DE ZWOLSE
STADSLANDERIJEN

Final Report

21-12-18

Minor Supply Chain Engineering
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Preface

In front of you lies the project report of the Zwolse De Zwolse Stadslanderijen we carried out for the minor Supply Chain Engineering. We found it a very challenging and interesting assignment to do. None of us had experience in a company of this small scale before. It got us thinking in new ways we never thought about before. Because of the different backgrounds of the group members, the team has a very unique group-dynamic in which all of our different backgrounds came to use in the completion of this project. We want to thank Jos van Leussen for the great opportunity he gave us and for trusting us. He was not bound to his own ideas but wanted us to find out what was the best way of working for the company. This was really appreciated and we learned a lot from it regarding the company, and to supply chain processes. Also, we want to thank Rachèl Woltering for her supervision on our project and process. She was really helpful in her feedback and thinking along in the process.

Management summary (Abstract)

Research structure

The structure of this research is based on logical decisions, the thread of this research leads from the central question to the final project scope. The central question is: How should De Zwolse Stadslanderijen's (ZSL) supply chain be designed so it is sustainable and is resistant to the planned growth to 500 customers in 3 years? The research has shown that reliability is the key value proposition of De Zwolse Stadslanderijen. Based on the assumption that this value should remain at a high level when growing to 500 customers, the researchers deducted several constraints that could interfere with this goal. The main constraint is the storage & processing space at the current central hub, Kas van Kaat. The products of this research are solutions to the constraints at the central hub. In addition to that, this research also contains several side advises to the De Zwolse Stadslanderijen. The advises about KPI's and sustainability are considered to ensure the fact that the total supply chain of De Zwolse Stadslanderijen is future proof.

Research products

The results of this study can be distinguished in four different parts. The first two parts are considering the future bottleneck in packaging & processing. This results are divided into a part about the storage and different concepts of packaging processes. In chapter 5 is concluded that extra frozen and cooled storage space is needed to cope with the demand of 500 customers. For frozen storage this is 8,2m^2, and for cooled space this is approximately 15m^2. In all production concepts, the boxes are packaged in a fixed sequence on 3 workstations. Within this framework three different concepts are designed. The best concept is a design build around a L-Shaped roller conveyor. The specifications of this concept are: 17,85m^2 and a conveyor length of 4,98m. Studies on KPI's and sustainability have revealed several interesting conclusions. The KPI chapter describes a comprehensive consideration of management tools that are designed specifically to construct managerial tools for De Zwolse Stadslanderijen. The first section of the sustainability part constructs a theoretical basis for implementation at De Zwolse Stadslanderijen. This chapter consists of sustainability solutions for the total supply chain of the company.

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1 Introduction

To give an insight into the assignment, in this chapter a short introduction is given on the company which the supply chain optimisation project is done for and the problem analysis. Analysing the origin of issues, the company is facing is the fundamental step for this research. Major problems must be analysed thoroughly since the goal of the research relates to solving these problems and in order to do so, the challenges must be identified and described comprehensively.

1.1 Client organisation

De Zwolse Stadslanderijen (ZSL) is a cooperation of 7 members (5 farmers, 1 customer relationship manager (CRM) and 1 initiator). These members also (CRM excluded) form the board of ZSL. In addition, there are 2 aspiring members looking to become a part of the cooperation.

The total turnover in 2017 was €40.000, and the total turnover in 2018 is estimated between €75.000 and €100.000.

ZSL purchases products from their own members, or colleague farmers/suppliers in the area around Zwolle (in a radius of 30km around the city), combines the products into packages and sells these to private individuals/end customer in the city of Zwolle, via pick-up points or home delivery. The products consist of a wide and growing product range of locally produced organic products like meat, vegetables, cheese and eggs.

All members and suppliers are certified organic or switching to it. ZSL aims to build on sustainable and long-term relationships with their suppliers. All suppliers are obliged to have a Skal certificate. For the further processing of certain products, processing companies like butchers will be assigned. These processors are, when necessary to be certified organic, also Skal certificated.

1.2 Background

The cooperation applies basic supply chain processes since it is a small business at the moment. The problems covered below are affecting the company's growth and ideology as well. First, it is a challenge for a growth-seeking company to maintain the quality of the product while economizing the financial resources that are necessary for future investments for technological growth and market share expansion. Subsequently, lack of investment can interfere with the speed of business growth and the main mission of ZSL – providing organic goods for citizens of Zwolle.

ZSL is still in the stage of growth, considering the small market share with only approximately a hundred customers (households) and some occasional trade with other businesses. Hence, all the processes of products' flow in the cooperation between farms and final customers are included.

ZSL's supply chain includes processes that have some major and some minor logistical problems that can cause even more challenges later when the demand increases:

1. The supply chains of different types of products are not optimized. There are different chains of flow for meat products, dairy, vegetables and eggs. Since these supply chains are not interrelated in the process as the chains of flow are managed by the farmers themselves, the movement of products until they reach the final destination is not effective enough in terms of financial investment, transportation and time.
2. Last-mile logistics implementation is also essential to the supply chain of the company. In the very beginning, the delivery method was bicycle delivery, though currently the delivery is made via a truck courier. One of the goals is to make the last-mile as efficient as possible regarding the sustainability issues as well.

3. Also, processes in the central hub located in De Kas van Kaat should be adjusted to fit the future rise in demand. For instance, the packaging is done by the farmers themselves, since the current demand is not high enough to benefit from outsourcing the services for this procedure. The chilled and frozen capacity of De Kas van Kaat is also a problem when the future demand rises.
4. Another challenge for the company is the implementation of an online shop. The current state of the online services provided only include a possibility to subscribe to the product boxes. The implementation of an online shop is the core of the business in the modern world, which as well contributes to the growth of demand and the future flexibility of product kits available.

These problems are examined in more detail in this study. The students will also look at possibilities to cope with these limitations or solve these problems.

2 The assignment

In this chapter, success indicators will be given to what the success of the assignment can be measured. This will be divided into the context, objective, central and sub questions and the study model of the project.

2.1 Project context

ZSL wants to expand their customer base, therefore they need to examine the supply chain, and analyse where improvements need to be done in order to fulfil the larger demands. Right now, ZSL does not have a good supply chain coordination, the farmers are responsible for the logistics of their own products. In order to expand the business ZSL wants to be the supply chain manager and control the whole supply chain. In addition, a web shop is being developed at the moment for customers to order their products more easily.

2.2 Objective of the study

The objective of this study is to analyse the current supply chain and come up with advises improving the supply chain, in order to fulfil the growing demand. To improve the whole business, both the physical and the digital supply chain need to be analysed. The digital supply chain includes the ordering, billing, administration, etc. and also the web shop.

2.3 Central question

How should the ZSL's supply chain be designed so it is sustainable and is resistant to the planned growth to 500 customers in 3 years?

2.4 Sub questions

1. How is the ZSL's supply chain designed right now?
2. What makes a supply chain sustainable and what does this mean for the improvements needed in the supply chain of ZSL?
3. What are relevant KPI's for ZSL to monitor the effectiveness of their supply chain and customer satisfaction?
4. Which problems can be distinguished in the current supply chain?
5. What supply chain improvements are needed to cope with the expected growth and serve the customer in an efficient way?

3 Current process

Evaluating the performance of a company is fundamental for planning further steps in the process of supply chain adjustment. To do so, KPIs must be set and measured. In this section, most relevant KPIs for the performance of the supply chain of De Zwolse Stadslanderijen will be cleared out as well as measuring the current state of those.

3.1 Current subscription process

This paragraph is centred around an in-depth description of the subscription cycle of De Zwolse Stadslanderijen. The cycle is also both described and visualised in this part of the report. The first part of this paragraph consists of a clarification on the definition of the subscription cycle. After the definition, this report is continued with an example cycle from the last quarter of 2018. This paragraph is concluded with an analysis of the current supply chain state regarding time-related assets.

3.1.1 Definition

The subscription cycle is a method used by De Zwolse Stadslanderijen to prevent a surplus of stock in a certain part of the supply chain. This part is referred to as the 'Meat chain' in this report. The next section explains why this cycle is used within De Zwolse Stadslanderijen operations. In fact, the subscription cycle means that customers are only secured for the company for a quarter or twelve weeks. In the current situation, it is possible for customers to join ZSL during an ongoing cycle. This both applies to customers joining vegetable and meat programmes. However new meat customers during an ongoing cycle could face a limited amount of meat availability. This is because meat for new customers during an ongoing cycle is supplied from surplus stock from the current cycle.

3.1.2 Incentive of usage

The reason why ZSL uses the twelve-week subscription cycle is because of limitations in the meat chain. A comprehensive description of the meat chain itself is included in paragraph 4.2.2. The main limitation of this part of the chain is the fact ZSL only orders every twelve weeks. This has to do with limitations in the minimum order quantity, namely: one animal. As, for instance, a cow can weigh 1000Kg, this is a large amount considering the small customer base ZSL has right now. The purchase of whole animals has an upside as well. Because of this way of sourcing , ZSL can offer a large variety of different meat products which they cycle throughout the twelve weeks to ensure a diverse range of products to their customer. ZSL also wants this way of working as they want to use animals from head to tail to ensure as little as possible is thrown away. As of the subscription round of September 2018 usage of the meat chain applies to 95,7% of all ZSL's customers. This is the reason why ZSL decided to apply the subscription cycle to all customers. A result of this is the fact that customers who only join the vegetable options of ZSL's are also bound to the 12-week subscription cycle. In a round of 47 subscribers there are only one or two non-meat subscriptions, which is negligible.

3.1.3 Analysis

To execute a thorough study on the subscription cycle different views on the subject have been included in this paragraph. In order to clarify the system a visualisation of the current cycle has been made. This visualisation of the fourth quarter of 2018 is depicted below.

SCC Quarter 4 overview — Deadline

Week	Mon	Tue	Wed	Thu	Fri	Sat	Sun	
38	17-sep	18-sep	19-sep	20-sep	**21-sep**	22-sep	23-sep	
39	24-sep	25-sep	26-sep	27-sep	28-sep	29-sep	30-sep	
40	1-okt	2-okt	3-okt	4-okt	**5-okt**	6-okt	7-okt	Meat Cycle
41	8-okt	9-okt	10-okt	11-okt	12-okt	13-okt	14-okt	
42	15-okt	16-okt	17-okt	18-okt	**19-okt**	20-okt	21-okt	
43	22-okt	23-okt	24-okt	25-okt	26-okt	27-okt	28-okt	
44	29-okt	30-okt	31-okt	1-nov	**2-nov**	3-nov	4-nov	
45	5-nov	6-nov	7-nov	8-nov	9-nov	10-nov	11-nov	
46	12-nov	13-nov	14-nov	15-nov	**16-nov**	17-nov	18-nov	
47	19-nov	20-nov	21-nov	22-nov	23-nov	24-nov	25-nov	
48	26-nov	27-nov	28-nov	29-nov	**30-nov**	1-dec	2-dec	
49	3-dec	4-dec	5-dec	6-dec	7-dec	8-dec	9-dec	Term of notice (1 month)
50	10-dec	11-dec	12-dec	13-dec	**14-dec**	15-dec	16-dec	
51	17-dec	18-dec	19-dec	20-dec	21-dec	22-dec	23-dec	
52	24-dec	25-dec	26-dec	27-dec	**28-dec**	29-dec	30-dec	
1	31-dec	1-jan	2-jan	3-jan	4-jan	5-jan	6-jan	

Figure 1 – Fourth quarter cycle 2018

During the twelve-week subscription, customers can make changes to their original choice of (non-meat) ingredients every two weeks. In the picture above this repeated sequence is reflected by the coloured parts that each have a length of two weeks. The two-week cycles consist of the following elements:

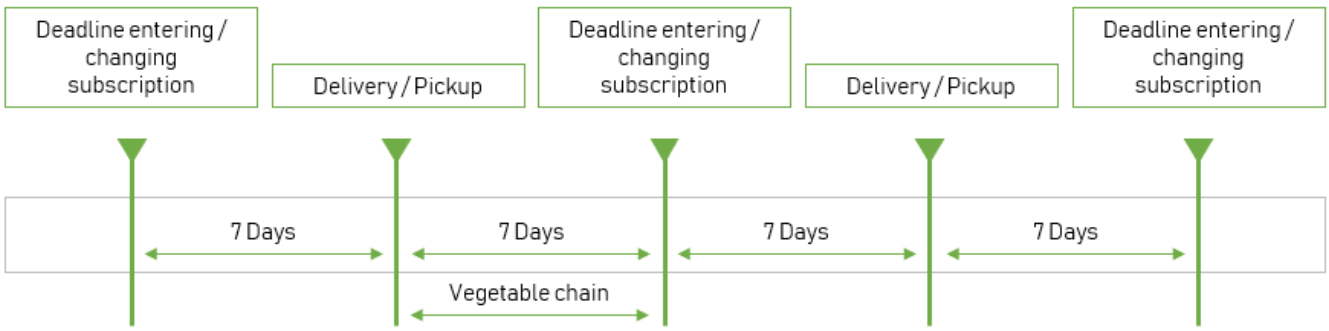

Figure 2 - Overview 2-week cycle

3.1.4 Deadlines & Term of notice

In the current subscription system, certain deadlines for ordering or changing meal boxes exist. When a customer orders a box, it takes 1-3 weeks before it is delivered to any chosen location. This depends on the cycle the customer is able to enter. When he or she orders on a Saturday in an even week, the customer must wait 3 weeks. When a new order is made on a Thursday in an even week the box can be delivered in the next uneven week. A term of notice implies to the meat subscriptions. Any new orders should be made one month before the start of a new meat cycle.

