Process optimisation of internal transport at FruitMasters

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Reading guide

This research is composed out of 7 parts. The first part is the introduction of the research. The second part is giving the current situation on the internal transport of FruitMasters. The third part focuses on the idle times of internal transport and the fourth on the literature of visualisation. The fifth part talks about the solutions that came out of this research. The sixth part will show how the recommended changes will change the visualisation. The last part is evaluating this research.

Chapter 1
Chapter one introduces the company FruitMasters and the problem identification of the problem FruitMasters delivered to solve. The problem cluster that shows what the core problem is also added here and shows what problem should be solved to solve the problem the company had assigned. This chapter contains an even more detailed structure of the report. Last, the scope of this research, the data gathering methods, the validity, reliability, and the deliverables of this research will be delivered here.

Chapter 2
In Chapter two the current situation of FruitMasters will be explained and substantiated. This is done by the visualisation of the actions of internal transport with the matching decisions and relations, the KPIs of internal transport, the idle times of the employees of internal transport and the employees view on the current situation.

Chapter 3
Chapter three is focused on the bottlenecks that create the idle time of the employees of internal transport and the limitations of the processes of internal transport the carts interface with.

Chapter 4
Chapter four is the substantiated literature on the visualisation of FruitMasters, limitation of visualisation and the processes on visualising the processes of internal transport.

Chapter 5
Chapter five is the solution approach containing the recommended changes and the opinions of the employees on these recommended changes.

Chapter 6
Chapter six will contain the improved visualisations of the processes of internal transport containing all recommended changes. The reasoning of the recommendation is underpinned here by the literature of Chapter 4.

Chapter 7
Chapter seven will reflect on this research with a survey done by the employees that need to implement the recommended changes. The recommendations that are created by this research will also be discussed here.

Chapter 8
Chapter eight will conclude the evaluation on this research, discuss the limitations and suggests further recommended research.

Preface

Currently, you have my bachelor thesis “Process optimisation of internal transport at FruitMasters” in front of you. In this research we have investigated the internal transport processes of FruitMasters, located in Geldermalsen. The content of the thesis is about the visualisation of the processes of internal transport.

I was very lucky to have this opportunity to get an insight into such a huge company and do research on what will impact the efficiency of the processes of internal transport. Due to the corona virus there was only one alteration to the proposed project plan. This research required observations of the internal transport processes, but the measures made it difficult to drive with the car of internal transport, which resulted in doing the observations on my bike. It was a bit hard, but during these observations I learned a lot of which I am very grateful for.

The motivation for this research came from the interest in logistics. During the research I was also motivated by all the employees I talked to that had problems where I could help them with, with this research. The employees gave appreciation for my observations and tough questions which made me even more motivated.

Finally, I would like to thank my supervisor of the university of Twente, Eduardo Lalla, on all the support I have received. I also would like to thank my supervisors of FruitMasters, Marco de Haas, Michel Schopman and Anthony Wakker, for guiding me during the project and creating a great work environment. Last, I would like to thank the current employee of internal transport, Richard van Uden, to help me this much with my research and always being able to answer my questions on the internal transport.

I hope you will enjoy reading this research.

Linda Schepens, 2020

Management Summary

Introduction Research

The research started with a wish to decrease the idle time of the internal transport employees. FruitMasters wanted this problem solved, but to solve that problem, the processes around the moving carts should be visualised. Visualising the processes will give knowledge on how the processes surrounding the carts look like. This knowledge will show how the idle time is created and what should be done to decrease the idle time. The research of this thesis consists of visualising and analysing the current situation, the bottlenecks are detected and tackled, and the required changes are added to the visualisations. The overall research question in the thesis is:

How should a visualisation of the processes of internal transport look like at FruitMasters?

To visualise all ideal processes, after visualising the current processes, the first step is to measure the performance. The indicators that are determined in this research to measure the performance are the tasks assignments per day, on-time delivery per day, availability per day, order tracking ability per day and idle time per day. These are the Key Performance Indicators (KPIs). To decrease the current idle time is the goal of this research and tracking the idle time is important to do so. Tackling the origin of the idle time, will decrease the amount of idle time.

Current situation

The actions of internal transport consist of transporting the carts and the terminal trailer, cart maintenance, fruit weighing, battery replacement and communication with other departments. The flow of the processes of internal transport can be improved after determining the current situation. The KPIs that were previously determined are analysed during this research. The tasks assignments per day is determined by the ratio between completed assignments and total assignments. This was not optimal for each observed day because there were carts transported by the other departments and only tasks completed by internal transport were used to measure the internal transport performance. The on-time delivery per day is determined by the ratio between completed delivery expectation and total assignments. Some internal transport was done by other departments, but all the products were delivered on time. The availability per day is determined by the ratio between total requested carts and total requested carts. The employees that were on internal transport might have had other tasks which created a delay on the orders but when tasks were prioritized there was no delay. The order tracking ability per day is determined by the ratio between total tracked orders and total orders. This indicator shows that on average 49,2% of the orders was tracked. The idle time per day is determined by the ratio between total idle time and total working hours. The idle time fluctuated during the observations of each day, but on average of all observed days during the day shifts 39,0% of the time was idle time and during the night shifts this was 64,4%. When FruitMasters is tracking all this data on a regular basis, the processes are easier to optimise further.

These Key Performance Indicators show that the current situation is not optimal. There are multiple bottlenecks that slow down the process flows and create the idle time. These bottlenecks were not having an employee on the second shift and on the Saturday shift of internal transport, changing batteries when they need a new one, no insight on where the carts are, no insight on the tasks of internal transport, loaded carts cannot be unloaded yet, the products from the cold store need to be deliver before 5 o'clock, no communication after finishing the tasks, getting unnecessary retour, communication differs per employee, loaded cart cannot be unloaded yet, the internal transport delivers cask during auction hours, it is unknown who takes over tasks, there are no deadlines for orders and the occupation times are too long.

Solution approach

When looking at the bottlenecks that were collected in this research, the origin of each bottleneck is important in the solution approach as they strongly influence the flow of the processes. The origins of each bottleneck that need to be tackled are the lack of employees, leaving empty batteries in the car and the forklifts and not all batteries get charged, all internal orders are done through communication and the communication is not optimal, only half of all data is collected, long occupation times because of bad communication, understaffing and unpredicted amount of tasks, missing communication after tasks, no insight on what kind of cask the soft fruits are entering in, it is uncertain if everything is communicated what also develops with the one-sided communication that sometimes occurs, the unloading/loading is not done directly, the parking spot of soft fruits and pears packing station is location wrongly, people do not feel the responsibility to know that the task they did is known at the employee that needs to take over, not all orders have a deadline and because of that planning the orders gets difficult and last the difficulties of adapting habits. Tackling the origin of each bottleneck is the solution approach and creates the recommended changes to solve the bottlenecks. The improved visualisations include the recommended changes that need to be implemented in the processes of internal transport.

Recommended changes

Sometimes the recommended changes could solve multiple bottlenecks. The changes can be done on the short or the long term. The short-term changes that are recommended are discussed first. FruitMasters should hire an employee for the second shift and the Saturday shift of internal transport, hire an employee as an extra forklift driver for the apple preselection, if after the adaption of the other changes the occupation time is still too much because of understaffing, create insight on the cask the fruit arrives in let the apple preselection adapt the habit of not putting the pallets at a spot they are not supposed to be at and create deadlines for the orders. The employees of internal transport should change the batteries when finishing the shift, change the parking location of the soft fruits/pears packing stations

The impact these short terms recommended changes will be that no employees need to do extra work, there are filled batteries when needed, no unnecessary cask is sent retour, no problems/irritations at the auction hall, easier management on the orders through the tracking of the deadlines and shorter occupation time of the carts.

The long-term changes that are recommended are adding the statuses of the carts into the new ERP system and when changes are made, notifications on that need to be sent to the receiving department, orders from the departments should also be added to the new ERP system, the deadlines should be added to the orders in the ERP system and the data that is put into the ERP system to analyse the performance of the processes of internal transport should be collected.

The impact these long terms recommended changes will be that there is more insight in the situation and notifications on the statuses of the carts, easier management on the actions of the employee of the internal transport, easier management on the actions of the forklift drivers of each involved department, improvements on the performances of the processes of internal transport and also shorter occupation time of the carts.

Evaluation

The evaluation indicates that the respondents of FruitMasters were positive and the majority pointed that the recommendations would have a positive effect on the current situation. The positive effects of the recommended changes are predicted. Most of the problems were already known by the employees in the workplace but this somehow does not mean changes are made to solve the problems. When employees observe problems, these problems should also be tackled in the future, to tackle the problems faster and preventing it on becoming a habit.

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Definitions of terms

This definition of terms is created for a more structured and clearer overview of important terms that were used in this research.

- Car: The electric car where internal transport drives in/with and transports the carts across the company area.

- Cart: The cart that is transported from department to department as transportation equipment of the different products.

- Cask: The umbrella name for all the packaging the fruit is packed into, the pallets and the pallet crates are called cask at FruitMasters.

- Flowchart: A type of diagram that visualises and represents a process or workflow.

- Idle time: Inactive time, time during the day where no required tasks could be completed. Verification rounds that are currently done where the employee of internal transport checks up on the situation should not be required, because the flow of the processes should take off updating the situation. Breaks were not included in the idle time, but also not in the working hours.

- Occupation time: The occupation times of the carts at a department is the time the carts stay untouched at the department, the time of unloading and loading and the time the carts stays at the department until it is picked up. When the carts are directly unloaded or loaded and picked up, the occupation time is equal to the unloading/loading time. This means that the definition of the occupation time might differ each time but what is always the situation is that during the entire occupation time, internal transport is not able to use the cart at another department.

- Terminal trailer: The trailer that is also part of internal transport and used to transport different products from departments dock to departments dock.

- Scan order: The internal order that is done from one department to another department.

- Shift leader: The team managers, these team managers are called shift leaders sometimes because they are both managers or the day shift employees or the night shift employees.

1. Introduction

1.1 Company introduction

FruitMasters originally started as the fruit auction in the area called Betuwe. Currently FruitMasters has grown to a company that works for 400 fruit growers for whom they sell their fruit directly to customers, like Jumbo and Lidl, at the best price possible for both parties. It used to be an auction house but now they only have a small auction spot where they sell the fruit to smaller companies. They store their fruits in different cooling buildings and pack the fruit when sold to a customer. The packaging is also done in different buildings. Now the fruit and packing material is transported by the employees of internal transport between the different departments with carts like in Figure 1.

