. . The most useful methods were Digiscan by Evofenedex and the decision tree from Dutch Blockchain coalition the stakeholder matrix gave a good overview of power and interest of stakeholders and was important for the project as well. In Table 9 an evaluation of all the selected models.

	Model	How was it used?	Why (not)?
Stakeholders	Stakeholderswheel (SHW)	To complement the Mendelow-matrix and provide context to the different stakeholders in the chain	What wasn't used was the full essence of the wheel and following the step-by-step guide
	Mendelow-matrix	To place stakeholders in different quadrants and decided an approach	A global approach was developed instead of a specific one
	RACI-model	To assign roles to stakeholders based on level of responsibility	Processing the perspective of the stakeholders in the model
Process	BPMN flowchart	To show process steps	Gives the overview of the whole process
	Data flow diagram	To show information flows	Good visual tool, shows stakeholders
Bottlenecks	Digiscan by Evofenedex	The digiscan was used to analyse the current digital status of the company and discuss what topics should be improved to make a future solution a success.	This method came to us in a guest lecture from Evofenedex and is specially made for SMEs, like Nijkamp Raalte. It was very useful to identify bottlenecks.
	Olson quality criteria	The Olson criteria was used to reflect on the current data quality of the company and used as a standard framework for data in the future to be of good quality.	The Olson criteria came to us via our supervisor, Miss Paardenkooper. She used it in her article and attended us to use it for this project as well. After all the criteria is very useful to make sure the quality of the data is sufficient, also for collaborators in the future.
Value	VRIO	Describe the competitive position of the company	It was valuable as input for possible improvements and analysing potential benefits of blockchain
	Slack&Lewis levels	Performance metrics	Were used for the current situation and partly for data about salmonella

			but was not very necessary.
Implementation & Evaluation	Roadmap	Roadmap was to define our future steps of the project and supposed to be some kind of steering wheel	It was only used for the start, but not during this project.
	Risk analysis	Was used to identify the risk of implementing the solutions of this project.	Is used how it supposed to.
	Cost & benefit analysis	It was used to define the costs. What cost have to be taken into account and what are the biggest investments	It is not used to sum up the benefits of blockchain
	V-model	To compare requirements and outcome	Not very necessary but a good reminder to look back at the initial goal

Table 9: Evaluation of models

9.2. Evaluation of the solution

In this paragraph the evaluation regarding the blockchain project solutions will be discussed. First and foremost, in the report it was concluded that blockchain is relevant for this case (by using the decision-tree model). Then the current situation of the company was described, certain bottlenecks were discovered and for that, fitting solutions were developed.

The solutions are *robotic process automation, data analysis improvements and collaboration with other farmers*. These solutions are advised in combination with a private premissionless or permissioned blockchain.

For further elaboration on the solutions, the company itself had a few additional concerns, that by implementing these solutions can be apprehended. These concerns were:

- To inform the retailer about salmonella without pinpointing from where and who (showing specific data).
- Exchanging data between multiple platforms.
- Less visits from authorities.

However, Nijkamp needs advice first on how these solutions can be implemented as well as steps for internal process improvement. Nijkamp could contact experts in the field of blockchain and suggest the current handed proposition of how to better its position in the chain by the usages of these solutions. Also, the company could approach other stakeholders and enlighten them about potential possibilities and how they could both profit from it in terms of capital and knowledge.

This could create continuous improvement for the supply-chain and the company itself as well.

10. Discussion & recommendations

This chapter briefly describes the issues encountered during the research and main recommendations for the company.

10.1. Discussion

Evofenedex couldn't share the full Digiscan questions with us, so it was decided instead to implement the Digiscan in collaboration. Also the company offered that our client can fill in the questions and see the result and they provide statistics.

Digiscan diagnostic questions turned out to be not as helpful as expected because the researchers already asked the more detailed questions. However the Digiscan questions had a broad scope and there were questions with additional focus on certain technologies so the tool ended up being useful to making further questions and better questions to ask the stakeholders.

Remaining questions from Evofenedex were not asked, so how reliable is the outcome.

Corona outbreak prevented us from meeting stakeholders physically and the farm visit was postponed till the middle of October. Eventually it has been decided to conduct the visit online.

The blockchain itself is very reliable but many problems can arise before data is put into the system and leaves it – this can be further research.

10.2. Recommendations

The recommendations are divided into internal and external recommendations. Internal recommendations are related to Nijkamp's case where external recommendations are not.

Internal

Once Nijkamp has optimised his broilers data infrastructure, it is recommended to continue improving his overall data infrastructure for other animals as well. Therefore, it is advisable to do research on his other physical and digital processes. In this way, Nijkamp is able to find the bottlenecks himself and can figure out how to minimise these bottlenecks.

In order to implement blockchain it is important that other parties in his chain are willing to collaborate. The best way to approach this is to create support and to do further research on how to persuade stakeholders. Maybe a student interested in for example Change Management can help Nijkamp, as this student knows how to change and convince an environment.

To give a better overview of the maturity stage of digitalization at Nijkamp, it is recommended to answer the remaining questions given from Evofenedex. These questions can be found in appendix 3

External

A research on blockchain in other farmer industries, other than poultry, is recommended. Blockchain can have a significant benefit for Nijkamp and its stakeholders, but maybe it can also be beneficial for other farmer industries, for example pigs or cows.

Another recommendation is to do research on how blockchain can be copied in a database. As for blockchain, it is unknown who is responsible if something goes wrong and is therefore legally hard to cover. It is easier to hold someone accountable if the basics of blockchain can be copied in a database.

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