3.2 Current Supply Chain

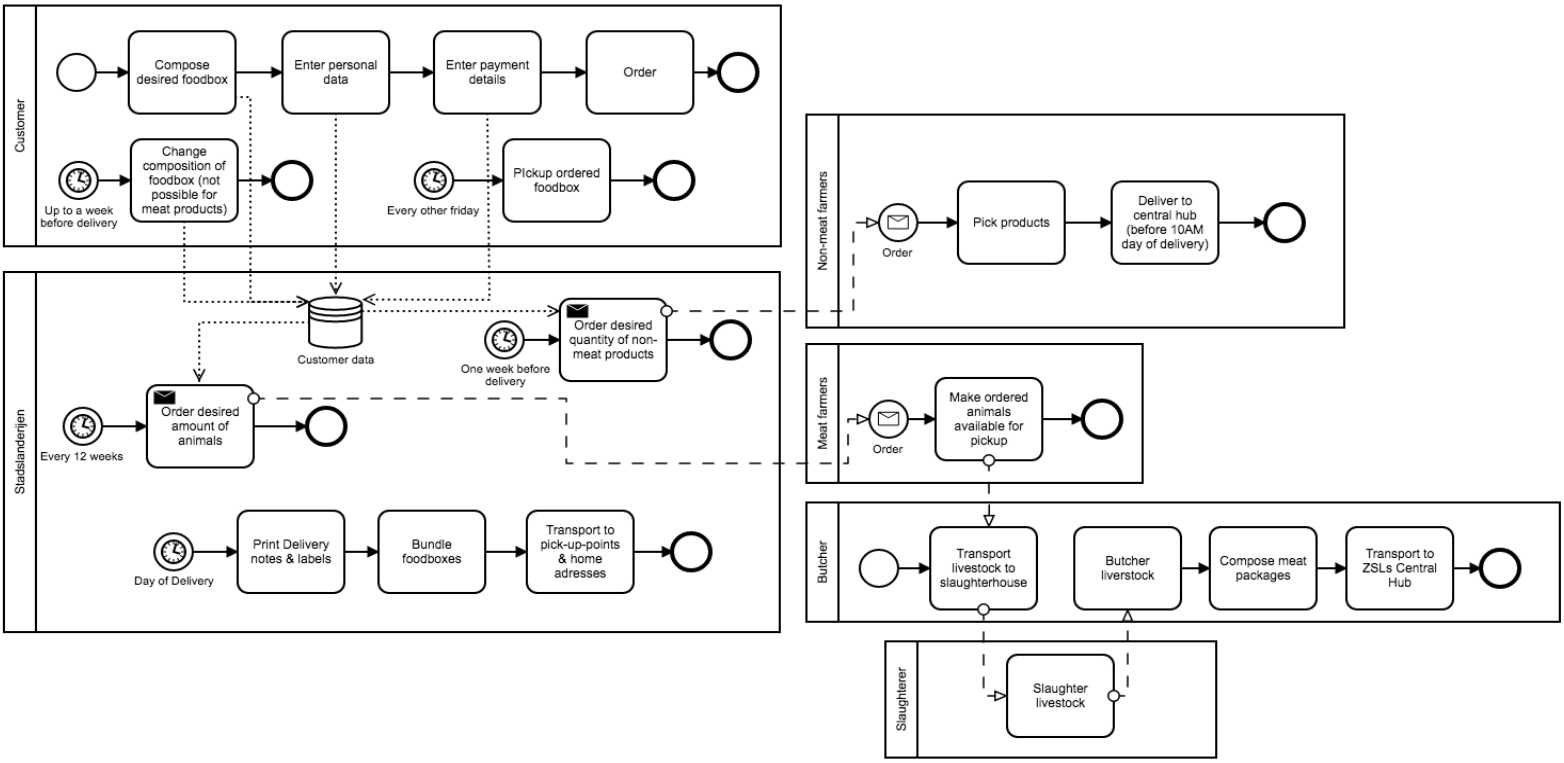

Figure 3 – Process Flow ZSL

To come to KPIs on how to improve the supply chain, it is necessary to map the current supply chain. In the picture, the current process is visualised in a process flow. In this chapter, all different aspects of the process flow will be described. A distinction is made between different parties in the supply chain and every party, and the connection between them will be explained. Day of delivery is not a separate party in the supply chain but is part of the process of De Zwolse Stadslanderijen. The reason it is added as a party is to have an overview of the supply chain and keep in chronological.

These parties are:

1. Customer
2. De Zwolse Stadslanderijen
3. Non-meat farmers
4. Meat farmers
5. Butcher/slaughterer
6. Day of delivery
7. Transport company

1. Customer

The process starts at the customer. At the moment the customer base exists out of inhabitants of Zwolle who have subscribed on the website of De Zwolse Stadslanderijen. If they are registered, customers can compose a food box, the content of which must amount to a certain minimum sum of money. Every other Friday they can pick up the food box or get it delivered to their home. If they are not content with the composition of their box, they can email the changes to De Zwolse

Stadslanderijen and at the next delivery, they will receive the changed box. Therefore, all the customer role in the process happens online hence the customer will not be obligated to leave their homes.

2. De Zwolse Stadslanderijen

The next party in the process is De Zwolse Stadslanderijen itself. When the customers have subscribed, De Zwolse Stadslanderijen receives the subscription including the order of the specific composition of the box. Because of using subscriptions instead of independent orders, the total demand for meat is fixed. This is necessary because they must purchase meat as a total animal. One animal provides for approximately twelve weeks of meat. So, every twelve weeks they sent out an order to their meat suppliers and stock the meat in the freezers of De Zwolse Stadslanderijen.

For the non-meat suppliers, De Zwolse Stadslanderijen must order one week before delivery.

3. Non-meat farmers

The non-meat farmers take care of all the products besides meat. These are vegetables, dairy and eggs. These farmers receive the order of De Zwolse Stadslanderijen one week before delivery. In this week they have the time to pick the products from the land and pack them. After that, they deliver the packages with their own cars to the central hub of De Zwolse Stadslanderijen. This needs to be done before 10 A.M. on the day of delivery to the customer.

4. Meat famers

The reason a distinction has been made between meat and non-meat is that the supply chains of these parties are a lot different from each other.

ZSL places orders for livestock every twelve weeks. The number of animals is determined by looking at the ordered quantity from the subscribers and adding a surplus in case there are any additional subscriptions in this period. The size of this surplus is purely based on the company's view on the next twelve week cycle. After ZSL decides on the number of animals they place orders at either a pig or a cow farmer.

5. Butcher/slaughterer

De Zwolse Stadslanderijen contracted a butcher to process the meat. This butcher receives the order which animals need to be processed and at what time. The butcher then collects these animals and transports them to the slaughterhouse, where they slaughter the animals and cut them in half. Next, the butcher picks up the carcasses and processes them into different cuts of meat and vacuum seals them.

6. Day of delivery

At the day of delivery all the products from all suppliers are received and are ready to be packed. Personnel of De Zwolse Stadslanderijen prints notes of each box on which is indicated how each box is composed. Also, the print label contains customer and address information, so they and the transport company knows which box belongs to whom. On the bases of the notes they compose the boxes and put a label on it. When this is done the boxes are ready for transport.

7. Transport company

For the last mile transportation De Zwolse Stadslanderijen has contracted a transport company. They receive the day of delivery a delivery list. Here is stated which boxes need to go to what which pick-up point, and which boxes need to be delivered at what home address. This transportation is conditioned at all time because of the fresh products that need to be cooled to stay fresh.

4 Growth-limiting factors in the current supply chain

In this chapter an in-depth analysis of different factors in the supply chain that limit the proposed growth of De Zwolse Stadslanderijen is included. To conclude which factors should be considered the SCOR model is used. This model is applied to construct a theoretical basis for the identification of limiting factors. In the next paragraphs limiting factors are also called bottlenecks. Based on both the SCOR model and the strategy of ZSL certain attributes are picked and reviewed on the current supply chain.

4.1 Performance attributes

According to the SCOR model different KPIs can be categorized into five performance attributes. Namely:

1. Reliability;
2. Cost;
3. Responsiveness;
4. Agility;
5. Asset Efficiency.

Reliability attributes focus on performance indicators that revolve around getting the right products to the right customer at the right time, whilst cost attributes focus on measuring the total cost and its cost drivers. Responsiveness attributes emphasise how quickly and effectively a company delivers goods to the customer and agility elements looks at a company's ability to adjust to their operational processes in reaction to shifting market wishes. The last attribute distinguished in the SCOR model, asset efficiency, focusses on managing work and fixed capital.
Whether an attribute is important depends on the business strategy of a company. That why it is key to define the business strategy of ZSL. To do this the value proposition model of Treacy & Wiersema is used (Wiersema & Treacy, 1996).

Figure 4 - Value proposition model

According to Treacy & Wiersema, a company's strategic goals can be defined upon three different directions of focus. These three focus areas are the following:

- Operational excellence
- Product leadership

- Customer intimacy

In order to determine what direction ZSL is heading the students put the company's products to the reference of the model. According to Kluin, a company must comply with certain characteristics in order to focus on a strategic direction (Kluin, 2004). The ingredients for every strategy are described below, in addition to that, ZSL's strategy is examined based on these values.

According to Kluin, the three strategic directions define a company in the following way:

- Operational Excellence:
    - Provide the customer with reliable products or services at competitive prices, deliver with minimal difficulty or inconvenience
- Product Leadership:
    - Providing products that continually redefine the state of the art
- Customer Intimacy:
    - Selling the customer a total solution, not just a product or service

To define the strategic direction of the Zwolse De Zwolse Stadslanderijen the properties above are applied to their strategy.

The field of operational excellence cannot be considered a main strategic focus area within ZSL. This is because selling products at a competitive price is not one of the goals of the company. (Leussen, 2018). Kluin also states that operational excellent companies deliver a combination of quality, price, and ease of purchase that no one else in the market can match. This cannot be considered a strategic goal of De Zwolse Stadslanderijen either.

Kluin states that a company pursuing product leadership continually pushes its products into the realm of the unknown, the untried, or the highly desirable. This is a strategic goal that applies to De Zwolse Stadslanderijen, the form in which the products the company delivers are grown were unknown before. In addition to that, the product quality and origin is the most important competitive advantage of ZSL. It is also the area where the company adds value to their customers weekly food supply. An important viewpoint of the company owner on the food he delivers is the fact that it's healthy for his customers (Leussen, 2018). When combining all these factors the students conclude that product leadership is a main strategic focus area of ZSL.
The last strategic focus of the model of Treacy & Wiersema is customer intimacy. To define the properties of this target, the definition of Kluin is used again. He states that companies that put their spotlight on Customer intimacy can be distinguished by the following: A company that delivers value via customer intimacy bonds with customers like those between good neighbours. A customer intimacy focused company does not deliver what the market wants, but what a specific customer wants. It can be said that De Zwolse Stadslanderijen focusses on both properties stated above. The company has a good intimacy bond with the current customers. This connection is maintained by the several "Open days" that are being held at the farms. Also, the fact that the farms are open to all customers to see where their food is being produced helps with customer intimacy. The third applicable customer intimacy attempt ZSL executes is the opening of so-called "Struinpaden" at the farms of suppliers.

Figure 5 - 'Struinpaden' (In purple) in the area of Zwolle

All De Zwolse Stadslanderijen customers are invited to see where their food is being produced. This is a way to create a bond between the customer, the product and the company that delivers the product.

The second main attribute Kluin assigns to customer intimacy is the fact that the company delivers what the customer wants, not just what the broad market expects. In ZSL's case, customers can choose the contents of their box and even change their initial choices too. This way ZSL creates a bond with their customers on a customer intimacy level. Based on the theoretical research the students conclude that De Zwolse Stadslanderijen as a company is focussed on both customer intimacy and product leadership.

Coming back to the performance attributes. *Cost* and *Asset efficiency* are particularly interesting for companies focussing on operational excellence, whilst *Reliability, Responsiveness* and *Agility* are aimed at companies that use a customer intimacy and/or a product leadership. Yet, since agility is more focused on the market as a whole and not on the changing individual needs of customers it is less important in this study.

SCOR model's performance attributes, however, is missing one attribute, which is very important for ZSL, namely: sustainability. Therefore, any KPIs that will be set for ZSL can be categorized into:

1. Reliability;
2. Responsiveness;
3. Sustainability.

Reliability is the fundament of the supply chain. Thus, it should be the basis and the primary focus of ZSL to keep attributes within this category at a high level. For ZSL, the challenge will be to keep the reliability at a high standard whilst scaling up its operation. That is why it is important to map the limitations of the current supply chain. In designing solutions for the current bottlenecks both responsiveness and sustainability will be considered, however, the primary focus will be to retain a high service level. If the supply chain supply is resistant to the coming growth, ZSL can look at opportunities to improve the responsiveness and sustainability specifically.

4.2 Growth limiting factors (Bottlenecks)

As decided in the previous chapter about the performance attributes the main focus of De Zwolse Stadslanderijen should be on reliability. To identify which parts of the supply chain are not able to keep the performance at the current level when the throughput raises a model is made. In this model, the different stages in both the physical and information supply chain are depicted. In addition to the stages, a limit for each part is included in the boxes underneath the process step. When there is no identifiable or relevant limit in a process step the limit is displayed as: n/a (Not applicable).

4.2.1 Physical supply chain

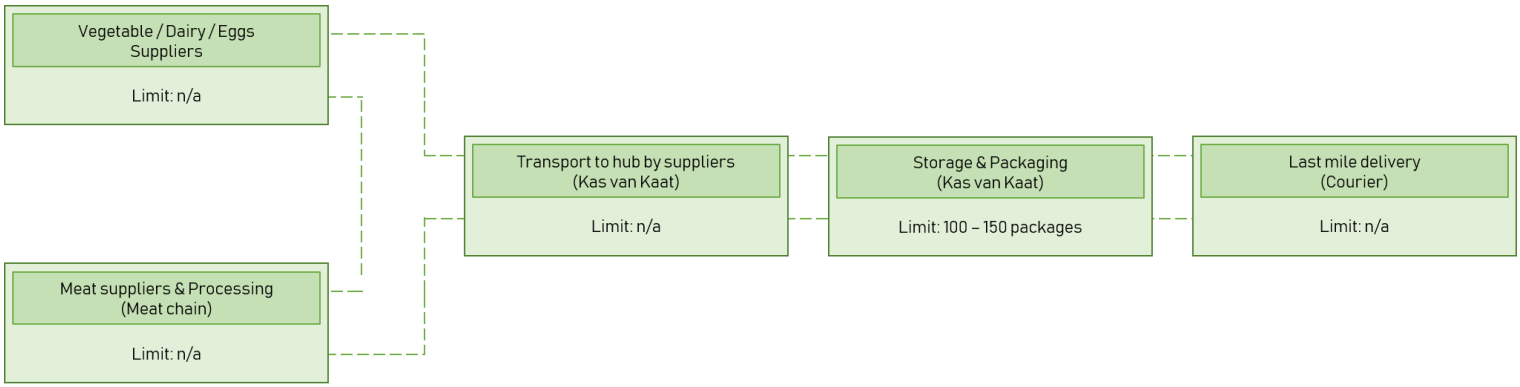

Figure 6 - Physical supply chain

The psychical supply chain, as shown above, is a visualisation of the complete operational process of De Zwolse Stadslanderijen. As can be seen in the picture above the only process step that limits growth in the current supply chain is the storage and packaging at Kas van Kaat. The constraint for the central hub of ZSL is currently 100-150 packages in each round[1]. This is a constraint because of several reasons. First, because storage space is limited at Kas van Kaat. This lack of space also constraints the number of people that can work on packaging and the effectiveness of the packaging, because employees get in each other's way quickly. This will become a bigger problem as demands grows as time will become of the essence.