Figure 1 The two carts that transport the fruit from and to the different buildings. One of the two carts is filled with the fruit now and shows the fruit crates get unloaded by forklifts.

Besides these carts there are forklift drivers that unload the fruit crates. Every department owns the needed number of forklift drivers to complete the activities. The last specific equipment that is used in the internal transport is a weighbridge. When for example a cold storage with unsorted pears opens for the pear packing centre, it needs to be weighted before it gets unloaded at the pear packing centre. The net weight is used for the administration. When it is summer, they closed the carts to protect the fruit from the heat during the ride from one building to the other building. When looking at the processes of this internal transport, there are a lot of employees involved. The employees that are involved in this research and are also my supervisors are the manager of logistics, the old manager of the expedition and the supply chain management planner. The remaining employees that are involved in this research are the planning inbound, the employee of internal transport, the manager of the cask centrum (the cask centrum is the storage and the transhipment of the empty crates, boxes, labels etc.), the manager of the soft fruits packaging station, the manager of the pears packaging station, the manager of the apple packaging station, the operator of the industry department (the industry processes fruit that will be processed), the manager of the cold store and the new manager of expedition. The communication between the employees goes through calling each other and sending emails if the questions do not need to be answered quickly.

Since FruitMasters is a fast-growing company and they start to get some troubles with the moving carts that transport the fruit across the company area, because a lot of processes have not been visualized. The car that is transporting the different fruit between the buildings, is most of the time just waiting at one of these buildings. The moving carts are needed at different spots at different

times, it happens too much that employees need to wait for them and that they are travelling empty across the business area. The processes around these carts are not visualized and in Dutch they say the carts “gaan van hot naar her”, which means that they are going everywhere, depending on where they are needed/requested.

Currently, with the coronavirus all the employees are designated to different buildings, to create a safe environment. Walk around the business area outside and asking questions to employees keeping a safe distance of 1.5 meters is still possible. Asking questions to employees that are not outside of the business area is possible by skyping or mailing them. There is the opportunity to work inside one of the buildings to minute the data that has been collected outside. The observations need to be done by bike because the car of internal transport is not large enough to keep the correct distance from the employee of internal transport.

1.2 Problem identification

Currently the employees of the internal transport department of FruitMasters spend an important fraction of their working hours doing nothing. FruitMasters has asked me to look at this problem and give suggestions to decrease their idle time. To solve the action problem, the problem should be made quantifiable. This means that the action problem should be expressed in the norm and the reality. They have set a norm that the idle time of the internal transport employees should decrease with 15%. The idle times are still unknown because there has been no measuring and no monitoring. The gap between the norm and reality is the following action problem: **The idle time of the internal transport employees should decrease with 15%.** This action problem has a measurable variable being the idle times of the internal transport employees. FruitMasters wished for a visualisation of the processes of internal transport the carts interface with to solve the action problem which does not make the visualisation of the processes, the action problem.

1.3 Problem cluster

The problem cluster is created by the action problem: **The idle time of the internal transport employees should decrease with 15%.** The action problem is explained in the paragraph above and when you look at the problem cluster, see Figure 2, you see that this problem derives from other smaller problems like the problem that the moving carts are waiting at different buildings. This problem is created when an employee at one of the buildings sees they will need one of the carts and already requests it. When the cart cannot be used directly it is just waiting at that building even though another building could have been using it at that moment. This refers to the second problem that creates the action problem, where employees of internal transport need to wait for the moving car. If the carts are being used at a different building or just waiting at a different building, there are employees that cannot pursue their work. These two problems are created by the knowledge problem that there is no knowledge on how the processes surrounding the carts look like. This problem is created by three core problems. The first core problem is that there is no planning made of the processes the carts interface with. This core problem is correlated with the second core problem, that there are no agreements made on requesting the carts. The reason why these problems are correlated is because to make a planning for the processes, agreements on requesting the carts should be made. When agreements on requesting the carts are made, a planning will emerge from it. The last core problem is also corelated to the other core problems.

The last core problem is the core problem this thesis will be tackling, that the processes around the moving carts have not been visualised.

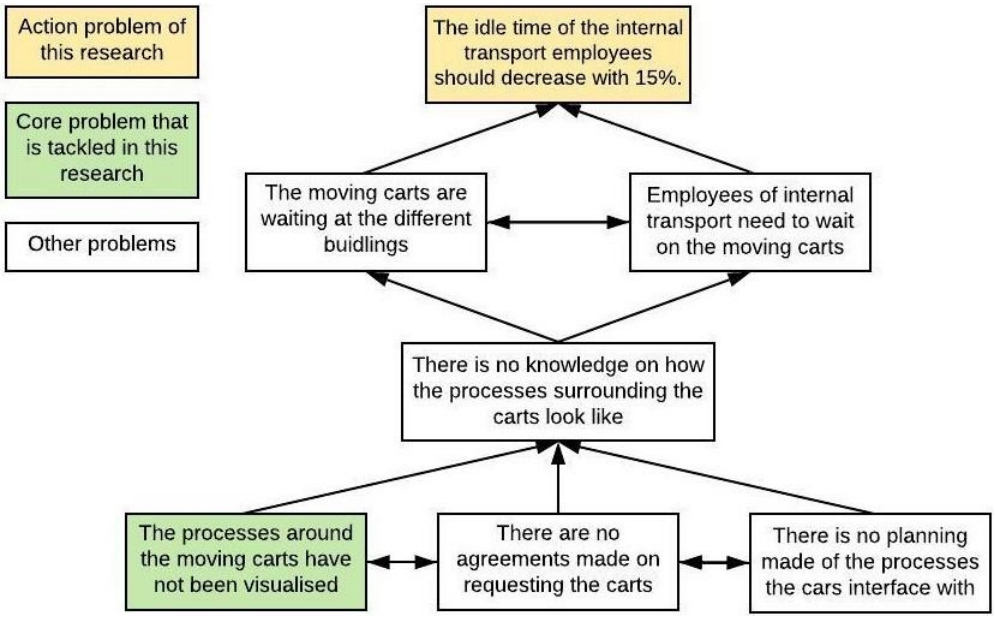


Figure 2 The problem cluster visualising the core problems that create the different problems.

1.4 Core problem

As can be seen from the problem cluster (Figure 2), there are 3 different core problems that create the action problem. The reason why these are core problems is because they have no cause in themself (Heerkens & van Winden, 2017). Choosing the core problem: **The processes around the moving carts have not been visualised**, from the three core problems is because a visualisation of the processes will help me with understanding the situation more and once the bottlenecks have been found, improvements can be made. These improvements can create less idle time to solve the action problem. Solving this core problem has the greatest impact effect at the lowest cost (Heerkens & van Winden, 2017). The reason the core problem that there are no agreements made on requesting the carts and the core problem that there is no planning made of the processes of internal transport the carts interface with, are not chosen is because to tackle one of these core problems, the process flow should be clear and that is not the case for an outsider like me at the moment. Important for the core problem is that it should be a problem I can influence now (Heerkens & van Winden, 2017). This makes creating a visualization for these processes is the most feasible problem for this bachelor thesis. Finally choosing this core problem was a good decision because FruitMasters wished for the visualization of these processes as a deliverable to have a clear vision on what is going on now. They want the visualisation because it gives insight in the current factors (input, execution, and output of the process) and visualises the bottlenecks which makes it possible to create measurable and clear solutions.

1.5 Structure of the report

The structure of the report is divided into chapters which are focused on the current performance of the internal transport, visualizing the processes around the moving carts and the improvements

that are recommended to improve the flow of the processes around the moving carts. The following research questions are included to clarify the structure of the report and to answer the main research question. The main research question is: "**How should a visualisation of the processes of internal transport look like at FruitMasters?**". Besides this main research question, there are some sub research questions that need to be answered to gather all the knowledge and data to answer the main research question. These sub research questions can be divided into questions that are specific to this situation at FruitMasters and questions that are specific on the literature of internal transport processes.

In Chapter two the current situation of FruitMasters will be explained and substantiated. This will answer the research question: **"How is the current situation of FruitMasters?"**. The reason why this question is important is because to be able to look at the visualisation of the processes of internal transport, there needs to be knowledge on the current situation of FruitMasters. There are different aspects here that need to be considered here, and with the following sub questions, it is made sure that all the needed data is collected. This chapter starts with visualising the current processes surrounding the moving carts and solve the core problem of this research.

- What actions are done, what decisions and constraints are related to them and how the actions are related to each other, in the processes of internal transport the carts interface with?
- What are SMART KPIs of the internal transport processes of FruitMasters?
- What is the current idle time of the employees of the processes of internal transport the carts interface with?
- What do the employees of internal transport processes the carts interface with, think of the current situation?

Chapter three is focused on the idle time of the employees of internal transport. This chapter will answer the research question: **"Where could the idle time of the employees in the current situation be limited?"**. The norm and reality of the action problem are measured in the idle time of the employees that are researched. The reality of the action problem is unknown because the current idle time is unknown, which means to make sure the norm is reached, the reality first needs to be measured. The bottlenecks and the limitations are needed to make sure improvements can be made to improve the reality and to reach the norm of the action problem.

- What are the bottlenecks in the processes of internal transport the carts interface with?
- What are limitations of the processes of internal transport the carts interface with?

Chapter four is focused on the literature that can be used for this research. The research question that will be addressed during this chapter is: **"What literature is available on visualisation of processes in a supply chain that is needed for this research?"**. When the data of the current situation of FruitMasters and the idle times of the processes and their bottlenecks and limitations are collected, it might be useful to look at theories on visualisation of processes in a supply chain. How this visualisation is done and what the limitations of visualisation need to be considered, how the processes of internal transport are visualised and comparing different theories is important.

This literature is also important to underpin the reasoning of the recommended changes that are created to improve the current situation.

- What are limitations in the visualisation of processes?
- How are the processes of internal transport visualised?
- What improves the readability of the visualisation of the processes surrounding the carts?

Chapter five is focused on the development of the improvement plan. This chapter will answer the research question: **"What solutions can be implemented in the internal transport of FruitMasters?"**. When the current situation is documented and the bottlenecks are detected, solutions to improve the reality can be determined. The limitations of the processes and the vision of the employees of FruitMasters need to be considered when creating a solution. The recommended changes that are created in this chapter are required to improve the current situation and to tackle the action problem to decrease the idle time of the internal transport.

- What changes need to be made to improve the current situation of FruitMasters?
- What do the employees of internal transport processes the carts interface with, think of the solutions?

Chapter six will be used to answer the main research question of this research, to explain and substantiate the recommendations towards FruitMasters. This means that this chapter will answer the research question: **"How should a visualisation of the processes of internal transport look like at FruitMasters?"**. This is the only research question and all the research questions of the other chapters will help to answer this research question.

Chapter seven will reflect on the predictions of the research after implementing the solutions. The research question that will be answered in this chapter is: **"What improvements will be made after implementing the solution?"**. The predictions of this research and the opinions of the employees both underpin the reasoning and answer this research question

- What are the predicted insights and recommendations after applying the solution approach?

Chapter eight will finish this research through giving an answer on the research question: "**What will decrease the idle time of the internal transport employees with 15%?**" and give the conclusions that are made of each research question, conclusions made based on the predictions after applying the solution approach and the further recommended research. The insights on this new situation should create recommendations for the future.

- "What are the conclusions on the main research questions answered in this research?"
- "What are the conclusions on the situation after applying the solution approach?"
- "What further research is recommended by this research?"

1.6 Data collection

There will be different data gathering methods chosen for this research. The data gathering of this research will be done according to three methods: communication approach, literature study and observation. Both the communication approach interview and survey were used during this research. To collect the opinions of the employees on the current situation, the employees that are involved were interviewed. To collect the opinions of the employees on the research and the recommended changes, the employees that are involve were given a survey. The advantages of these communication approach are that is very broad/deep, very suitable to collect opinions, the data from the past and the future can be collected here, and it is very efficient. The disadvantages are that there are potential interviewer and respondent errors and this need to be considered during the use of the data that is collected here.

The literature to underpin the choices made during this research was collected though the data collection method literature study was used. The advantages of this data gathering method is that a literature study is very comprehensive, efficient, it has a body of knowledge and multiple perspectives are possible. A literature study also has disadvantages because this data gathering method is not tailored, it has a distance from the subjects, it might not be valid, different sources are not always comparable and it might be hard to choose the most relevant method. These disadvantages make sure that the reasoning of the choice of the literature is very important here to show the view op the researcher. The entire research will be created based on the view of the researcher and based on its reasoning the data collected here is useful.

To collect the data on the processes surrounding the moving carts and the bottlenecks of the processes, the data collection method observation was used. The reason why this data was collected through observations was because there was not enough data collected before this research on the processes of internal transport and to create an objective vision of the current situation. The observations were done behavioural were there was looked at the behaviour of the employees. The observations were also done openly through biking across the company area together with internal transport. The observations were done directly because of my presence during the observations. The advantages of this data gathering method for this data was that it creates rich data which can be exploratory, and the data will be objective. The main disadvantage was that this data is only collected during the research period. The research was done during a quiet period but during the busy periods of time, the situation looks completely different and the conclusion based on this data might not be completely relevant here. This disadvantage is considered but when a period is hectic more problems might occur than in a quiet period. The reason why this is probably not problematic is because all observations were checked by the employees on the reliability. The bottlenecks that occurred during this research also have a high probability to also appear during the busy periods (Heerkens, 2020).

1.7 Scope

There are some limitations that need to be considered and create the scope of this research. The limitations of this research are the following:

- One of the limitations is that this research is limited to ten weeks, this means that not all the findings and solutions can be implemented in this period. Therefore, only a report with conclusions and recommendations to the team-manager and a solution approach with all activities that are needed written down will be delivered. In these ten weeks, the focus will be on visualizing the processes, and not implementing the implementation plan to improve the processes.
- To create a scope that is possible to do research in in 10 weeks, the research is done on the processes of internal transport and the part of the processes of the other departments that interact with the carts of internal transport.
- Another limitation of this research might be the fact that we are in an uncertain time when dealing with the coronavirus. This created a situation where the research was done in a situation that was different than its usual situation during this time of the year. Interviewing will already be done through skype, calling and meeting at a proper distance. Collecting data on the processes is done through observing the current situation on a bike. Processing all the data is possible at a good as empty office where there is enough space between each desk and contamination of both parties is not possible.

1.8 Validity and reliability

Reliability is about the consistency of a measure, and validity is about the accuracy of a measure. Reliability tells you the extent to which the results can be reproduced when the research is repeated under the same conditions (Middleton, 2020). Reliability is about the stability of the research results. This means it should hold that similar research that is conducted later with the use of the same methods should yield the same results (Heerkens & van Winden, 2017). The situation might change in the future, which means the data will be different. If the procedure is clear and well documented, the reliability can be guaranteed.

Validity tells you the extent to which the results really measure what they are supposed to measure (Middleton, 2020). To prove the validity of the research, I will ask for feedback from the supervisor or employees from FruitMasters for feedback, to double check the data. Validity is divided into internal and external validity. Internal validity is about whether the researcher has formulated and constructed the research design and measuring instruments correctly. A lot of risks to internal validity are due to human mistakes. A threat to internal validity is self-selection (Heerkens & van Winden, 2017). My research design is checked by my supervisor of the University of Twente and I will let the supervisor of FruitMasters also check it. When I start measuring the data, I will ask for confirmation if I am doing everything right. External validity is concerned about the question to what extent the research can be applied to other groups than the used research population. The main threat to external validity is an unjustifiable generalization (Heerkens & van Winden, 2017). The research I do creates a visualisation of the processes the carts interface with. If the implementation plan has a good result it can be useful for the other processes because the same research can be done at the other processes to create the same positive effect. But because this research is for a very specific part of internal transport, it cannot be applied exactly to another group of employees.

1.9 Deliverables

This research design will deliver the deliverables to hopefully let the internal transport employees work more efficiently at FruitMasters. Some of these deliverables were demanded by FruitMasters and others by the University of Twente. The following list of deliverables makes it possible for me to distribute the tasks and cross them off my list once they are done.

- Visualisation of all processes surrounding the carts of the current situation
- Visualisation of all processes surrounding the carts of the ideal situation
- A report with conclusions and recommendations to the team-manager of internal transport
- A solution approach with all activities that are needed written down step by step
- An evaluation for all steps of my approach and solution

2 Current situation

In Chapter two the current situation of FruitMasters will be explained and substantiated. This will answer the research question: **“How is the current situation of FruitMasters?”**. The reason why this question is important is because to be able to look at the visualisation of the processes of internal transport, there needs to be knowledge on the current situation of FruitMasters. There are different aspects here that need to be considered here, and with the following sub questions, it is made sure that all the needed data is collected. The Sections 2.1, 2.2, 2.3 and 2.4 will answer the research question of this chapter.

2.1 Actions surrounding the processes of internal transport

In this section all the actions surrounding the processes of internal transport will be discussed. The research question that is answered is: **“What actions are done, what decisions and constraints are related to them and how the actions are related to each other, in the processes of internal transport the carts interface with?”**. Everything that is discussed here shows the situation that is observed during this research. The processes that did not occur during the period of this research but are part of internal transport, were informed by the employees that are part of these processes. This section will tackle the core problem of this research: **the processes around the moving carts have not been visualised.** The rest of this report will make sure that the action problem and the research question of this research is also tackled.

2.1.1 Actions of internal transport

First, this research will start with looking at the process routes from each department, the inflow and outflow of products, that are transported by internal transport. There are nine departments at FruitMasters. These departments are: The cask centre, the apple sorting & packing station, the preselection apples, the auction, the expedition, the pear packing station, the soft fruit packing station, industry, and cold store. The transport of fruit from and to the auction department and the transport of fruit from a refrigerator at the cold store department to a different refrigerator, are not done through the internal transport. Figure 3 shows the map of FruitMasters, where internal transportation happens between the departments. The literature of Section 4.1 should be considered during the entire research. All theory of the systematic literature of Section 4.2 show that using flowcharts is the best way to visualise the processes in this research. The literature of Section 4.3 is used to create the flowcharts. Chapter 6 gives an elaborate description on this choice, but the following will summarize it. Visualising a process starts with determining what the strategy is. Second you need to collect all the activities that are done, all transitions and decisions that are made, and the conditions that need to be fulfilled before the decisions, but there is more to this. There are requirements that are needed to execute the visualisation of a distributed process (Momotko & Nowicki, 2003). Flowcharts are a process model, what is an abstracted and simplified way to represent a real process. An advantage of this notation is to be simple to represent and straightforward to interpret. No theoretical knowledge is required to read a model (Prodel, Augusto, Jouaneton, Lamarsalle, & Xie, 2018). The unbeatable advantage to visually depict the flow of a business process in a way that no technical expertise is required is very appealing to the business analysts (Vergidis, Tiwari, & Majeed, 2008).

After the choice made to create flowcharts to visualise the processes in flowcharts by the theory of Section 4.2, the choice was made to create them in Microsoft 365 Visio. The reason to use this program is because visualisations that are made in Microsoft 365 Visio will be easy to implement in their new ERP system Dynamic 365.

When looking at the actions that are done at the internal transport, FruitMasters itself does not collect a lot of data on it. FruitMasters does collect data of the transitions of the carts when products are transported to a different department, see Appendix A. One of the reasons they collect this data is because, currently they have this system where they ask for products, they pay for the internal transport that is needed to get the products. No other data is currently collected because the company has grown fast in the last years and internal transport just changed with it. They have not really taken such a specific look at internal transport before and have not looked at the performances and ways to track them (how this could be done is explained at Section 2.2). Transporting the carts and the terminal trailer are the main tasks of internal transport and cart maintenance, fruit weighing, battery replacement and communication with the other departments are all remaining tasks that are done by internal transport. Some of the processes appear in other processes and to refer to a process, to each process a number is added to refer to the process.