At present, the packaging process is done by two employees. One reads out the orders and the other picks the products and put them into the right crate. Chapter five of this report contains several solutions to this problem.

4.2.2 Meat chain

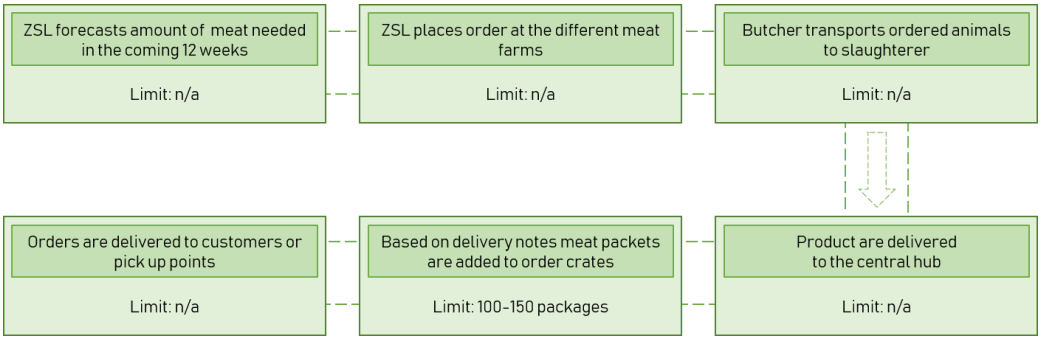

Figure 7 - Meat chain

This part of the psychical supply chain is distinguished by the fact that the meat chain contains two external parties. These parties are both the butcher and the slaughterer. When it comes to supplying, slaughtering and transporting the meat no growth limits are applicable to De Zwolse Stadslanderijen. The only limit this part of the supply chain encounters is the amount of frozen storage space at Kas van Kaat. In addition to that, it is, according to Jos van Leussen, not an option to hire extra frozen storage space in the area of Zwolle. He tried to acquire more frozen storage space in the past years. However, he was not able to find any frozen storage for hire. The maximum storage space at the current central hub has already been filled with the stored meat. The frozen storage space will certainly be a constraint when the meat demand is equivalent to that of 500 customers. In addition

[1] According to an interview with Jos van Leussen

to that, the researchers concluded that internal transport will also be a constraint when De Zwolse Stadslanderijen scales up to the desired customer base size. In the pictures below the current state of storage in the freezer of Kas van Kaat can be perceived.

Figure 8 - Current frozen storage at Kas van Kaat

4.2.3 Backoffice processes

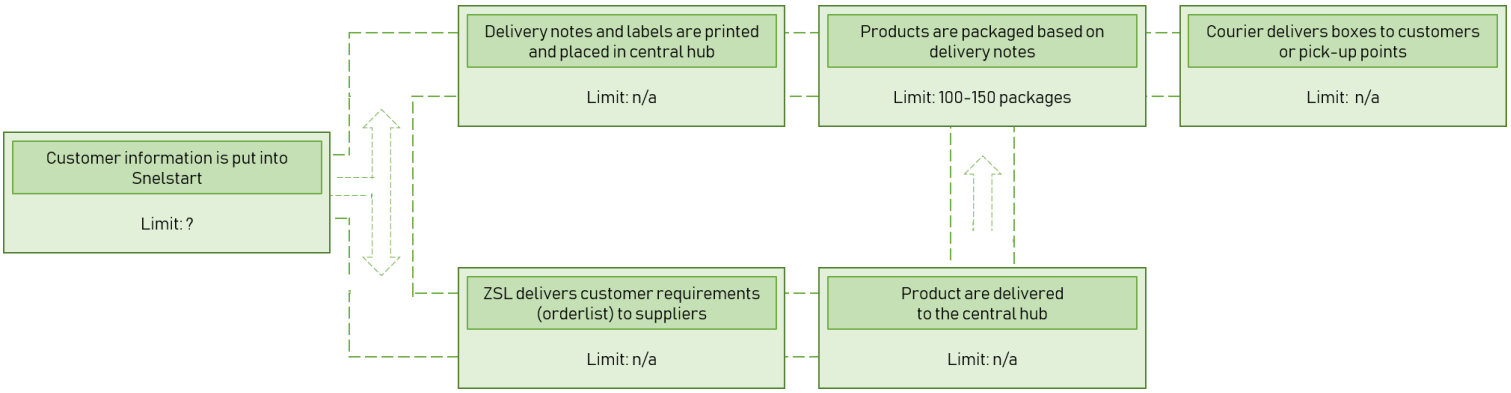

Figure 9 - Backoffice processes

Another limiting factor to ZSL's growth is the lack of integration between the website and *SnelStart* (the software ZSL uses). At the moment whenever a customer subscribes all customer information must be manually entered in SnelStart. Also, any adjustment customers make to the composition of their food box has to be changed and replied to manually. This takes time will not be maintainable in the long run. It could be solved by automating this.

However, since they are implementing a web shop, ZSL is already dealing with this issue. Because in the future state this will not be done by hand anymore. Therefore, this bottleneck won't be looked at anymore in this study.

4.2.4 Conclusion

The most important thing that stands in the way of ZSL's growth is *Kas van Kaat* as the central hub. For the storage of both frozen and cooled goods as well as the packaging operation, the space available there is simply inadequate. As it is not an option to expand this at *Kas van Kaat* and possibilities to rent other space in the area of Zwolle are limited, it would be wise for ZSL to invest in their own storage space. The next chapter will elaborate on the question how big this storage would need to be to fit both storage and packaging processes and how this packaging process could best be set up.

5 Storage space constraint

5.1 Future state calculations

As mentioned in the previous chapter the limited availability of cooled and frozen storage space at *De Kas van Kaat* constraints the growth of ZSL. Therefore, more storage space is needed. This can either be done by creating storage space at, for example, *De Dijklandhoeve* or hiring cooled storage space. In both cases, it is necessary to calculate how much storage space is actually needed when serving 500 customers with the current way of sourcing. To estimate this, calculations have been made based on the subscriptions of September 2018. The calculations have been based on this month because of the fact that it's the most recent one. It is assumed that these amounts increase evenly when the customer base grows to 500.

5.1.1 Frozen storage

A distinction should be made between cooled and frozen storage space because the frozen storage is only used for meat products whilst the rest of the products are stored in cooled storage. Firstly, the frozen storage will be calculated.

Meat in % of customers	2 people	3 people	4 people	5 people
Beef 3 meals	10,87%	10,87%	4,35%	0,00%
Beef 4 meals	0,00%	2,17%	0,00%	0,00%
Beef + pork 3 meals	41,30%	10,87%	4,35%	4,35%
Beef + pork 4 meals	4,35%	0,00%	2,17%	0,00%
No meat	4,35%			

Meat 500 customers	2 people	3 people	4 people	5 people
Beef 3 meals	54	54	22	0
Beef 4 meals	0	11	0	0
Beef + pork 3 meals	207	54	22	22
Beef + pork 4 meals	22	0	11	0
No meat	22			

Total	Pallets in production	Total 12 weeks	Pallets in storage
402 Small packets	1	2412	6
77 Big Packets	**1**	**462**	**3**

Figure 10 - Frozen storage overview

To calculate the space needed, the number of pallets needs to be estimated. A distinction is made between small and big boxes. Boxes are 15x15x15cm and 20x20x20cm respectively. The larger boxes are only used for orders for 4 people or more.

To ensure the boxes are still grabbable by a person, the stack height must not exceed two meters (including pallet height). Therefore, 5*8*12= 480 small boxes and 6*4*9=216 large boxes fit on one euro-pallet. As shown in the table, 2412 small and 456 large boxes need to be stored. This means that the total number of pallets needed is 9. Which means a total storage space of 8,6 m². In the graphic below an indicative depiction is made.

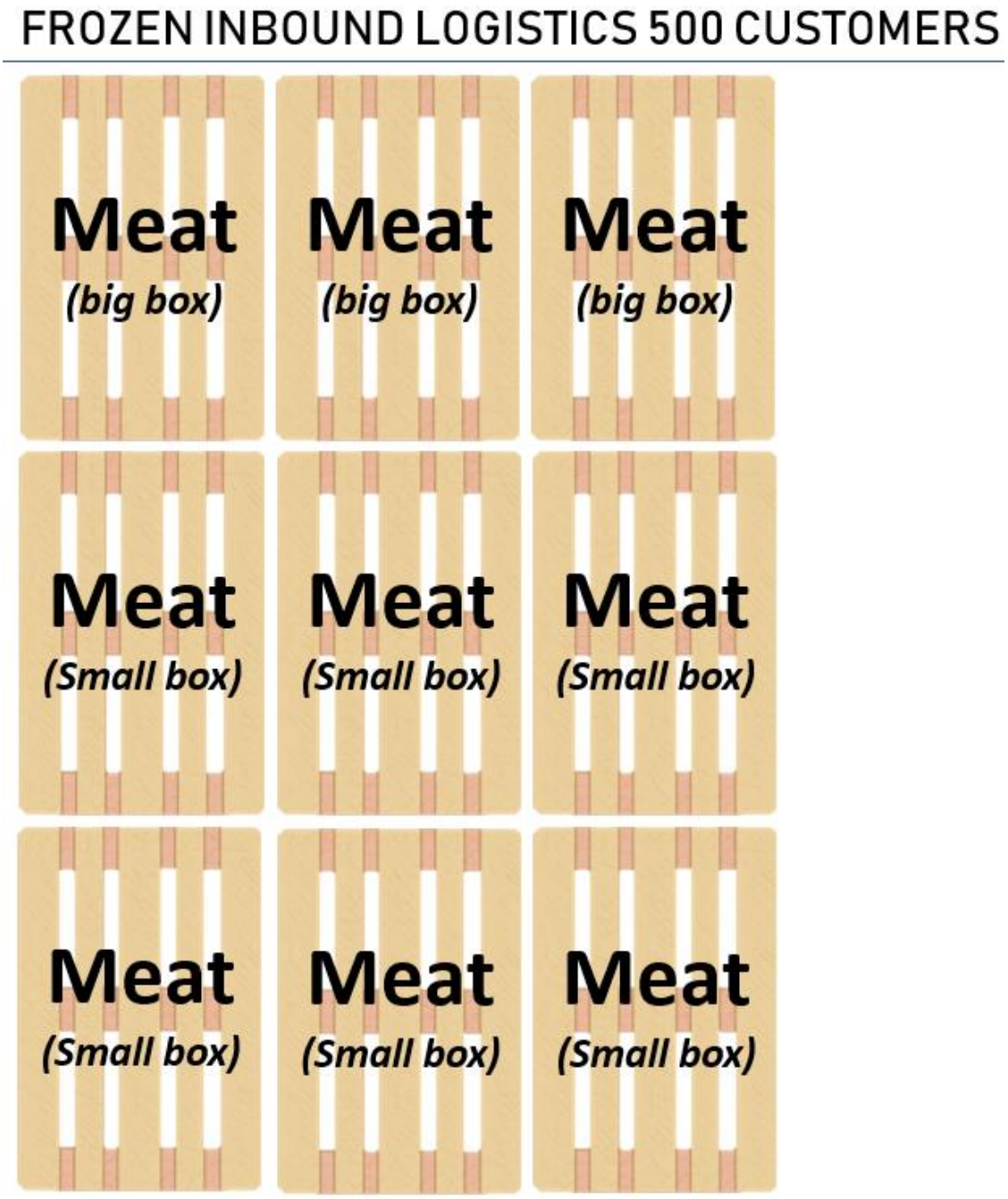

Figure 11 - Graphic frozen storage needed

5.1.2 Cooled storage

Next, the surface of the refrigerated storage is estimated by looking at the vegetables and other products.

Vegetables	% of customers	500
Big	28,3%	142
Standard	39,1%	196
None	32,6%	163
# crates		169

Figure 12 - Cooled storage needed (Vegetables)

In September 2018 32,6% of customers did not order vegetables. This means that in the case of 500 customers, 338 vegetable bags would be needed. Because two bags fit into one crate a total of 169 crates would be needed.

Because for the rest of the products the amount per customer differs, the average amount of a product is calculated to estimate the number of crates needed. This results in the following table:

Product	# per customer	500
Cheese	1,174	587
# Crates for cheese		59 Crates
Dairy	0,783	391
# Crates for dairy		17 Crates
Eggs	1,239	620
# Crates for eggs		52 Crates
Potatoes	1,457	728
# Crates for potatoes		n/a
Shoarma	0,22	109
# Crates for shoarma		4 Crates
Total Crates		132 Crates

Figure 13 - Product overview (crates)

Because of the size of bags of potatoes, they will not fit well in a crate. Therefore the bags will be stacked in trolleys without crates. The number of crates is therefore not relevant and not taking into account in the calculation which can be seen in the table above.

The crates will be put on trolleys (as explained in chapter 5.1.2.1) which can fit 18 crates. A trolley is 68x81cm. Trolleys for cheese are 50x70cm and fit 7 crates. Added to that, a surplus of 5cm around the trolley makes 78x91cm and 60x80cm Therefore, the storage space needed is:

Vegetables	169 Crates	10 Trolleys	7,1 m²
Cheese	59 Crates	9 Trolleys	4,32 m²
Dairy	17 Crates	1 Trolleys	0,71 m²
Eggs	52 Crates	3 Trolleys	2,13 m²
Shoarma	4 Crates	1 Trolleys	0,71 m²
Total			14,97 m²

Figure 14 - Space calculation table

So, the total amount of storage space in the refrigerator needs to be about 15m².