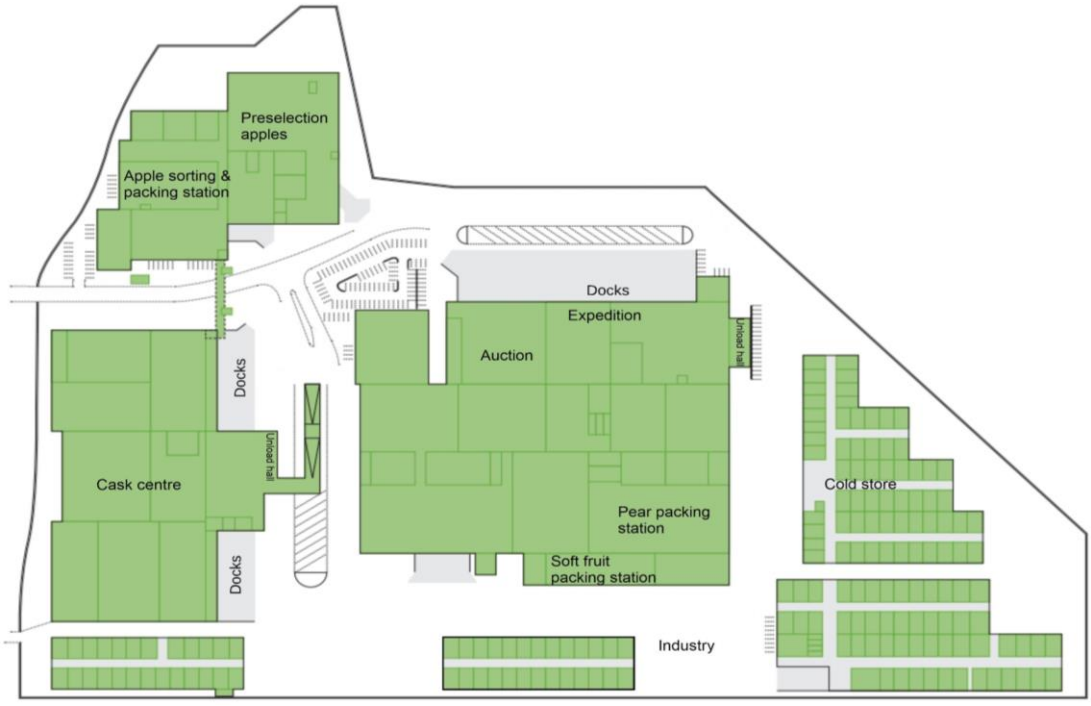


Figure 3 The current map of FruitMasters that shows the location of each department.

2.1.1.1 Transporting the carts and the terminal trailer

The data of the transportation of products of week 25 of 2019 till week 24 of 2020 is used to get an insight on what routes are more common than other routes, see Appendix A. Appendix B, shows the maps of FruitMasters where all incoming internal transportation of products at each department is shown. There is also incoming internal transportation of empty carts when a department needs to be loading a cart, but these carts can be brought from each parking place and each department and were not tracked. This internal transportation is not visualised because

it is very variable and unpredictable. Appendix C shows the maps of FruitMasters where the outgoing internal transportation of products at each department is shown. The outgoing internal transportation of empty carts is also not visualised for the same reason the incoming empty carts are not visualised, the empty carts can go to each department that requested a cart or be placed at the company area to create space at the department it came from. The routes at Appendix B and C are determined by the data of Appendix A. The entire transportation process of requesting and delivering the empty carts of internal transport is visualised in Figure 4 & 5. The process of picking up the filled carts is visualised in Figure 6. The transportation process of requesting and delivering the terminal trailer of internal transport is visualised in Figure 7. Transporting the carts and the trailer is the primary job of internal transport and when problems occur here, it is not ideal. Currently there are multiple problematic situations that occur during these processes but should not. These situations are marked red in Figure 4, 5 and 6. The legend of the shapes of the flowchart are in Appendix D. The other problematic situations that occur surrounding the processes are also discussed. Some problematic situations that are not specific to one of the processes will be discussed in Section 3.1.

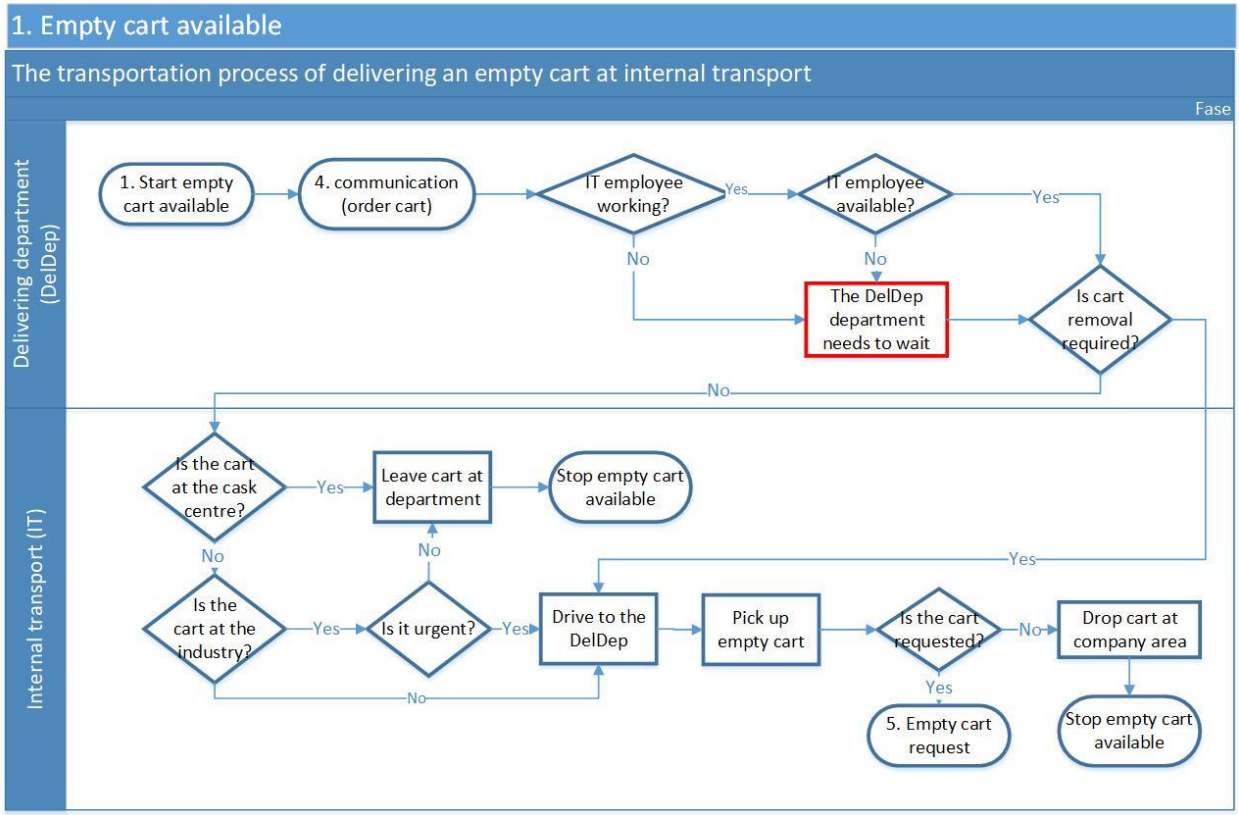


Figure 4 The transport process of delivering an empty cart at internal transport.

The first problematic situation is when internal orders at internal transport are done at the same time and there is not immediately time to process them. The situation is problematic because when some orders were done earlier, each internal order could be done before needed. Another problematic situation is the uncertainty of not knowing if there are carts at the receiving department that need to be removed first. Not being aware of the situation is not ideal but also happens at the process of requesting and delivering a filled cart, see Figure 4. It is noted as a problem in the processes because the real problem is that internal transport is not up to date on

the situation and needs to check if the cart is done unloading/loading. Not each department communicates when they are finished with a cart. The third situation, and most problematic situation, is that it could occur that there are no empty carts left. This means that internal transport needs to wait on a cart before being able to drop it off at the receiving department. This problematic situation could originate from lack of carts, lack of employees that need to unload/load the carts or the lack of communication that creates the situation where the unloading/loading might take to long because of unawareness. This means that the carts are occupied to long at a department. In the process of picking up carts, the most problematic situation is when there is the choice to not communicate at all towards internal transport. More details on these problematic situations will be reviewed and tackled later in Section 3.1, as they hold back productivity of the processes.

The transportation of requesting and delivering an empty cart that is visible at Figure 5, has a lot of decisions that could create problematic situations. Communication has an important role to play in this situation. The communication where the carts are requested is not problematic because the requesting department understands the importance of this communication. The communication where the departments keep the internal transport updated on the situation is communication of which the importance is not as visible. Driving across the company area will keep internal transport just as much updated on the situation as the communication of the departments, but the communication makes a lot of difference in time. The unawareness of the situation also creates all the decisions that need to be taken in the current process. When the situation is clear a lot of decisions do not even need to be made what also simplifies the entire transportation process.

The transportation of a filled cart is visible at Figure 6, differs a lot from the processes of requesting and delivering an empty cart. What creates these changes is that in this process more communication is required and done, and the situation is way clearer. During this transportation process internal transport internal transport is also able to depend more on the communication and looking at how that simplifies the situation also shows the importance of it.

Most of the time this decision is made based on habits, the fact that they have always made the decision to act a certain way also creates the situation where they are very comfortable with this. A lot of employees have had the same job for years which is positive and negative for different reasons. The most important reason why it is positive to have an employee who did the same job for over years is their experience. They know how to respond to different situations and where to think about. The fact that they can make their own decisions is very useful and saves time. The most important reason why it is negative to have an employee who did the same job for over years is their habits. Their mindset is often: how they handle situations has been good for the last years, so why change. The fact that a lot of changes have been made at other parts of the company means that changes also might need to be made on how to handle situations. How employees are as a person might also influence this because stubborn employees are difficult to change their habits and the approach on how to implement changes is very important. If the employees are also annoyed by the problems that have been occurring for years will make it easier for them to be open to the change when they are convinced of the improvements of the changes.