5.1.2.1 Graphic inbound cooled logistics

In the graphic below an indicative depiction of the inbound cooled logistics is made. This figure is meant to give the reader an idea about the space needed to accommodate supplies for 500 customers. This graphic must be seen as an imaginary map that gives a suggestion about how all needed goods can be efficiently lined up. However, a comprehensive research is necessary to find out if this layout is indeed the most optimal solution. The crates are placed on trolleys in this case, this is to maximize internal logistics. The trolleys can cope with 18 crates at a time. A picture of those crates on a trolley can be found in Attachment B 'Internal logistics'.

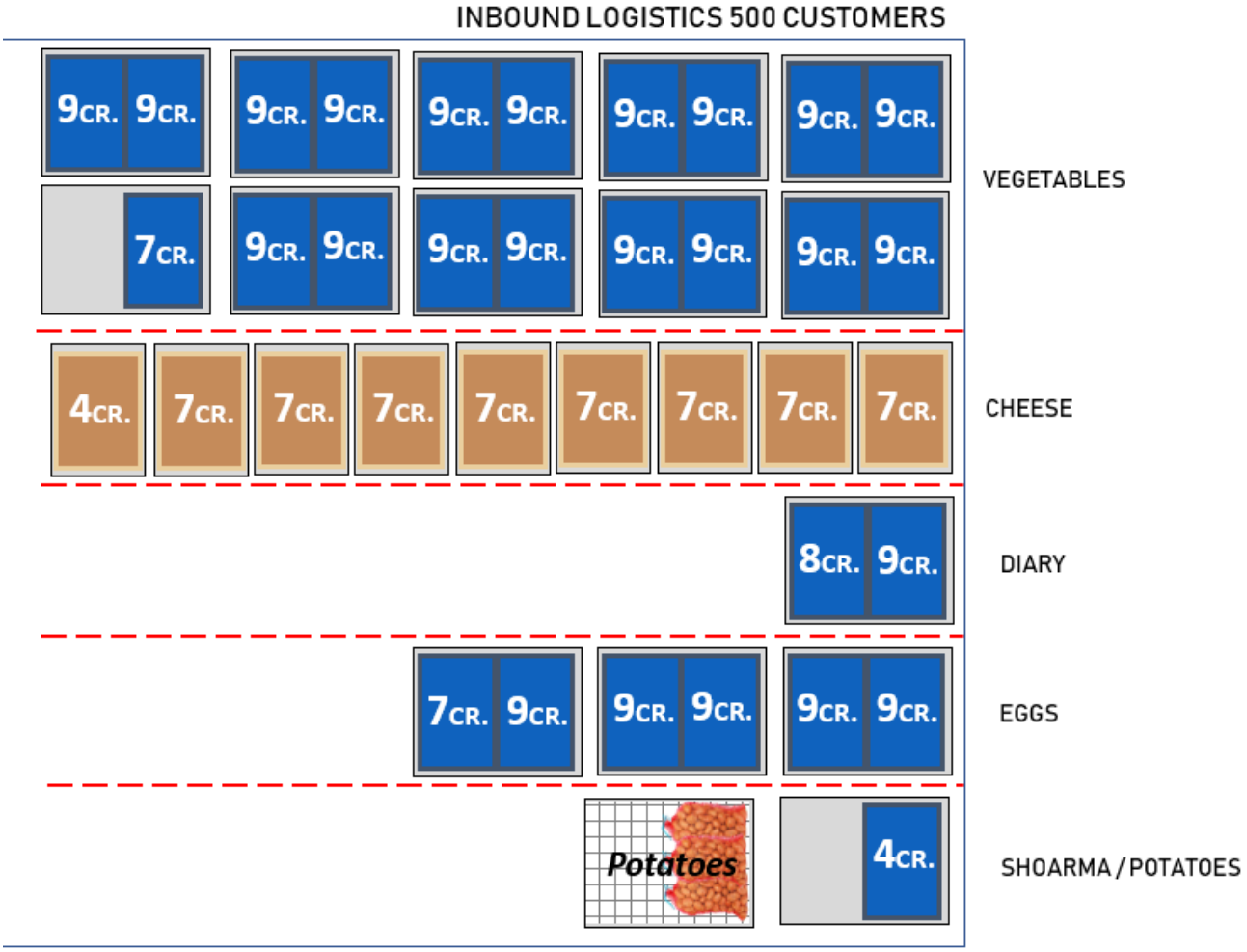

Figure 15 - Cooled inbound logistics 500 customers

5.1.2.2 Graphic outbound logistics

During the research, the researchers also looked at the space needed for the outgoing crates. However, it must be borne in mind that there are more efficient ways to organize this logistics. However, this is outside the scope of this research and will therefore not be discussed further. This figure can therefore be considered as indicative. For example, in this graphic the fictive future delivery regions north and south of Zwolle are also added. The crates are placed on trolleys in this case, this is to maximize internal logistics. The trolleys can cope with 18 crates at a time. A picture of those crates on a trolley can be found in Attachment B 'Internal logistics'.

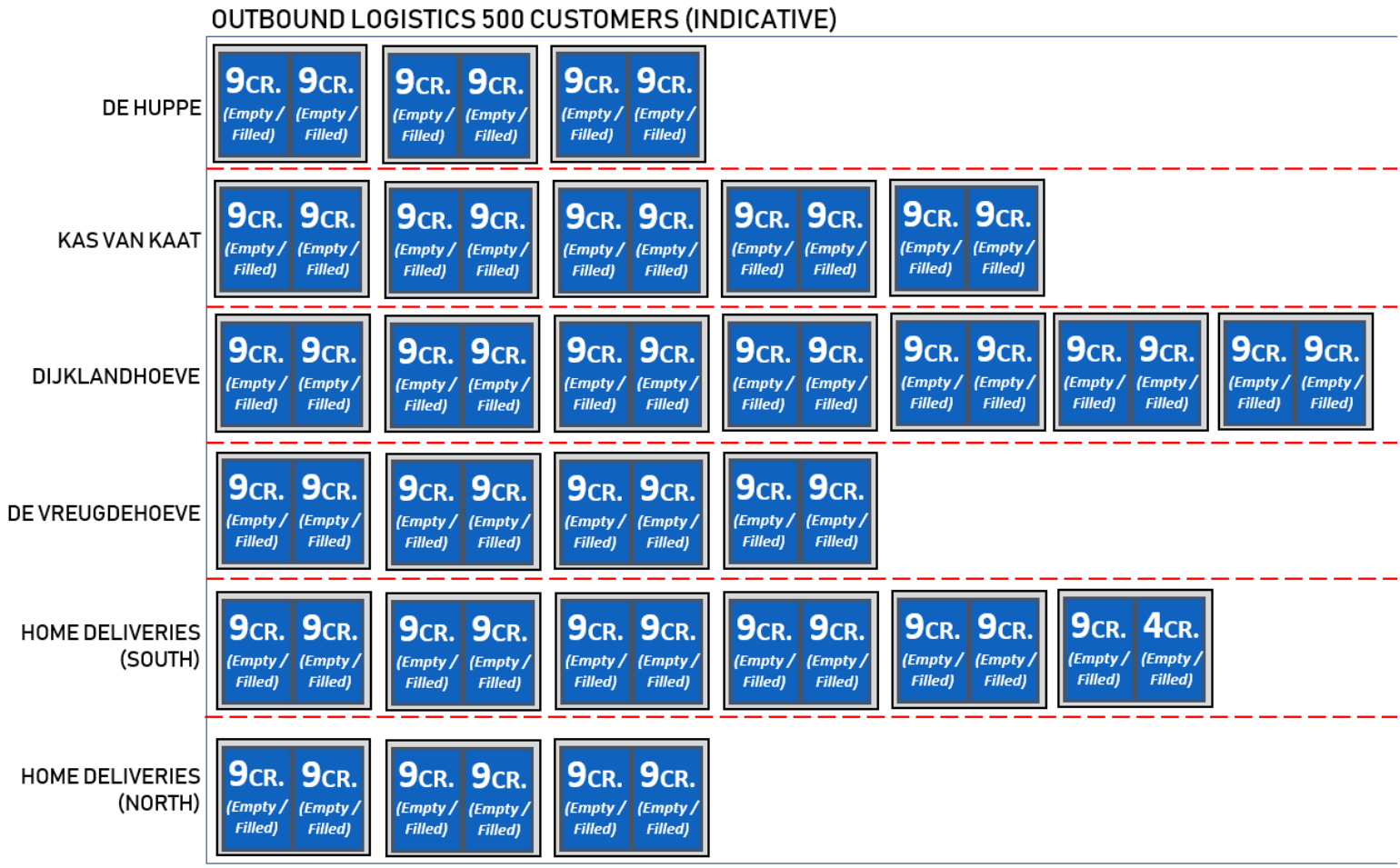

Figure 16 - Overview outbound logistics 500 customers

5.2 Improvements – Packaging limit

The main subject of the previous chapter are the factors that limit De Zwolse Stadslanderijen's growth in the number of packages delivered. The most important factor of the ones described is the space constraint that is defined at Kas van Kaat. This chapter answers the following sub-question of the complete research: What supply chain improvements are needed to cope with the expected growth and serve customers in an efficient way? This chapter links improvements to the bottlenecks defined in chapter 4. To ensure the improvements are constructed in both relevant and effective ways, the complete process of realizing such a solution is presented in this paragraph.

5.2.1 Product throughput

The total throughput in the number of packages in the desired situation is fixed, as stated in paragraph 4.2 the total number of packages that the process must handle in the future situation is at least 500

At De Zwolse Stadslanderijen, each customer can choose the contents of their own box. This results in the fact that almost every package is different from others. To deal with this kind of variety maximal flexibility in the packaging process is needed. Because of the still relatively small scale of the process at 500 packages/round and to realize cost reduction in cooled processing space needed all boxes are processed on the same production line. This decision will also result in a limited number of employees needed to operate the weekly process.

The calculations are based on the amount of time a certain operation would cost in comparison to other movements. For example, the following consideration: It would cost an employee twice the time it takes to pick Shoarma to pick a certain cheese from one of the different cheese crates. This is because ZSL delivers only one kind of Shoarma to its customers, therefore picking Shoarma is an easy and quick task. Picking cheese is a more complex job, the employee must choose the right cheese from different options. In addition to that, it could also be possible that a customer demands two different kinds of cheese. Because of this reason, the following assumption is done: Picking cheese costs two time-units and picking Shoarma costs one time-unit.

Product	% Of Crates	Number of picks	Unit of time	Workload
Vegetables	68%	340	1	340
Meat	96%	480	2	960
Eggs	74%	370	1	370
Cheese	72%	360	2	720
Dairy Products	39%	195	2	390
Potatoes	59%	295	1	295
Shoarma	80%	400	1	400

Figure 17 - Workload based on an output of 500 crates

In the table above the column '% Of crates' states the percentage of boxes that contain that product. For example, this means that meat is present in 96% of all boxes that are processed in the process. This percentage is based on the ratio that is currently existent in the subscriptions of the September 2018 cycle. The analysis of this ratio is done by the data analysis software Qlik Sense, as depicted below. The example shown is an analysis of the presence of potatoes in the boxes that are processed. This kind of examinations is done on all possible product combinations in a delivered package.

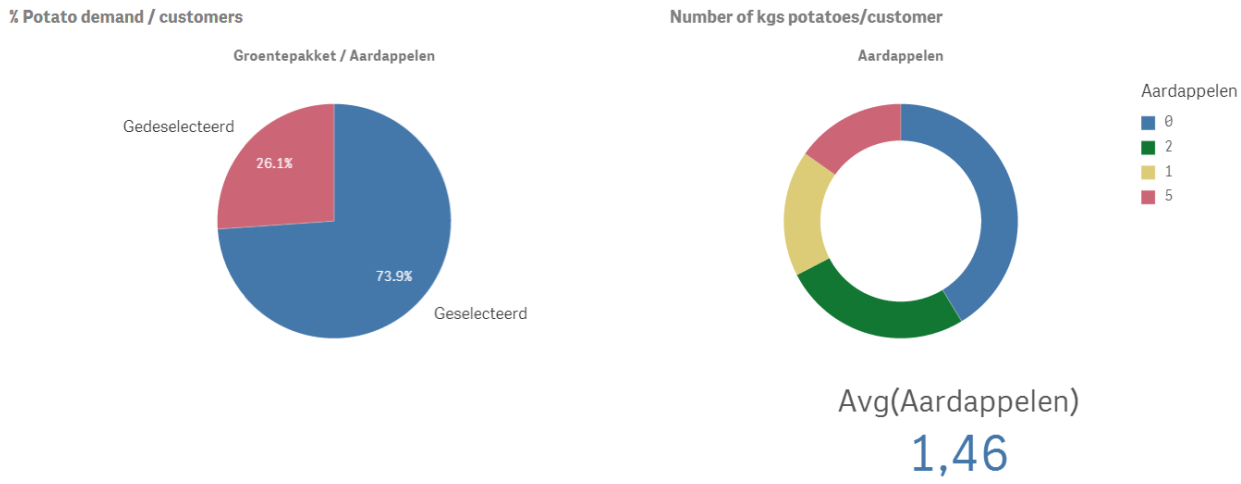

Figure 18 - Subscription analysis (Powered by Qlik Sense)

5.2.2 Total workload

The total workload in a growth scenario of 500 boxes per round is depicted in the table below. This table is sorted based on the total amount of workload per product. In addition to that, data on the % of total workload and the cumulative percentage is in this table as well. To give a reference in time to the workload the researchers used desk research to form a fundamental basis for the assumptions in time. These assumptions are based on two sources. The first source is a field reconstruction by the researchers. This reconstruction is done by one of the researchers in a similar setup to the concepts as described in this report. The outcome of this test is that all 'easy' tasks would cost approximately 10 seconds of time for any employee. The second source of the assumption is an external source, this states that the total packing time for orders (Including execution & setup) is 7,300 seconds (Musaoglu, 2017). This calculation is done on second level because it is unnecessary to further indistinct the time needed to do the packing.

$$\frac{7{,}300 + 10{,}000}{2} = 8{,}650\ Seconds$$

Adding both sources up and dividing them by the number of sources results in an assumption of 8,650 seconds per employee action. This duration is used in the remainder of this research to state the total workload of the process in seconds. In the table below the workload in ratio's is translated to seconds.

Product	% Of Crates	Movements	Ratio	Time required (Sec)	Total Time (Sec)	% of Total.	Cum. Time	Cum. %
Meat	96%	480	2	17,3	8304	28%	8304	28%
Cheese	72%	360	2	17,3	6228	21%	14532	48%
Shoarma	80%	400	1	8,65	3460	12%	17992	60%
Dairy Products	39%	195	2	17,3	3373,5	11%	21365,5	71%
Eggs	74%	370	1	8,65	3200,5	11%	24566	82%
Vegetables	68%	340	1	8,65	2941	10%	27507	92%
Potatoes	59%	295	1	8,65	2551,75	8%	30058,75	100%
Total					**30058,75**			

Figure 19 - Total workload overview

The conclusion that can be deduced from these calculations is the fact that the total workload of the new process is 30059 Seconds. This is based on the ratio times the number of movements that the employee must do to pack all 500 boxes.

5.2.3 Production window

The time that is available to do the processing in the new situation is formed by several constraints. One of these constraints is the last moment the suppliers can deliver their goods to the central hub, this is 10 am on a delivery day. This means that preparations can start at that time. The effective start time of the process is approximately 11 am. The end constraint is the delivery of the packages to the customers on the same day. To make sure enough time is available for delivery the process must be executed as fast as possible. In this research, three hours of dedicated processing time is reserved. After three hours, there will be enough time left to load the delivery truck(s). After that, the deliverer should have enough time left to deliver to both the customers at home and the pickup points as well. This implicates that in the calculations 10800 seconds are reserved for packing 500 boxes.

$$3 \times 3600 = 10800\ Seconds$$

Figure 20 - Delivery day overview (Future situation)

5.2.4 Employees

Available Time (Sec)	10800
AVG Pick time (Sec)	8,650
# Crates	500
Number of employees	2,78

Product	% Of Crates	Movements	Ratio	Time required (Sec)	Total Time (Sec)	% of Total.	Cum. Time	Cum. %
Meat	96%	480	2	17,3	8304	28%	8304	28%
Cheese	72%	360	2	17,3	6228	21%	14532	48%
Shoarma	80%	400	1	8,65	3460	12%	17992	60%
Dairy Products	39%	195	2	17,3	3373,5	11%	21365,5	71%
Eggs	74%	370	1	8,65	3200,5	11%	24566	82%
Vegetables	68%	340	1	8,65	2941	10%	27507	92%
Potatoes	59%	295	1	8,65	2551,75	8%	30058,75	100%
Total					**30058,75**			

Figure 21 - Total workload overview (Including employees)

Based on the total workload within the production window the amount of work per employee can be deduced. The first step in this process is to determine the number of employees. This can be done by dividing the total workload in seconds by the available time, in this case, this calculation is

$$\frac{30058{,}75}{10800} = 2{,}78$$

The calculations above state that the total workload exceeds the available time 2,78 times. This means that the workforce should be 2,78 times bigger than one. Logically 0,78 employees are not hireable. Therefore, a third employee should be employed in the process to pack all 500 boxes within three hours. The remaining 0,22 workforce that exceeds the current need of the process is however not useless. The input and output of filled and empty crates in the process is not considered in calculating the total workload. In the paragraph 'Idle time', this remaining capacity will be addressed.

5.2.5 Uniform workstation loads

In the paragraph above is determined that three employees will be the optimal workforce at the production line. The work that has to be done has to be levelled in a certain way over the three workers. This certain way is levelling the work in such a way that the pressure of workload is put at the beginning of the process (Workstation 1). Because of levelling the work this way the first employee will always be adding value to the end product. The other employees have spare time and have to do other work that adds value to the process. This way waiting time is not an issue in the process. (Lohman, 2011) This process has a takt time of 21,6 seconds, this means that it has an output of 2,78 crates per minute. (Krajewski, 2016)

Product	Vulnerability level
Eggs	4
Vegetables	3
Cheese	2
Dairy Products	2
Shoarma	1
Meat	1
Potatoes	1

Figure 22 - Vulnerability levels

$$\frac{3 \times 3600}{500} = 21{,}6\ Seconds\ (Takt\ time)$$

When levelling the workload two decision variables were taken into account by the researchers. These variables are the following: 1. The workload should be descending along the production line, 2. The products of De Zwolse Stadslanderijen that are most vulnerable to damage should be put in the crate last when possible. This is decided based on a vulnerability level as stated by the researchers below.

Both decision variables are considered when calculating the levelled workload in the process. The second variable (Vulnerability) is used as a decisive factor when the workload is levelled properly.

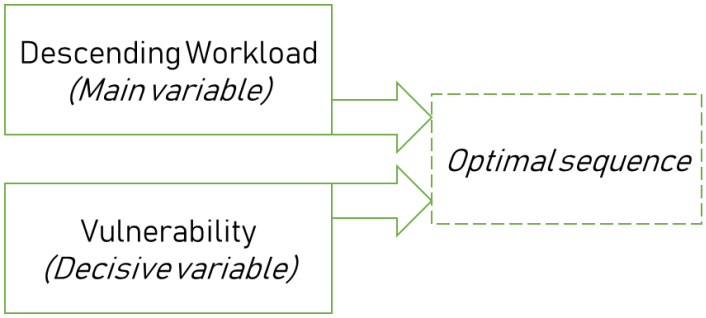

Figure 23 - Decision variables process sequence

As previously mentioned, both the decreasing workload and vulnerability have been considered when calculating the optimal workload. The table below is the result of this consideration. The vulnerability is calculated as an average of all products that are processed on that workstation. An in-depth analysis of all workstations including the percentage of total workload can be found in the attachments. A comprehensive view on the workload per workstation is depicted in Attachment A 'Workstation overview'.

Workstation	Product	Workload (S)	AVG. Vulnerability
1	Meat	8304	1
	Potatoes	2552	1
	Total	10856	1
2	Cheese	6228	2
	Shoarma	3460	1
	Total	9688	1,5
3	Dairy Products	3374	2
	Eggs	3201	4
	Vegetables	2941	3
	Total	9515	3

Figure 24 - Workload overview & Sequence

The graphs below show graphically how both the decreasing workload and the vulnerability level develop along the process. In this graphic overview, the trends that have been discussed earlier can be found. So, this means that the workload distribution as defined in the table above suits both variables.

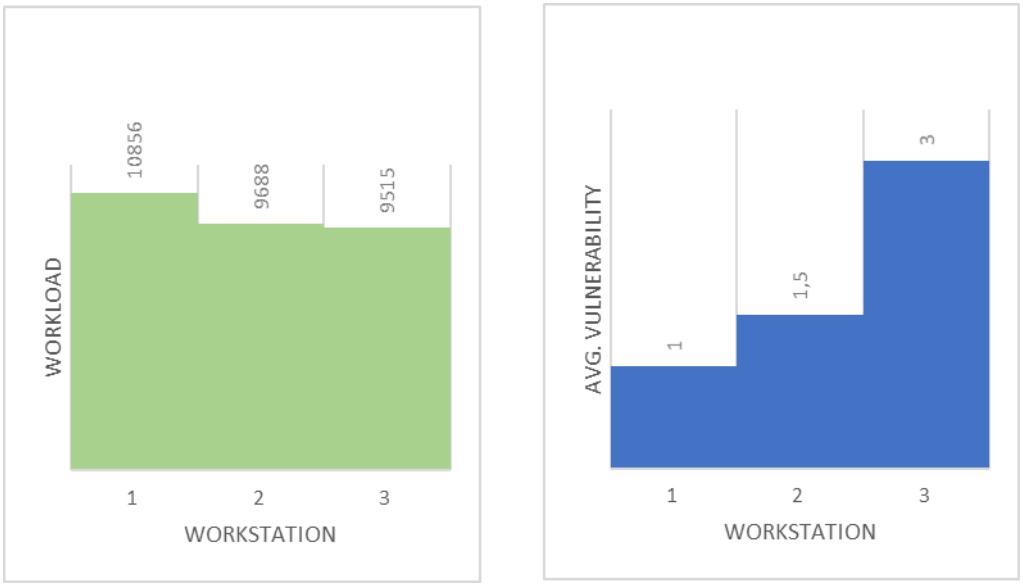

Figure 25 - Graphic consideration of workload & vulnerability

5.2.6 Idle time

As mentioned in paragraph 5.2.4 'Employees' the current workload distribution implicates idle time at workstation two and three. This is displayed in the graph on the right. This is displayed in minutes to give a reference to the reader. During this idle time, the employees that work on these stations have other duties to fulfil. The most important one of these duties is the handling of filled and empty crates at both the beginning and the end of the process. Regarding the takt time, calculated in paragraph 5.2.5 'Uniform workstation loads', the workload of these duties can be calculated. In this calculation, the researchers assume that employee two handles the empty crates and employee three the filled ones. Employee one is out of consideration in this case because his or her workload is already 100%. For employee two this means the following: he or she must make sure that employee one can pick a new empty crate at least every 26 seconds.

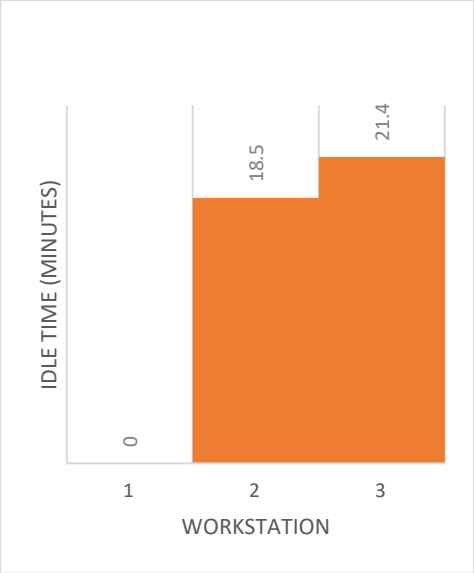

Figure 26 - Idle time per workstation

$$17.3\ (Meat) + 8{,}65\ (Potatoes) = 25{,}95\ Seconds\ (Input\ rate)$$

Logically, multiple crates can be supplied at once, therefore employee two has time left to do other duties that are necessary to keep the process running. This is to both always keep workstation one and two's stock replenished. Employee three has a similar extra duties scheme; The first and main idle time concern is to make sure that filled crates are removed from the line after he or she has executed the tasks related to workstation three. This means that the employee must remove a crate at least every 21,6 seconds (Takt time) In addition to that, employee three can also be used as a backup for replenishing workstation one and two's stock. The stock of workstation one should be replenished first, however. This station is not allowed to come to a halt because it is a bottleneck. According to the theory of constraints, time lost on the bottleneck is time lost on the whole system. In contrast, an hour saved at a non-bottleneck resource is a mirage, because it does not make the whole system more productive. (Krajewski, 2016)

5.2.7 Process concepts

Based on the results of the previous paragraphs process concepts can be designed. The most important outcomes of the research concerning the basis of a concept are the following:

- Each concept should have three workstations.
- Each concept should be able to handle products in the sequence defined in paragraph 5.2.5 'Uniform workstation loads.'

The researchers have added some additional conditions as well. This implicates decision variables; the presence of these variables is a benefit to a concept. Or when a concept does not maximize or minimize the following variables it can also be seen as a disadvantage. Some of these conditions are mandatory for a concept to be considered. The variables that are essential are marked with a *.

- Each concept should occupy as less space in square metres as possible. This is because the process must be executed in a cooled area, and it is an advantage to De Zwolse Stadslanderijen to cool as less space as possible.
- * Each concept must be suitable to be executed in a cooled area. A cooled area regarding De Zwolse Stadslanderijen's packaging process is defined as a space where the average temperature is between zero and seven degrees.
- * Each concept must handle the current De Zwolse Stadslanderijen blue crates. The dimensions of these crates are 40x60x20 cm.
  Each concept must handle cheese in brown bakery crates. The reason behind using these crates is the fact that cheese comes in a lot of different variations and kinds. It is simply not possible to pick all those kinds in blue 'common' crates. Therefore, bakery crates with open front ends are used. The dimensions of these crates are 70x50x20 cm.
- Each concept must consider the reach of the employees that are working at the workstations. Therefore, concepts that have highly used products at a location close to the packaging line are in an advantageous position in comparison to other possible solutions.
- The financial aspect of each concept should also be considered. However, the costs of each concept should be considered in a future business case. This variable can be used as a tiebreaker when judging two equal concepts.

The crates are placed on trolleys in all concepts, this is to maximize internal logistics. The trolleys can cope with 18 crates at a time. A picture of those crates on a trolley can be found in Attachment B 'Internal logistics'. The dimensions of these trolleys are 80x68x168 cm.

5.2.8 Scoresheet

Each concept that is included in this chapter is ranked based on several decision points. In this paragraph each of these points will be considered. Based on these variables the scoresheet that is depicted below is designed. All concepts will be ranked based on the scoresheet, and the concept that is ranked best will be advised to the company.

CONCEPT XYZ		Final Score:	7
Variable	**Factor**	**Mark**	**Score**
Square metres occupied	0,4	8	3,2
(Reverse) Flow	0,2	9	1,8
Product location	0,2	4	0,8
Length of conveyor	0,1	7	0,7
Employee crossover functionality	0,1	5	0,5
Total			**7**

Figure 27 - Example scoresheet of concept XYZ

- The variable square metres occupied is considering the amount of space each concept needs. The lower the space usage, the higher the mark.
- The reverse flow mark is considering the ease of dealing with both empty and filled customer crates from and to the storage.
- Product location is concerning the distance between products and the production line. When products are located relatively close to the line the mark given will be higher.
- The financial aspect comes into the blend at the variable length of conveyor. To minimize costs, the conveyor should be as short as possible.
- Employee crossover functionality describes the ease in which employees two and three can replenish the stock of employee one. This process is described in paragraph 5.2.6 ‘Idle time’.