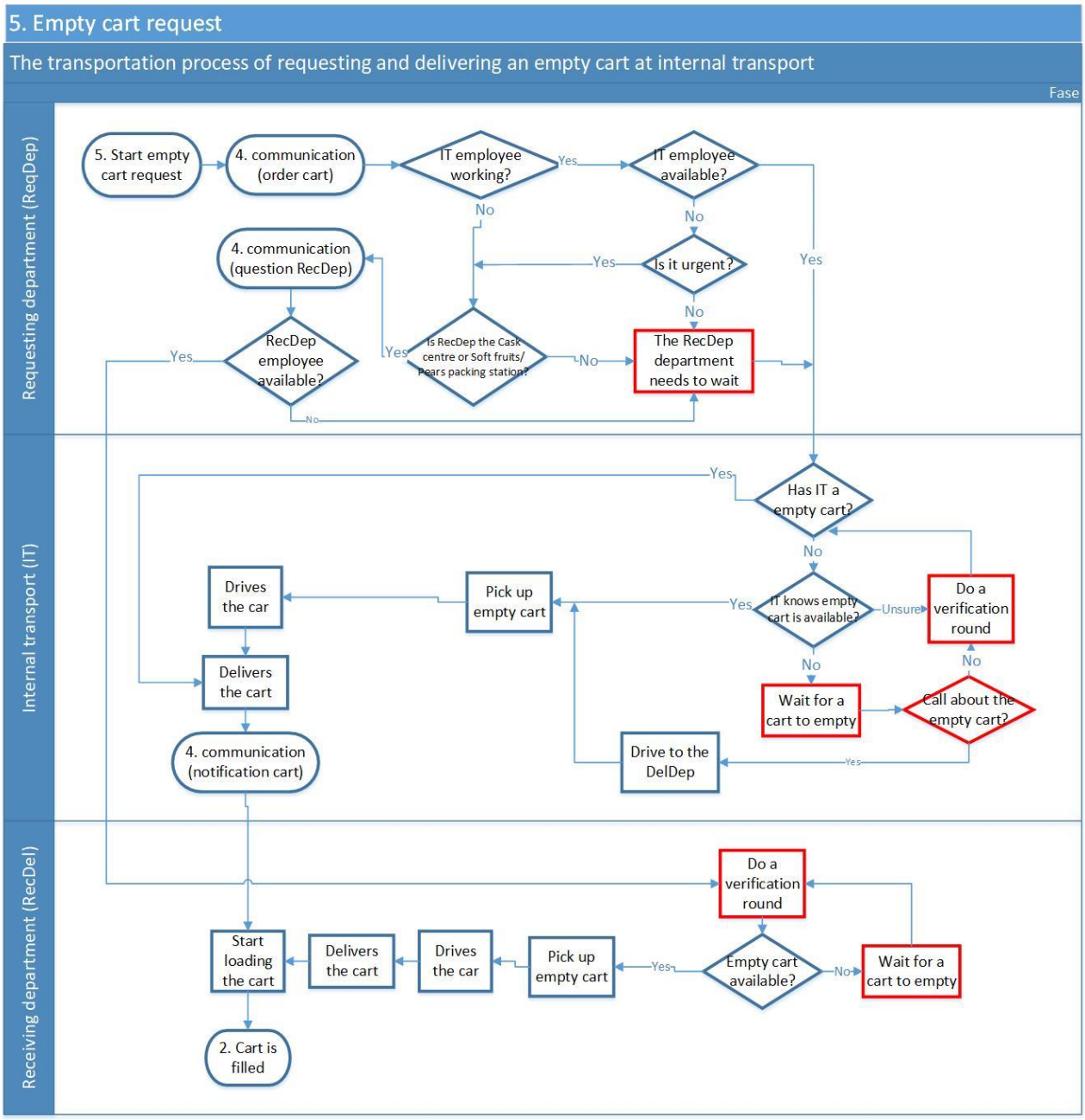


Figure 5 The transport process of requesting and delivering an empty cart at internal transport.

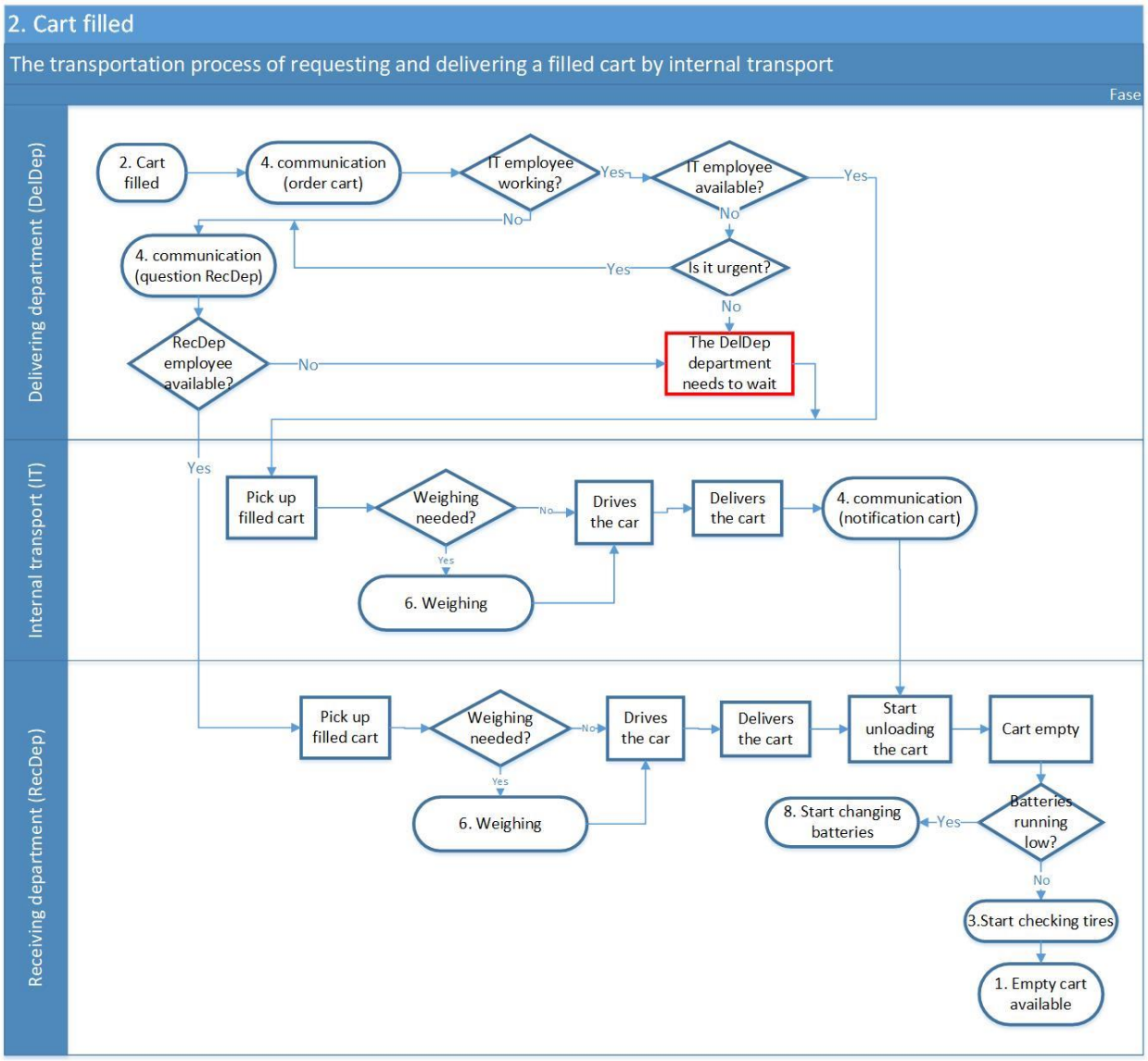


Figure 6 The transportation of requesting and delivering a filled cart at internal transport.

The transportation process of requesting and delivering the terminal trailer that is visible at Figure 7, has the problem of employee shortage. The communication is good, and the employees cooperate with each other which makes this transportation process simple and less decisions are needed. With the little amount of decisions that need to be made the process will flow almost the same each time, what is profitable for the course of the process. The situation where the internal transport team manager needs to do internal transport because of lack of employees is unideal. The other problematic situation also occurs because of employee shortage, when there is an employee permanent on the terminal trailer an employee is always available and the other employees can stick to their own tasks.

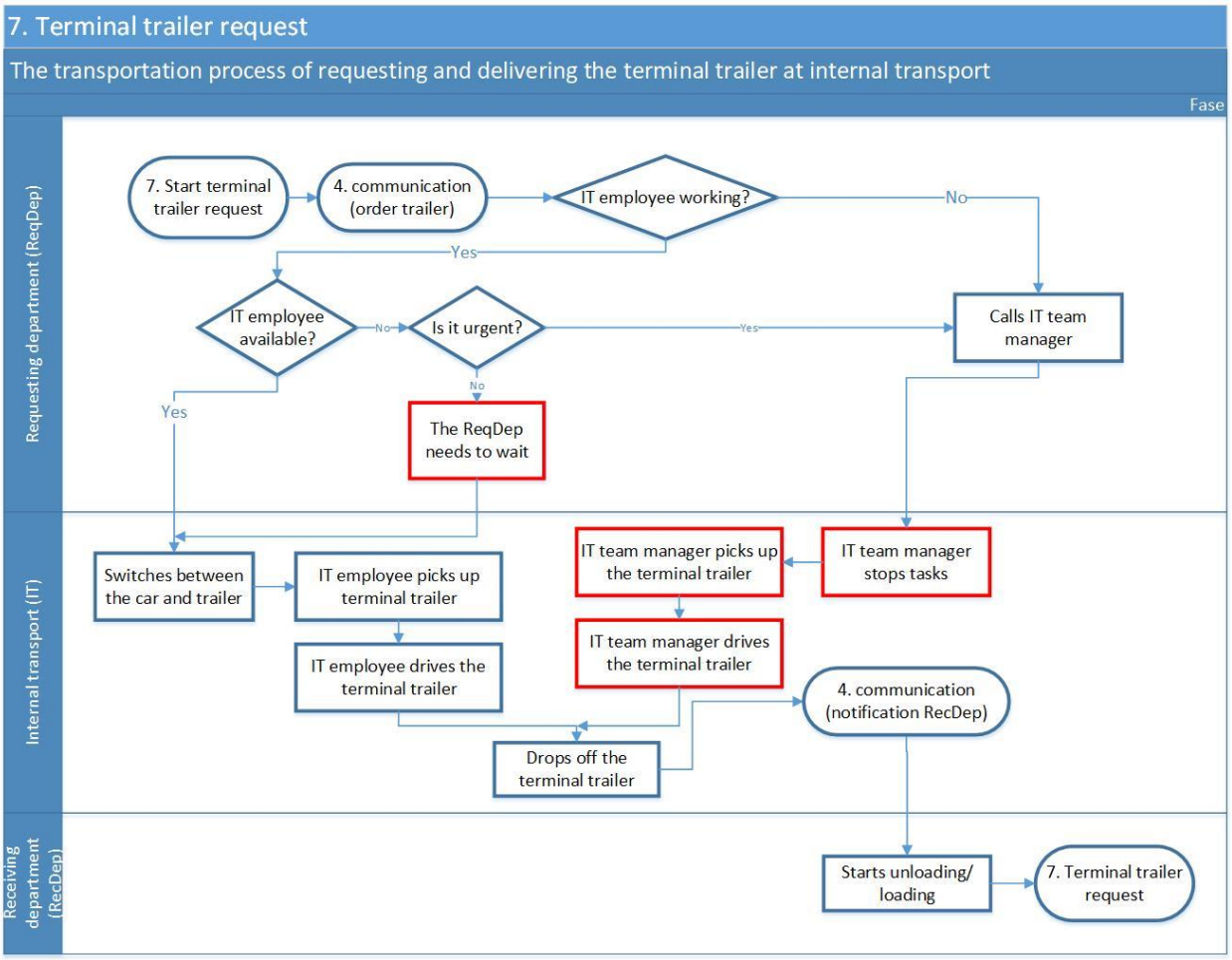


Figure 7 The transportation process of requesting and delivering the terminal trailer at internal transport.

As discussed above, internal transport is responsible for the transport of products between departments and delivering carts at each department, but internal transport does more than that. These actions are also arranging maintenance of the carts, weighing the fruits on the weighbridge, replacing the batteries of the car of internal transport drives with and, most important, communicating with the other departments. Each action will be discussed in more detail below.

2.1.1.2 Cart maintenance

The carts that are transported from department to department also need to be maintained. Internal transport is responsible for arranging this maintenance because the employees of internal transport will be the first employees to notice maintenance is needed. The maintenance is not done by internal transport itself, except for inflating the tires, but done by the technical service. All carts, except for cart number 8 because this cart has a different valve, needed to be checked once a week for the correct tire pressure. Cart number 8 will be done by the technical service. More details on the carts themselves, tire pressure and the air compressor that is used to inflate the tires is discussed in Section 3.3.1. This checking of the tire pressure and inflating the tires process of internal transport is visualised in Figure 8. This process only requires communication at the technical services and because this communication is going smooth and no problematic situations are created here.

2.1.1.3 Fruit weighing

When fruit is brought in by farmers or trucks from outside, the fruit needs to be weighed before it is processed at FruitMasters, but there are situations where internal transport needs to weigh the fruit. Every time pears need to be brought from the cold store to the pear packing station, internal transport needs to weigh the pears on the weighbridge. There is one weighbridge at FruitMasters and the weighing of both the trucks and the internal transport is done in communication with the department expedition. The department expedition is responsible for collecting the data on the type of product, the number of boxes of this product, the farmer number (this is written on the sticker on the boxes), the number of the cart and the total weight of that cart. More details on the weighbridge are discussed in Section 3.3.1. This weighing the fruit process of internal transport is visualised in Figure 9. The amount of trucks from outside that also make use of the weighbridge is out of our control and even though it might be a bottleneck, there is not enough time in this research to solve this problem. The bottleneck is also not observed which makes it impossible to improve it. The communication of this process is going well and will always be necessary.

2.1.1.4 Battery replacement

The electric car internal transport drives in, has a battery it runs on. The charging station of these batteries is stored at the soft fruits/pear packing station. The batteries that are needed for the electric cars are 80V 620Ah and there are always 14 of them at the charging station and 22 driving across the company area. During each day shift, the battery of the electric car of internal transport needs to be changed. The duration of the battery depends on the distance the car has travelled, but also the temperature has a lot of impact on that. When it is cold outside the duration of the battery is way less and it could need to be changed up to 3 times per shift. The batteries take 8 hours to charge. More details on the batteries are discussed in Section 3.3.1. This battery replacement process of internal transport is visualised in Figure 10. The problem of this process is the timing. When the batteries are changed when they need a new one, there are not enough replacements, but when the batteries are changed when they are done, that will improve the entire situation. When batteries are changed after a shift, full batteries will be stored in the car and the forklifts that use the same batteries and more batteries will be able to charge.

2.1.1.5 Communication with other departments

Last, but not least, communication with other departments is one of the most important tasks of internal transport. Through communication internal transport gets a vision of the situation on all of the work that is about to come that day, through communication internal transport knows what is expected of him by the other departments and what tasks need to be done. At the beginning of the day the cold store communicates its planning of the day, but the other departments do not communicate their planning. Without communication, internal transport needs to do control rounds to check up on the situation because currently it is not possible to keep track of the situation any other way. The problematic situations are not visible in the process of communication itself, but as told before the problem occurs depending on if this process is considered. A problematic situation is the situation that occurs where internal transport has dropped off the cart at the receiving department and kept the receiving department excluded. The fact that the receiving department is excluded creates a situation where there is a delay created of processing the cart until the receiving department notices it. This goes hand in hand with the second situation where the receiving department is only able to start unloading/loading the cart when it is noticed and there is time. This also means that the cart could be out for a longer period because it is not noticed, what is also happening now. The third situation is that the cart must wait somewhere at the company area before it can be brought to the receiving department and possibly also wait there. The last situation that is created when the communication lacks a bit is that the internal transport does not know when to pick up the cart again. These situations are not

ideal and will be tackled later in Section 3.1. The communication process of internal transport is visualised in Figure 11.

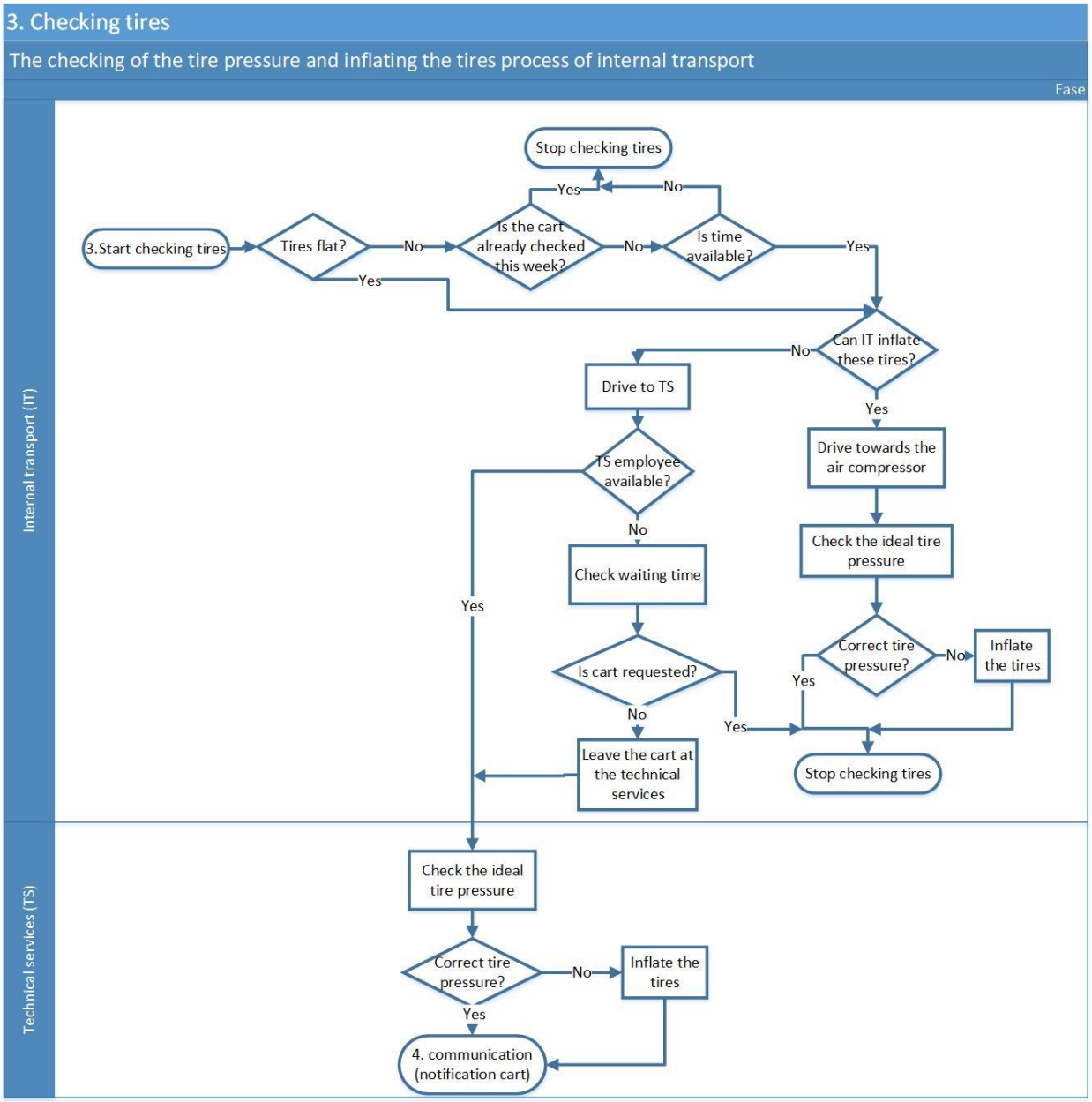


Figure 8 Checking and inflating the tires for the correct tire pressure.