5.3 Concepts

In this chapter the different concepts are considered and ranked based on the scoresheet that is mentioned earlier. This part of the research is structured as follows; The first part of each consideration is a graphic overview of the concept. Every concept is designed on scale and therefore useful to estimate size in relation to other parts of the layout.

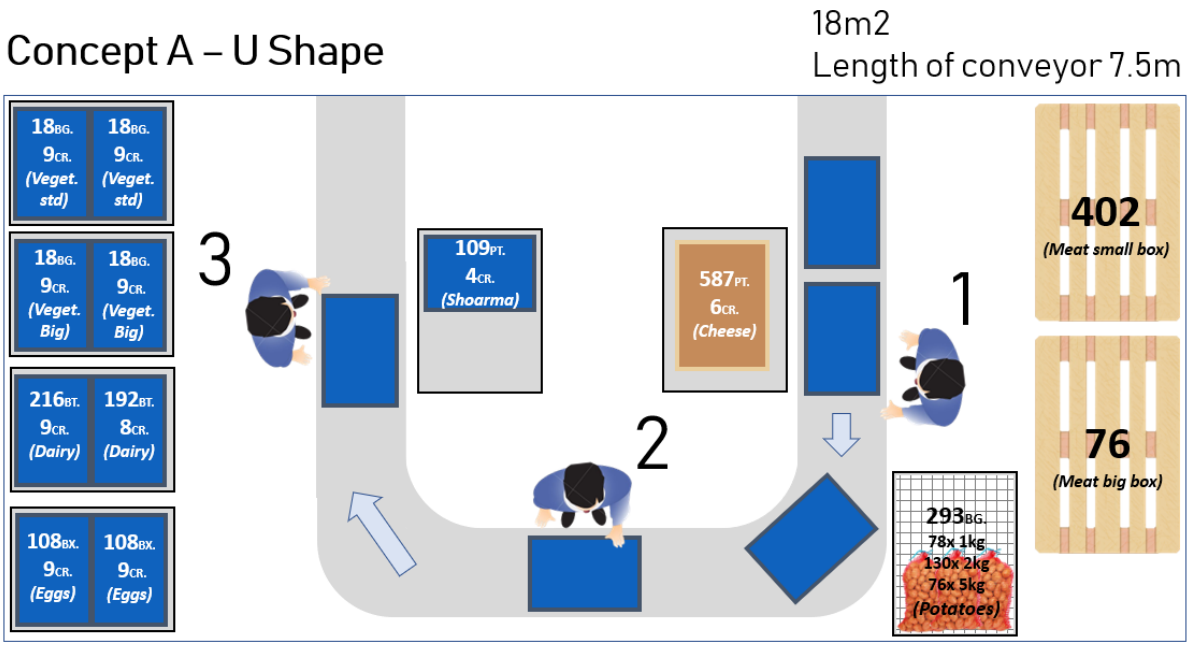

Figure 28 - Overview concept A - U shape

The first concept that is considered in this chapter is a design that follows the shape of the letter U. The design is centred around a flexible and removable roller conveyor. An example of a conveyor of this kind can be found in attachment 11.3 'Conveyors'. The benefit of such a removable conveyor is the fact that it can be stowed away when the process is not operating. The shape in which the conveyor is places implicates the biggest advantage this concept offers. Due to the shape filled crates end up in the same place as where they came from before being processed on the conveyor. This means that the same storage space can easily be used for both filled and empty crates. Thus, internal logistics are a really strong aspect of this concept. This is reflected in the scoresheet for this concept below.

CONCEPT A - U SHAPE Final Score: **7,2**

Variable	Factor	Mark	Score
Square metres occupied	0,4	7	2,8
(Reverse) Flow	0,2	9	1,8
Product location	0,2	9	1,8
Length of conveyor	0,1	4	0,4
Employee crossover functionality	0,1	4	0,4
Total			**7,2**

Figure 29 - Scoresheet concept A

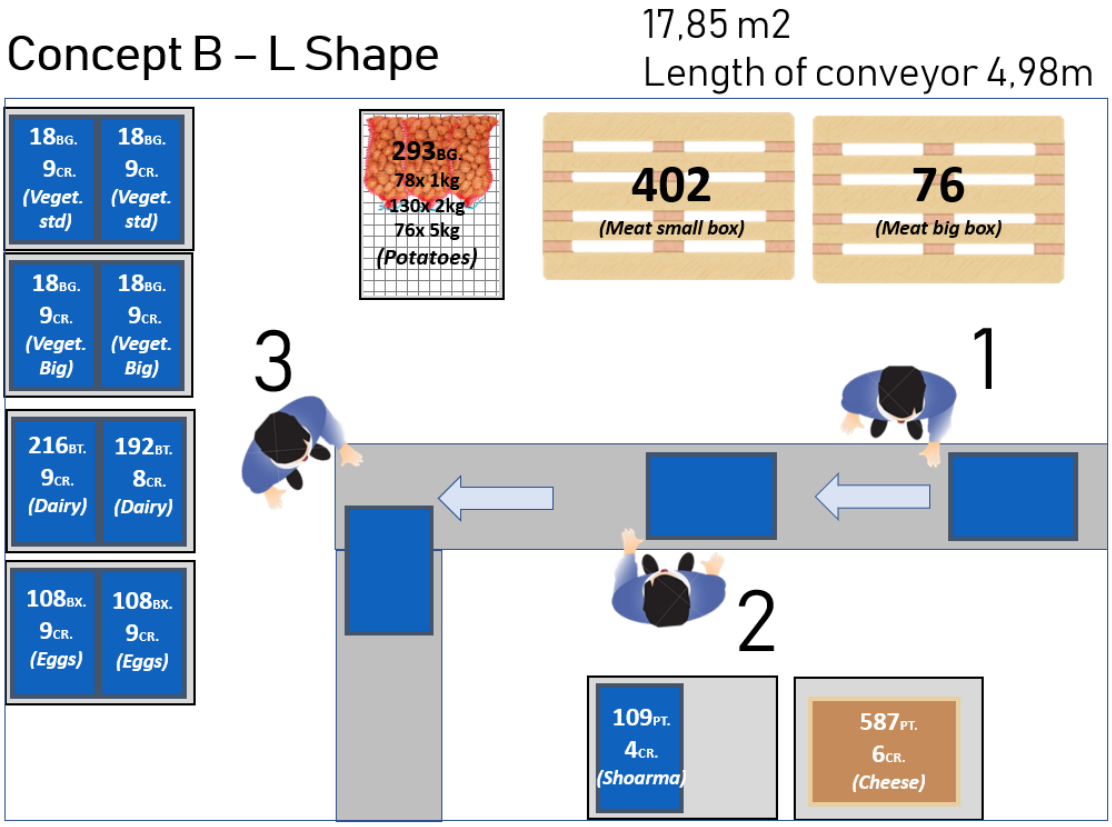

Figure 30 - Overview concept B - L shape

Concept B is typified by the L shaped conveyor that processes the crates from the first to the last step. The L shape is the most important factor in this design, it enables an excellent employee cross-function possibility. This aspect will be mentioned later in this paragraph. The flow in this design is important, because of the lack of space of the line between steps one and two. The L shape guarantees the flow of crates on the line by the extension on the line past workstation three. Whenever employee three is busy and not able to handle the filled crates, the overflow of crates can be stored temporarily on the conveyor extension. This is not the biggest benefit of this concept. This is the fact that employee three can easily access workstation one. In the case of replenishment needs at station one, he or she can step in easily and supply this employee. The reasoning behind the importance of this movement is stated in chapter 5.2.6 ‘Idle time’. This shift is depicted in the figure on the next page.

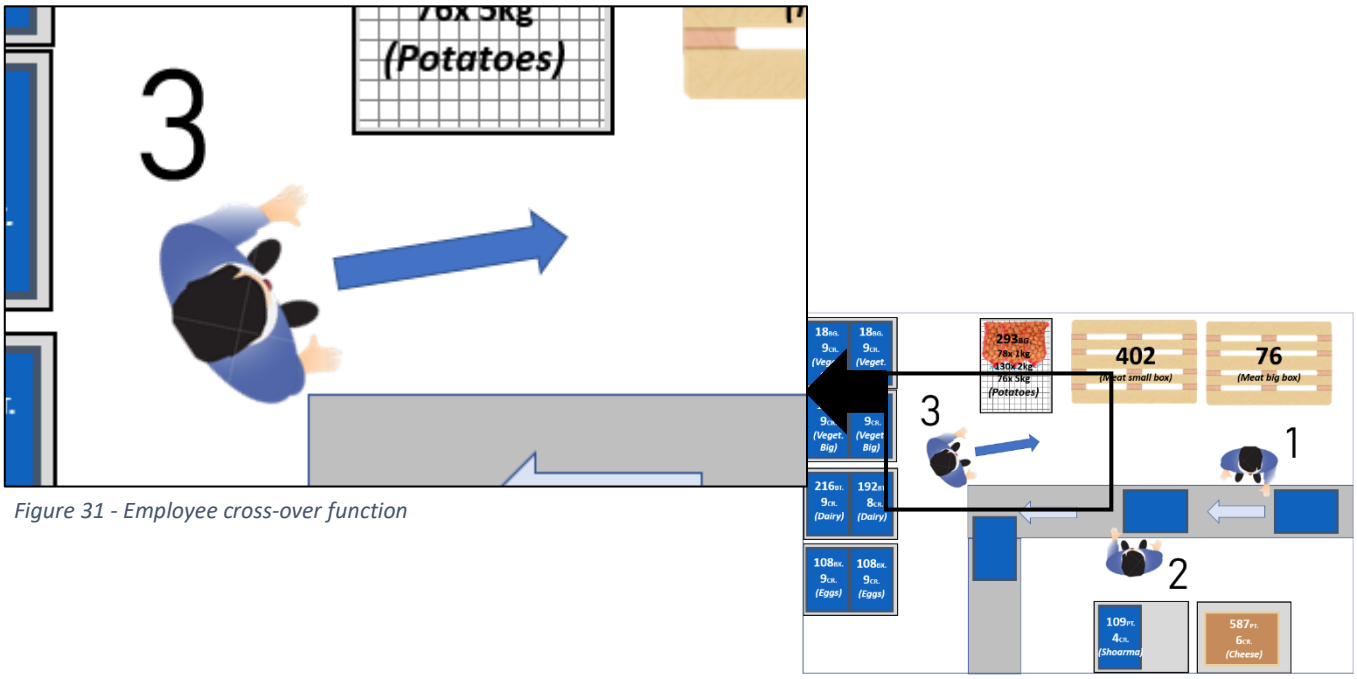

Figure 31 - Employee cross-over function

This concept can both be executed with a flexible- or a fixed conveyor, in this case the researchers advise a fixed conveyor based on the beneficial financial aspects when choosing the last option. A graphic of a fixed conveyor can be found in attachment 11.3 'Conveyors'. The high score on the employee cross-over function, mentioned earlier, is one of the aspects that are rated in the scoresheet below.

CONCEPT B - L SHAPE		Final Score:	7,7
Variable	**Factor**	**Mark**	**Score**
Square metres occupied	0,4	8	3,2
(Reverse) Flow	0,2	7	1,4
Product location	0,2	7	1,4
Length of conveyor	0,1	8	0,8
Employee crossover functionality	0,1	9	0,9
Total			**7,7**

Figure 32 - Scoresheet concept B

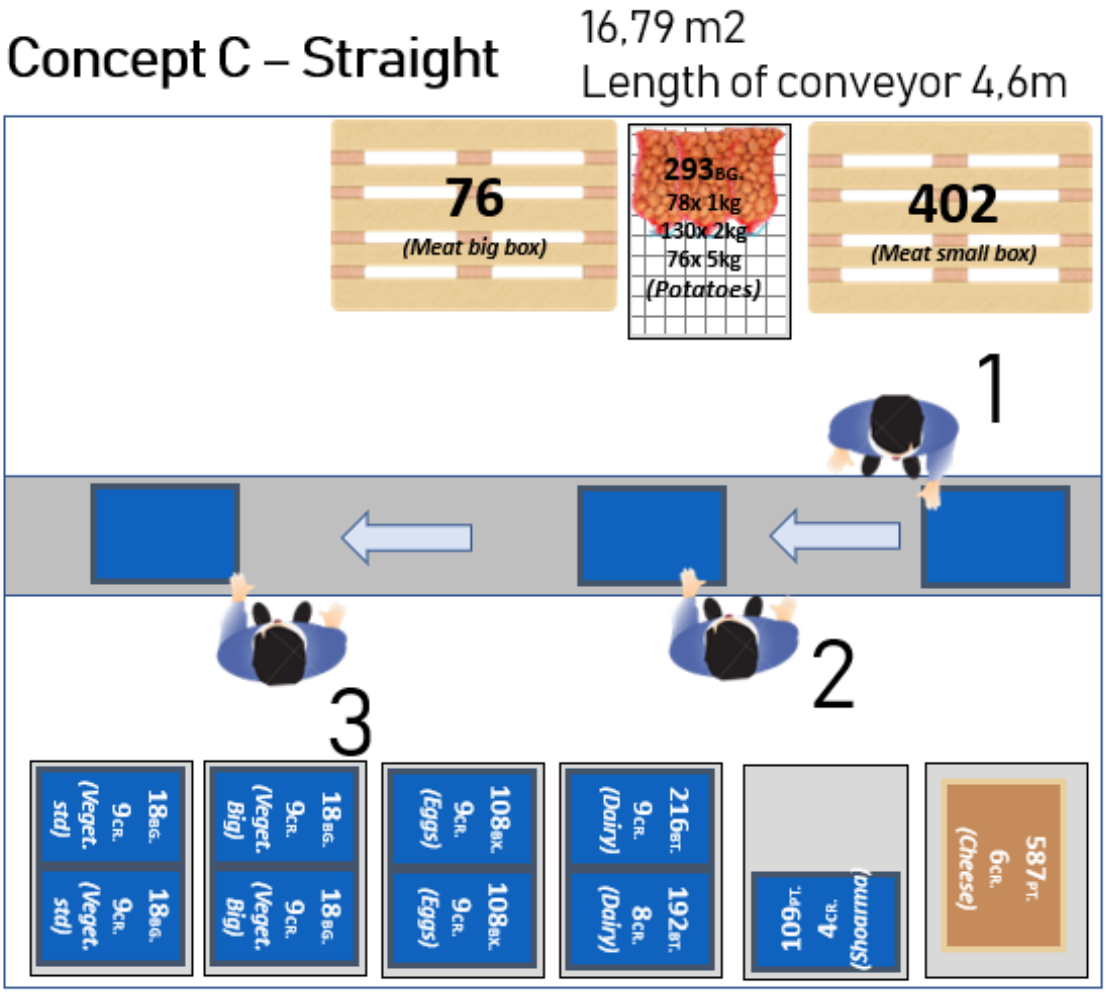

Figure 32 - Overview concept C - Straight

The third concept is a conveyor placed in a straight line between all three workstations. This design excels in two different aspects. Both features are related to the physical aspects of this concept. The first characteristic is the space it occupies, this is only 16,79 square metres, which is the least of all three concepts. In addition to that the conveyor length that it needs is also just 4,6 metres. The downside of this concept is that cross-functional employee switches are very hard to execute. The employees would have to cross the production line during the process, this might interfere the flow. A solution to this problem can be a process gate as depicted in attachment 11.3 'Conveyors'. The lack of this possibility is also considered in the scoresheet below.