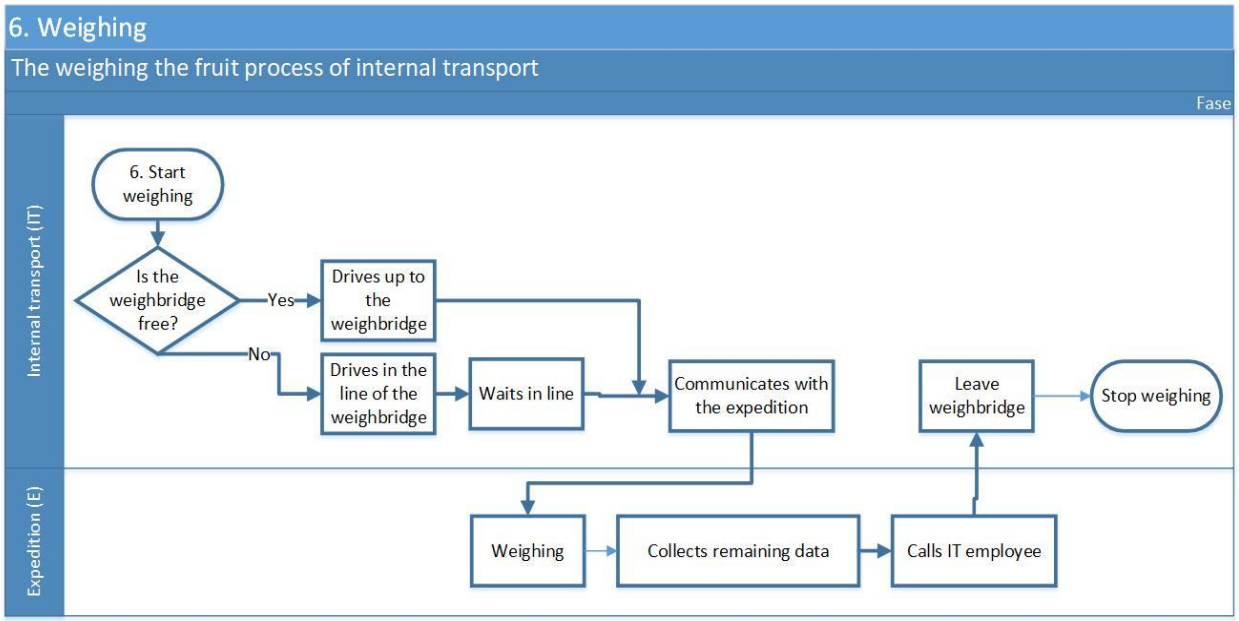


Figure 9 The weighing the fruit process of internal transport.

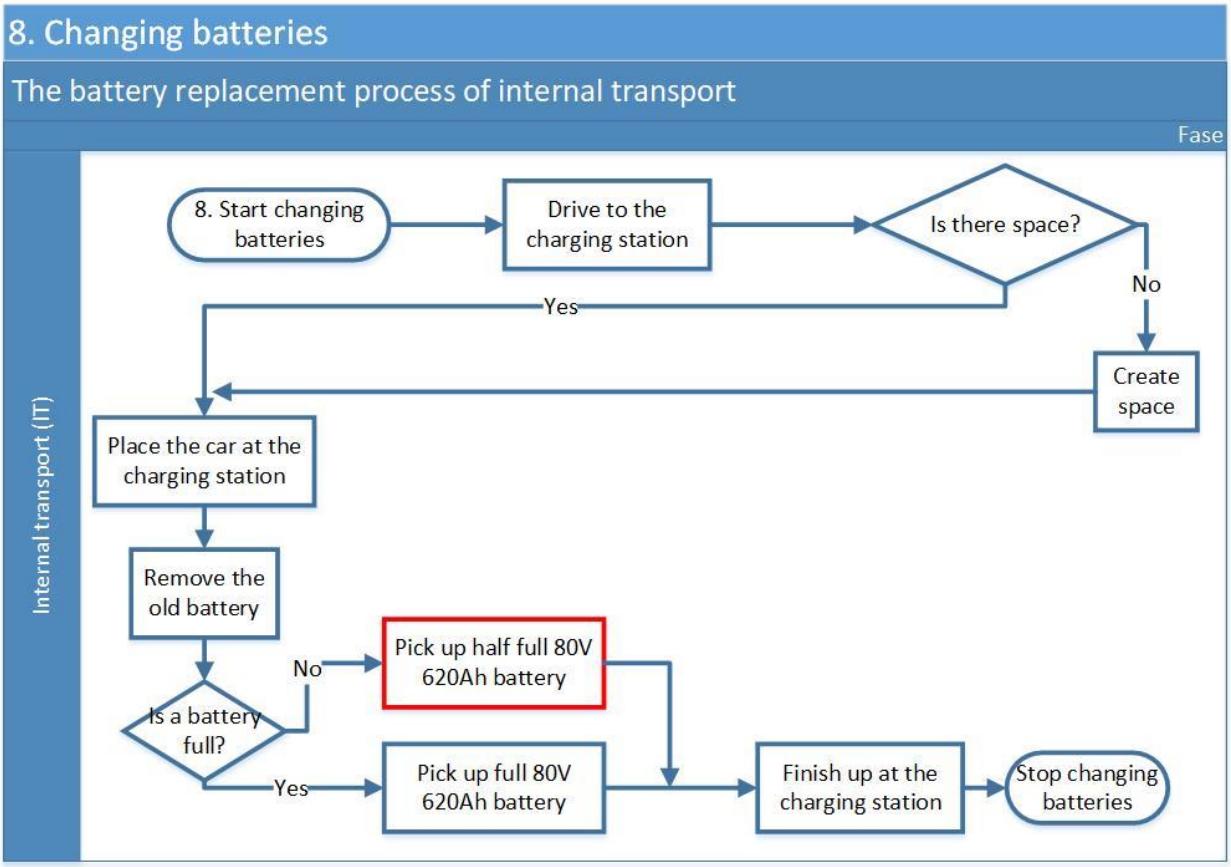


Figure 10 The battery replacement process of internal transport

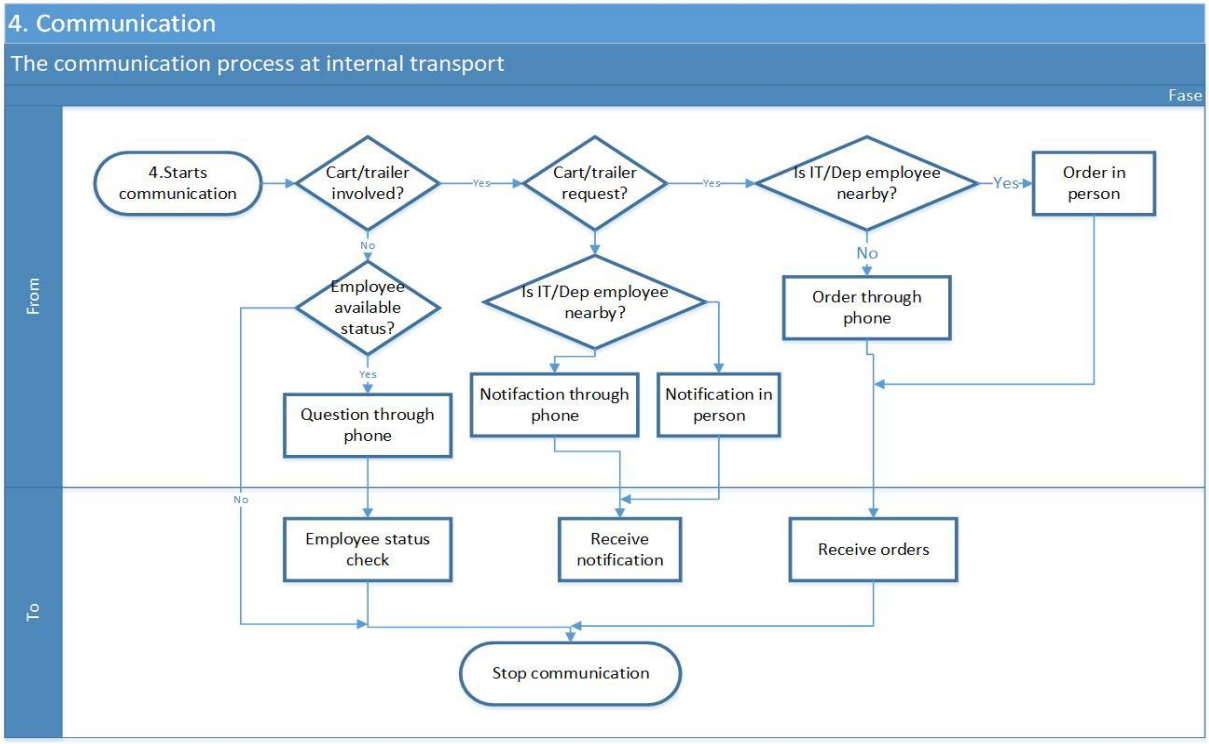


Figure 11 The communication process of internal transport with the other departments.

2.1.2 Decisions

When looking at the decisions and constraints that are related to the actions, first a few things need to be specified. Decisions could be made by different employees, first the employee of internal transport will make the decisions of internal transport. When a situation changes and the priorities need to be elsewhere, what might be because of different reasons like a customer otherwise needs to wait for the products what is never a positive situation or because of problems that otherwise occur at a different part of the company, the team manager that is present will communicate with internal transport to change priorities. The team manager will be the employee to make that decision. The team managers are responsible for the employee of internal transport what makes it logical their decisions overrule the decisions made by the employee of internal transport. When looking at the processes that are visualised in Section 2.1.1, some of diamonds are questions to specify the situation because in a different situation, different decisions were made. The other diamonds are decisions that were made, conscious or unconscious. It could be a conscious decision to handle a situation at one department different than at another department, but if some decisions to handle a specific way have been the same for years, this decision could be done unconsciously. The decision how to handle a situation could also depend on the department and how they act towards internal transport. Looking at each origin why decisions are made is important to know how a situation should change to be improved. Each important decision that is made will be discussed with all the corresponding constraints will be determined. The constraints that are related to a specific action or a specific decision are already discussed at this action or decision, but there are some general constraints on the actions and decision-making process. When looking at the limitations of internal transport on the equipment, people, and policy, more will be discussed at Section 3.2.

2.1.2.1 Communication between internal transport and the other departments

When a department needs products from another department, they call the employee that is transferring the cart at that moment. This communication towards the internal transport on requesting carts is required because otherwise internal transport will never bring a cart without that. That is why each department has no struggle with that communication, because it is required also for them to continue their job. There also will not be problems with communicating the correct location where the cart is needed, because it will also slow down their own flow when mistakes like that are made. But when it comes to communication they will not really benefit immediately from; problems occur more often. The fact that it is a choice for an employee of a department to update the internal transport on the status of the cart, is not an ideal situation. It should be the standard to always communicate and not a decision that can be made or not. In Section 3.1, more details on the communication problems will be given.