CONCEPT C - STRAIGHT Final Score: **7,3**

Variable	Factor	Mark	Score
Square metres occupied	0,4	9	3,6
(Reverse) Flow	0,2	5	1
Product location	0,2	7	1,4
Length of conveyor	0,1	9	0,9
Employee crossover functionality	0,1	4	0,4
Total			**7,3**

Figure 33 - Scoresheet concept B

6 KPIs

6.1 Definition of KPI

According to (Kenton, 2018) Key performance indicators (KPI) are a set of quantifiable measures that a company uses to gauge its performance over time. These metrics are used to determine a company's progress in achieving its strategic and operational goals, and also to compare a company's finances and performance against other businesses within its industry. Since there is a need to understand well what is important, various techniques to assess the present state of the business, and its key activities, are associated with the selection of performance indicators. These assessments often lead to the identification of potential improvements, so performance indicators are routinely associated with 'performance improvement' initiatives.

6.2 How can Zwolse De Zwolse Stadslanderijen use KPI's to measure their performance

A Key Performance Indicator (KPI) is a metric that gives an indication of company performance and can be used as a driver for improvement. The effectiveness of the supply chain performance of Zwolse De Zwolse Stadslanderijen can be measured by KPI. What is the Critical Key Performance Indicators of Zwolse De Zwolse Stadslanderijen and how it can be used to help to improve the supply chain process? Based on the situation that this company is still on the developing stage, the students choose five metrics to help measure the Zwolse De Zwolse Stadslanderijen performance.

The KPI's categorized in the chapter 4 is the general idea of how ZSL can use KPI to improve the whole supply chain.By clarifying the most important attributes of ZSL operation, namely reliability, responsiveness and sustainability, the students can map the limitations of the current supply chain and design solutions for the current bottlenecks. In this chapter, the students will explain it in a more detailed and specific way that ZSL can use it to measure their performance.

KPI score is a ratio of actual KPI's and the target KPI's value. For the KPI's score of ZSL aimer for, the students will use number to show how ZSL use number to measure the KPI score to make it more easy to observe.

The score level as showed below:

Excellent: 4 points
Good: 3 points
Acceptable: 2 points
Poor: 1 point
Very poor: 0 points

- Total Delivered Cost

One of the ways to support total delivered cost measurements is with a complementary metric on total cycle time, which measures the total amount of time it takes for a product to pass through the supply chain. Also, by measuring the cost of transportation fee from farmers to the central hub, animal transportation cost of delivering to the slaughterhouse, packaging fee, inventory holding costs, transportation fee paid to the logistics company, Zwolse De Zwolse Stadslanderijen can calculate the total cost of delivery cost by sum it up.

Total Delivered Cost = all transportation fee + packaging fee + inventory holding costs. The ZSL should aim for a score of 4, because after applying the conveyor design and the improvement the configuration the efficiency of the whole process could be improved for better level.

- Inventory

Metrics which support the Inventory KPI are in the areas of total inventory carrying cost, the write-off, inventory turnover rate, the cycle time and fill rate. The first factor affected the inventory indicator is inventory carrying cost. It includes labour rent utilities storage security theft and equipment etc. Another thing to measure the inventory is the number of write-offs. An inventory write-off describes goods that are no longer valuable and can't be sold. This could happen if the goods become damaged, stolen, or obsolete in the market. In the case of ZSL, this means the amount of food that must be thrown away because of being spoiled. It measures if the freezing system works well and if the package is reliable. If the measurement result shows large, recurring write-offs, ZSL may probably be suffering from poor inventory management. Because the write-offs affected by season, in hot summer day this indicator may be higher than that in winter, but ZSL should keep it as low as possible. The second important metric is the rate of inventory turnover since it is used to optimize the cash flow, working capital, and inventory costs. Inventory turnover is a ratio indicating the amount that a company has sold is how many times of replaced inventory during a certain period. ZSL could use the formula : Cost of Goods Sold divided by Average Inventory to have a better grasp on the market demand for their products, and what steps ZSL need to take to sell or stock more inventory, depending on the result of turnover rate. Another metric to measure would be the cycle time. The cycle time calculated begins from ZSL receives the order until the customers receive their products. To be more specific, it includes process order time, inspection time, package time, logistics company delivery time, and any other time used during the ZSL supply chain process. Basically, the equation sums all of the time from which a product is started to when it is shipped to the customer. By decreasing those time included in the measurement formula, the company could improve the inventory performance. Another factor is a less fitting metric would be fill rate. Since almost all of ZSL's inventory is matched with customer orders and arranged far in advanced the fill rate ought to be near 100%. However, if a new customer signs up this customer will be served from the surplus stock. If the surplus is already zero, the customer must wait until the next order cycle.

- Customer Service

Customer service can directly affect the image and turnout rate of a company, so customer service level is also an important factor to measure the performance of the company. ZSL could launch the regular customer satisfaction surveys to continuously gauge overall satisfaction levels by designing online questionnaires, sending it to subscribers, collecting data and recommendation, calculating the average point and evaluating the overall performance service level. Based on the current stage of ZSL, students recommend including these three factors to design the questionnaire: the satisfaction degree of delivery (ex. on time delivery, in full delivery, damage-free delivery accurate documentation), the product quality, and the post-sales service (ex. average issue response time, customer retention rate). Except from the scores that customers give, ZSL also can add a blank and collect the information of service or products recommendation from customers. After collecting all the subscribers' scores, ZSL could calculate an average point and use it to weigh what is the improvement priority of the service.
ZSL should aim for the 4 because in this current stage, because for ZSL customer service is the core of their business and it already did a good based on the feedback of current customer.

- Demand Variability & Supply Variability

Supply variability KPI measure the status of inventory against conformance to lead times and promise dates. Included are metrics for performance to the purchase plan, schedule attainment, asset utilisation, capacity utilisation, vendor deliveries, and item availability at all farmers stocking locations (including the customer's location). By using those factors to measure the variability of the whole supply chain, ZSL could have a clear picture of the variability of the process.
Because the operation demand variability is comprised of measurements for inventory, lead times, adherence to process capability, improvement to process capability, conformance to plan, actual demand versus forecast demand, forecast accuracy, and forecast error. To measure forecast error ZSL can keep logs of the surplus of meat and the amount of used surplus every order cycle. In this stage, ZSL doesn't use any forecast technique and currently, the order surplus amount is based on a guess. Using this forecast technique ZSL can more accurately estimate how much surplus should be ordered. So, the variability issue for ZSL is not a big issue because it's subscription system, but with forecast technique, ZSL will get a higher score.
Supply variability = distribution costs + procurement costs + warehousing costs + transportation costs + + meat outsourcing costs
Demand variability = measurements for inventory + lead times + adherence to process capability + improvement to process capability + conformance to plan + actual demand versus forecast demand + forecast accuracy + forecast error

- Operation-cost

It is important to increase the revenue and at the same to decrease the cost. For ZSL, the operation-cost took up a large part of cost. A clear cost overview is crucial for minimizing the cost.
The total operation-costs are rolled up in this metric, including distribution costs, procurement costs, warehousing costs, transportation costs, and meat outsourcing costs. From these, it is possible to calculate the cost of goods sold, cost per unit, or cost per kilogram, which are all useful KPI's relative to total cost. From this aspect, the aim score of ZSL should be 3, because the operation cost will increase in the future when the new equipment purchase.
Operation cost = distribution costs + procurement costs + warehousing costs + transportation costs + meat outsourcing costs

7 Sustainability

This chapter is aimed to analyse sustainability issues within the company. Theoretical analysis on sustainability and sustainable supply chain criteria will be covered; practical evaluation and assumptions will be given regarding solutions for improvements in the supply chain of De Zwolse Stadslanderijen.

7.1 Concept of a Sustainable Supply Chain

According to (Krajewski, 2016) the goal of a sustainability-seeking company is to provide services or products or perform processes that meet humanity's needs without harming future generations.

Supply chain integration is one of the main areas of focus seeking sustainable operations as it establishes communication and material flow. Krajewski also determines the three most important elements of supply chain sustainability:

Figure 33 - Supply chain Sustainability

1. Financial responsibility focuses on the financial needs of the shareholders, employees, customers, business partners, financial institutions – any entity that supplies the capital for the production or relies on the firm for wages or compensations. Financial responsibility in a supply chain also contributes to the return on assets; in addition, any improvement to processes improve the overall financial well-being of a company and increases competitiveness;
2. Social responsibility regards moral, ethical and philanthropic expectations that society has of an organisation;
3. Environmental responsibility addresses the ecological needs of the world and the company's supervision on the natural resources used in the production of services or products. The objective is to reduce environmental footprint to a minimum so that the natural resources would be available for future generations.

These elements are even more important for ZSL as its strategic approach to customers is based on the idea of health and a healthy environment.

Members of the cooperation are inspired and willing to adjust current processes as eventually, they would be able to represent themselves as an environmentally responsible cooperation. These achievements would be first steps to implementing further ecological processes not only in the supply chain of De Zwolse Stadslanderijen but in the farms as well since the project's scope does not include re-designing processes in farms.

Current environmentally-sensitive processes of ZSL the project is focused on are:

1. Transportation between farm locations and the central hub;
2. Last-mile logistics;
3. Reverse logistics.

7.2 Transportation of Supply

Using Third-Party Logistics (3PL) services is practically proven to be a beneficial decision when approaching the concept of a sustainable supply chain. No complex mathematical operations are required to acquire that aggregate transportation benefits regarding sustainability and efficiency; that is achieved by greater truck loading efficiency, resulting in fewer kilometres driven.

Talking about ZSL, transportation of products to the central hub is the most concerning activity in terms of sustainability. Farmers deliver their products separately by their personal means of transport. Moreover, as already mentioned in previous chapters, there are several meat products' suppliers, who also deliver the meat to the butcher by themselves. Currently, the butcher deals with all the animal transportation, which starts at the farm and ends at the central hub. The difference between the flow of meat products and vegetables is that the meat chain is more optimal and centralized. The farmers do not use their own transportation; hence they do not need to use additional equipment for animal transportation, they do not create separate routes and do not put unnecessary effort which does not add any quality value for the product. Hereby, in the meat chain, a primitive concept of 3PL is being approached.

The goal of the supply chain of ZSL is to implement 3PL to all separate supply chains in the most efficient way. The cooperation is seeking to multiple the demand five times in three years, thus the volumes of production will grow respectively. The reasoning for the current means of supply is quite clear – the demand is not enough to implement the advanced 3PL concept, though when the demand rises, integrating transportation together will become inescapable regarding efficiency.

7.3 Last-Mile Logistics

Last-mile logistics is a great issue, likewise, considering the interrelation with the transportation issue covered above. Demanded products must reach the central hub before 10 a.m. of every second Friday (every twelve weeks for the meat products) from each supplier. Thus, the timing is the same for each delivery, which is a rational and convenient requirement for implementation of 3PL.

The delivery service is already done by an outsourced carrier – Cornelissen Group. This transport company has an essential role in sustainable last-mile logistics of De Zwolse Stadslanderijen as it already uses environmentally friendly means of transportation and is expecting a second Lean & Green award. In general, outsourcing delivery services is more efficient financially and environmentally due to aggregation as already mentioned in the previous section of this chapter. Furthermore, ZSL could involve its current courier by offering more transparency and collaboration. They can help each other when planning the expected growth of demand and how to deal with it and with ZSL sharing their demand data along with the forecasts the courier would be able to manage their operations and aggregate planning more efficiently and sustainably.

The crates are currently being delivered by a Mercedes-Benz Sprinter (engine: 311CDI) powered by diesel. The vehicle is classified as a Euro 5 in the series of European Emission Standards. However, the most concerning specification is the fuel type. The White Paper on Transport 2011 issued by the European Commission outlines a goal of phasing out conventional internal combustion engine vehicles from the cities by 2050; on a legislative level, a great importance is dedicated to diesel engine vehicles as they emit a bigger amount of a toxic particulate matter (PM) which harms health and can even cause diseases, as well as other pollutants, like CO_2 (Carbon Dioxide) or NO_X (Nitrogen Oxides). (European Commission, 2011) Hence, the transportation method strongly relates to the mission of De Zwolse Stadslanderijen.

Approximately 38% of current subscribers (18/47 subscribers)[2] wish to get their products delivered home, which makes the route 56 kilometres long. Assuming the van's engine corresponds to Euro 5 Standard, it produces the following amounts of pollutants per route (based on the permitted level):

- 41.44 grams of CO_2 (0.740 g/km);
- 15.68 grams of NO_X (0.280 g/km);
- 0.28 grams of PM (0.005 g/km).

The map provided above shows a current distance-wise optimal route for home deliveries by a single van, including the distance travelled back to the start location of De Kas van Kaat, as the courier brings non-delivered crates back to the central hub. For the accuracy of further assumptions, the growth of the number of customers and boundaries of Zwolle City must be considered – the number

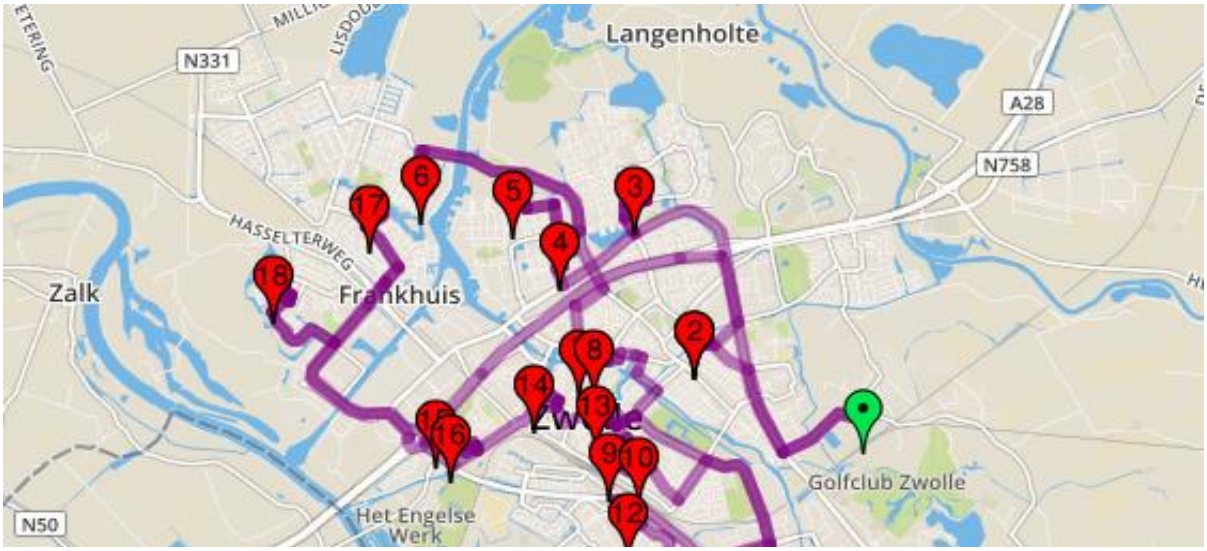

Figure 34 - Deliveries to end consumers

of kilometres driven per one route does not usually increase remarkably along with the additional number of households delivered, as the city boundaries do not allow any route-extending *extremum* locations to occur.

Lead by curiosity, the results of adding 18 more randomly selected household addresses[3] and recalculating the route showed that the duration and the mileage are both doubled with a slight

[2] Some of the previous references to a number 100 of customers regards the number of inhabitants that consume the food, as subscribers indicate how many people is the package serving.

deviance; the number of locations will furthermore have less impact on the kilometres driven per route, as densely located stops will often occur to be *en route*. Measuring the amount of emissions for a doubled number of stops would most probably double the number of pollutants emitted as well. Note, that the significance of the location distribution factor will grow bigger again if the deliveries will be made more often, which is one of the solutions for storage capacity issues ZSL will face when the business grows.

The company would find little benefit if the last-mile transportation was an insource service, as it would most likely provide several options and outcomes:

a) Delivering once per two weeks would eventually require much more loading capacity. Bigger vans would suit to only some extent; the time window is too short to cope with all the home deliveries done by a single vehicle. Besides, purchase and maintenance or rent of an additional vehicle would pay-off very slowly if the deliveries continue to be arranged as rarely.
b) Arranging the deliveries once or twice per week would deal with the storage capacity and the delivery time window issues, though it would still require vehicle-related expenditures, e.g. purchase/rent, insurance, maintenance and repair, as well as payment for the driver.

An idea of using other means of transport like bicycles or electric/hybrid vans looks extremely attractive too. As a matter of fact, ZSL used to deliver boxes with products by a bicycle, though the rise of demand resulted in this way of delivery being too complex.

Frozen meat must be transported with proper cooling systems, which is another issue of the bike delivery concept. This challenge can be overcome by implementing the idea of refrigerator trailer-bike delivery; reduced fuel consumption in the delivery process would almost eliminate the environmental impact consequently. Although the delivery process is still ought to be outsourced from a transport logistics company, as purchase and maintenance of the equipment, similarly to investing in an additional loading capacity discussed before, would downgrade ZSL's fixed-asset turnover ratio significantly.

7.4 Reverse Logistics

Krajewski defines reverse logistics as the *process of planning, implementing and controlling the efficient, cost-effective flow of products, materials and information from the point of consumption back to the point of origin for returns, repair, remanufacture of recycling*. Despite the latter being the major aspect of reverse logistics, ZSL would most likely find little benefit implementing recycling process for several reasons: volume of the waste is insufficient; biodegradable waste (generated by households) is not considered as a source of pollution. However, seeking a more sustainable approach, the cooperation could make use of a reusable material idea.

The concept of reverse logistics potentially developed in De Zwolse Stadslanderijen would be quite critical to most sustainability-sensitive processes analysed above. Firstly, frozen meat products are currently being packed to paperboard boxes, resulting in paperboard waste, which will increase significantly in the future. The goal to reduce it to minimal amounts can be achieved by replacing paperboard boxes with cool boxes. Of course, any kind of reusable containers must be taken proper care and maintenance of, although quality cool boxes are usually designed to be durable and of sustainable material and whole manufacturing process. The benefits of the idea are seen to be:

[3] Number 18 was chosen because that is the limit of stops allowed to include by the *Speedy Route* online mapping software, which was used to design these routes.

- Elimination of paperboard waste issue;
- Somewhat faster packaging process as sticky tape wrapping is not needed anymore;
- More professional approach to delivery benefiting in a better image of the company;
- Customers would get their meat unharmed by temperature differences, increasing product quality and the level of customer satisfaction as a side result;
- Reusable boxes can make a great tool for marketing and promotion, as it can be decorated with logos; customer-intimacy related initiatives like adding personal notes or recipes could also be useful instruments.

Customers would get their meat in cool boxes which they should pay a deposit fee for in the first place, as such fees provide incentives for the user to return the box to get the reimbursement of the fee. A convenient arrangement of it for both parties would be exchanging empty cool boxes to full ones during the deliveries.

This way also benefits of increase of customer loyalty as people tend to unconsciously feel more attached to a product or service provider when they have more contact time, or the provider is already familiar to them.

8 Conclusion

The first part of the conclusion is based on the results of research on the storage space needed in the future state. A distinction is made between cooled and frozen storage in this chapter. Regarding the frozen storage a second difference is existent. In the storage of meat, which is the only ingredient that has to be stored frozen. These two categories are big and small boxes, and require the following storage space: six pallets of small packets and three pallets of big packets. This equals a total required frozen storage space of 8,6 square metres. The cooled storage is a combination of different products that are stored in crates. The desired cooled storage equals 15 square metres.

In chapter 5.2 different process concepts are considered, this part of the conclusion takes the production designs into account. In addition to that, the best concept according to the researchers is also defined. This advice is constructed based on the decision variables that are part of chapter five too. When taking the different scoresheets into consideration, based on the defined variables Concept B – L shape is the best concept. Concept B is defined and visualized in chapter 5.3. The scoresheet referred to in this case is depicted in the same chapter.

According to the decision variables concept B is the most appropriate concept for De Zwolse Stadslanderijen operations when having to deal with 500 customers. This concept excels in three important areas and is therefore the best choice for De Zwolse Stadslanderijen. As discussed, the researchers also conclude that it is beneficial for De Zwolse Stadslanderijen to implement the logistics concepts as defined in Attachment B.

Based on the analysis of the five factors in chapter six: total delivered cost, customer service, demand variability & supply variability and operation cost, ZSL could clearly know the performance of the company operation. To increase the performance of the company operation and management, it should give priority on these aspects: Packages speed, costs reliability and packaging efficiency (how to make it more compact and save more space); Customer satisfaction (on time delivery, in full delivery, damage-free delivery and accurate documentation); Variability of supply (item available could be improved by using the historical data to make a basic forecast in order to avoid the supply cannot meet the demand situation appears); Inventory carrying cost (improvements can be made by decreasing non-working inventory space and improving inventory utilization rate.).

Sustainable development is the principle for sustaining finite resources necessary to provide for the needs of future generations. Supply chain sustainability is an important issue influencing ZSL in terms of environmental costs, risks, and waste. Social responsibility, financial responsibility and environmental responsibility are most important for ZSL to develop sustainability during the process.

The following logistics process for De Zwolse Stadslanderijen would be quite critical to develop sustainability-sensitive processes: Transportation between farm locations and the central hub; Last-mile logistics; Reverse logistics. By implementing the 3PL to all separate supply chains in the most efficient way, applying the bike in the last mile logistics and implementing recycling process could improve the sustainability in the whole supply chain to a large extent.

9 Future considerations

This research has mostly looked at the storage and production location. However, there are several different other possibilities or necessities for improvement in ZSL's supply chain. In this chapter, some of those ideas are explained to some extent. Yet, to fully explore these possibilities further research is necessary.

9.1 Supplier agreements

To ensure that suppliers are capable of meeting ZSL's demand in the future, deals have to be made about amounts and prices. Potentially, ZSL has to look into expander their supplier base or look for other ways of sourcing their products to ensure they meet customer demand and keep customer satisfaction levels high.

Furthermore, ZSL needs to look into the way transport is arranged from supplier to the central hub. Currently suppliers are responsible for transporting their goods to the central hub. Though, the students are unsure if this situation is retainable with growing demand. Agreements have to be made about, for example:

- who will be responsible for transportation?
- will it be in- or outsourced?
- etc.

9.2 Sourcing

A big limitation at this point is the way ZSL sources their meat products. This is done only every twelve week and lead-times are extremely long. This causes several issues. Most prominently, it ensures large stocks, since ZSL has to keep stock for twelve weeks. This, in turn, ensures that ZSL need a high stock capacity and investment needed in storage space will be higher as well.

If it was possible to order, for example, every six weeks, this would already mean halving the storage space needed. ZSL should look into this before investing in storage space because improvements in this area will result in drastically decreasing the investment needed.

9.3 Optimize usage of time and space

Nowadays, ZSL only serves their customers only once every two weeks. This means that, considering ZSL only uses the storage only a few day every two weeks, utilization of the storage space is extremely low. This also means that time utilization is very low, since there every other week ZSL has no business. According to the students, this could be solved in two ways:

1. ZSL could decide to split up their customer base, by delivering to half of the customers one week and the other half the other week. This would spread demand more evenly. In addition, this also has the advantage of needing half the storage space.
2. ZSL could also decide to deliver to all customers every week. In addition, if weekly delivery is feasible, ZSL could also decide to still split the customer base in half and deliver for example the first half on Tuesday and the second half on Friday. In this way ZSL would still be able to half the needed storage space.

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11 Attachments

11.1 Attachment A – Workstation overview

Workstation 1

Products	Total Time (Sec)	% of Total.	Cum. Time	Cum. %
Meat	8304	28%	8304	28%
Potatoes	2551,75	8%	30058,75	100%
Total	10855,75	36%		

Workstation 2

Products	Total Time (Sec)	% of Total.	Cum. Time	Cum. %
Cheese	6228	21%	14532	48%
Shoarma	3460	12%	17992	60%
Total	9688	32%		

Workstation 3

Products	Total Time (Sec)	% of Total.	Cum. Time	Cum. %
Dairy Product	3373,5	11%	21365,5	71%
Eggs	3200,5	11%	24566	82%
Vegetables	2941	10%	27507	92%
Total	9515	32%		

Figure 35 - Workstations overview

11.2 Attachment B – Internal logistics

Figure 36 - Filled and empty trolleys

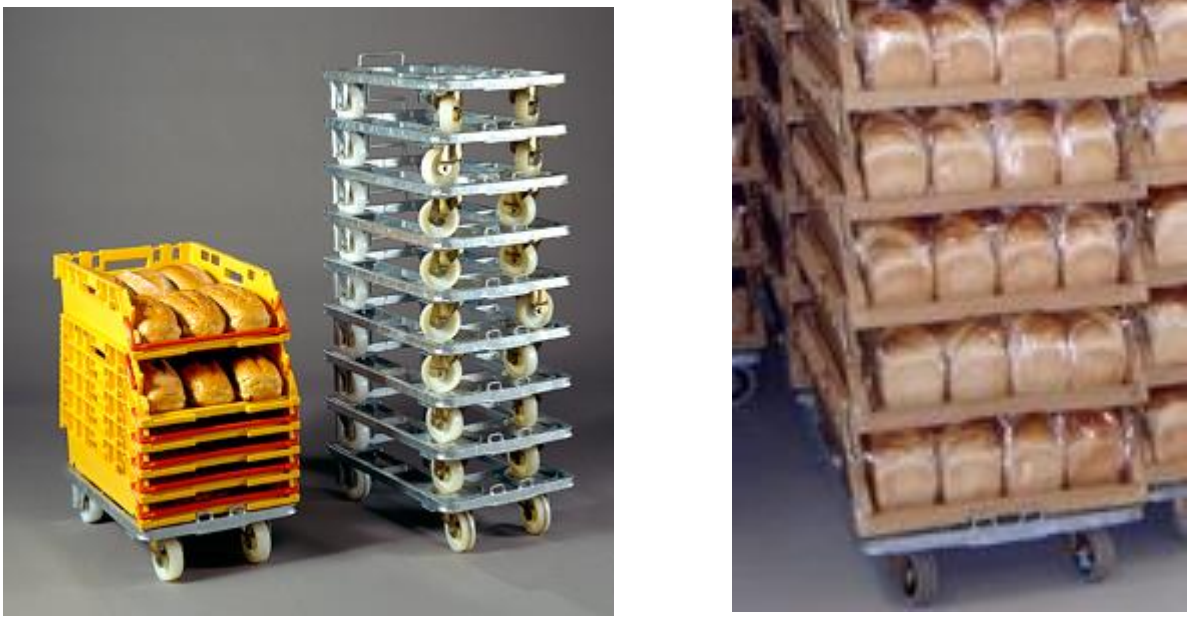

Figure 37 - Bakery equipment (Used to transport and pick cheese)

11.3 Attachment C – Conveyors

Figure 38 - Flexible conveyor (Used in concept A - U Shape)

Figure 39 - Conveyor corner (Used in Concept B - L shape)

Figure 39 - Straight conveyor (Used in concept C - Straight)

Figure 40 - Conveyor gate (Complementary to concept C)