2.1.2.2 Delivering a cart at a department

When delivering a cart at a department, there are also some decisions that need to be made. When the cart is delivered, because it might be that the department has no room now to receive the new cart. Another reason why a cart will not be delivered, or delivered with a delay could be because the situation is uncertain at the moment where carts might be occupied for too long when they are more needed at another spot at the company. The fact that it is a choice for the internal transport to not deliver carts when a department needs it, but internal transport cannot afford the occupation of the cart, is not an ideal situation. It should be the standard to always deliver a cart when there is asked for it and not a decision that can be made or not. In Section 3.1, more details on this problem will be given. Where a cart is delivered is also a decision, each department has different locations where the carts can be dropped off and this needs to be communicated towards internal transport but decided by the requesting department. The decision on where to deliver the cart is made by the requesting department and not internal transport.

2.1.2.3 Leaving a cart at a department

Besides delivering a cart at a department, leaving a cart at a department is also a decision that is made. It happens during the quiet times that the carts that we dropped off with products at a department, were left there even though they were empty. The reason to do so is because it might save time to pick it up later when it is needed at a nearby department. The decision of leaving a cart at a department can only be made when this cart does not hinder anyone, and the spot is not needed to place a new cart.

2.1.2.4 Checking the situation

When the situation is checked by doing a control drive is also a choice and each other employee that does the internal transport will be doing that differently. Officially there is only one employee of internal transport, but there have been days where other employees took over and they handled checking the situation differently. When the current employee of internal transport has no tasks to do and wants to check on the situation, first he will do a control round and after that he will wait for further instructions. This means he will wait at a spot in the company area, but if it takes too long for a next task another control round is done. The other employees just kept driving across the company area. This means that this decision on how to handle this situation also has a

different effect on the situation. When waiting on a new task without driving across the company, it is hard to visually see the new tasks that could be done, but the fact that the communication of other departments lacks sometimes does not mean that driving across the company area is the solution to solve that mistake. In Section 3.1, more details on this problem will be discussed.

2.1.3 Relations between actions

Each department has a different relationship with internal transport, but there are some relations within the different actions. When looking at the relations between the different actions, there is only one relation and that is that internal transport is involved in all of them and executes them all. The different relations within each action, that is addressed at Section 2.1.1, will be discussed and the relations that are there will be specified.

2.1.3.1 Transporting the carts and the terminal trailer

Internal transport brings products from department to department. The transport differs sometimes between different departments because there is transportation done by the terminal trailer and with the car that delivers carts. The incoming and outgoing flows also differ for each department. When looking at the data of Appendix A, the following conclusions of the internal transportation of the last year are made. In total, internal transport did 9432 drives, of which 1745 drives were done by the terminal trailer and 7687 drives were done by cart. The transportation of all the products is done by the department that delivers the products to another department. This means that the transport of the fruit is currently a push system. Essentially, a push system describes a situation where inventory is pushed to the receiving department of the products, and a pull system describes a situation where inventory is pulled from the sending department by the receiving department. In Lean Manufacturing, pull systems are used to avoid excess inventory and allow us to much more readily cope with changes that need to be made to that inventory (Geoghegan, 2020). The transport of the fruit is a push system because the planners request the order of fruit to be sent towards the apple preselection and the soft fruits packing station. How the situation is at the pear packing station is unknown because during the observation no pears went from the cold store towards the pear packing station. According to the employees of FruitMasters, the pear packing station communicates more with the cold store when the pears can enter the packing station. This suggests that at this packing station the transport is a pull system, but this is not observed and because of that it cannot be confirmed. If the apple preselection and the soft fruits packing station would request their own fruit, the unloading/loading would be improved a lot. The packing stations are up to date on the required cask and because of that they request their cask, which makes that a pull system.

Some departments, such as the department cask centre and cold store, make most use of internal transport for picking up products and bringing them to another department with carts. From the data of Appendix A, the cask centre was involved in 2635 drives, where in 1949 drives the cask centre was the sending department and in 660 drives the cask centre was the receiving department. Also, that data shows that the cold store was involved in 1595 drives, where in 1289 drives it was the sending department and in 108 drives the receiving department. These two departments have a few things in common. They overall send more of their products towards other departments than receiving products from other departments. There are also no large

struggles with slow unloading/loading and a long occupation time at these departments, because they have the steering role in this process.

Other departments, such as the apple preselection department, the departments soft fruits and pear packing stations and the industry department, make most use of internal transport for bringing products from other departments towards them with carts. The data of the apple preselection and the apple packing station are combined which makes it harder to estimate the correct situation. This means for the data of the apple preselection the drives of the trailer are left out and all these drives of the trailer were done towards the apple packing station. From the data of Appendix A, the apple preselection was involved in 5108 drives, where it had 2997 drives where it was the sending department and 2111 drives where it was the receiving department. This does not show it is more often the receiving department because the data might also contain more drives that go towards the apple packing station instead of the apple preselection. The soft fruits packing station was involved in 1596 drives, where it was the sending department at 390 drives and 1200 drives where it was the receiving department. The pear packing station was involved in 823 drives, where it was the sending department at 182 drives and 636 drives where it was the receiving department. The industry department was involved in 1084 drives, where it was the sending department at 77 drives and 990 drives where it was the receiving department. These four departments have a few things in common. They are overall more the receiving department and because the transport of the fruit is going through a push system, they are not the departments that steer the process. They are also the departments that keep the carts occupied the longest time and the communication towards these departments is not great. More details on that in Section 3.1.

The departments apple packing station and expedition make most use of the terminal trailer, see Section 3.3.1, for bringing packaged apples from the packing station towards the expedition. As discussed in the paragraph above, the data on the apple packing station will be the data on the trips involving the apple packing station with the terminal trailer. There are some trips done by cart, but since the terminal trailer is more practical, this does not happen often. From the data of Appendix A, the apple packing station was involved in 1652 drives, where it had 1576 drives where it was the sending department and 76 drives where it was the receiving department. The expedition was involved in 4254 drives, where it had 769 drives where it was the sending department and 3465 drives where it was the receiving department. These two departments have in common that most of the transport of the products is done by the terminal trailer. The fact that the trailer is most in use for driving in between these two departments makes it easy to load and unload it, especially when it is done again by the employee of internal transport.

The auction department does not need a lot of internal transport. From the data of last year, see Appendix A, it is visible that only 86 of the 9432 drives were requested by the auction department, which is less than 1% of all internal transport. 26 drives were from the auction towards a different department and 60 drives were towards the auction department. The actions of internal transport that were done for the auction department is when cask is needed or remaining. Transporting fruit from the packing stations to the auction is exceptional. The other incoming streams do not go through the internal transport.

2.1.3.2 Cart maintenance

The cart maintenance is done by internal transport and the technical service department. The cart maintenance that can be done by internal transport is different maintenance than the technical services does. They both have the same goal of keeping the carts in its best condition, but there are no further relations here. During the research, each time the process of inflating the tires took approximately 10 minutes.

2.1.3.3 Fruit weighing

The fruit weighing processes that are done by internal transport are also done by the trucks from outside that bring in fruit, but they have another action where they also need to weigh the zero setting of their truck. This zero setting is measured because with that the total weight minus the zero setting is the weight of the fruit. Internal transport does not need to measure its zero setting, because they run on electricity and do not have a fuel that differs each time. This means that there is a relation between these actions, but that is the only one.

2.1.3.4 Battery replacement

The battery replacement of the battery of the internal transport car is only done by internal transport and because of that there is no relation within this action and any other actions. This process is stand-alone from the other processes of internal transport.

2.1.3.5 Communication with the other departments.

The relations between the communication with the other departments also differ per department. This also depends per employee that is present at that time, because the communication of a department always changes with the change of the employees. What to expect from an employee is no real surprise and Figure 11 shows the communication process at internal transport. At this flowchart, the different decisions that can be made by the employees on how to respond to a situation are written down. This means that there is a bit of a relation between the actions because they all respond the same way to the situation that was created. This means that when there is no real communication towards a department, no real communication will return and the same visa versa. This sounds logical because this situation is created by doing the same things the same way for years. It could be that the communication was different, but communication comes from two different sides and when you do not get communicated back from a department, it is human to stop communicating yourself. This also does mean that this situation that is not ideal, has been here for a while.

2.2 KPIs of internal transport

This section will investigate the variables to analyse the processes of internal transport. In this section the research question: **“What are SMART KPIs of the internal transport processes of FruitMasters?”** will be answered. Each department has different KPIs, Key Performance Indicators, which means each department's performances are analysed based on different variables. The reason why each department has different KPIs is because each department has different processes with different indicators that can be measured. The processes of internal transport can measure indicators like the requested carts, total idle time, and total working hours,

where at other departments the quantities of fruits and the costs are more important to track. Figure 12 shows the different departments that are involved in the processes of internal transport.

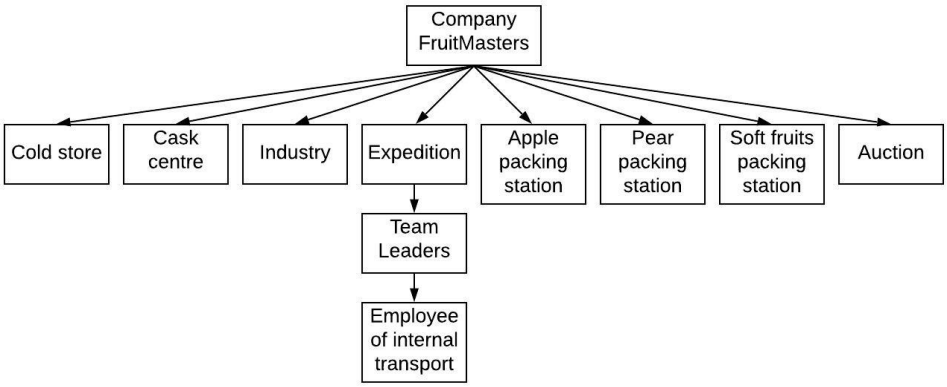


Figure 12 the different departments that are involved in the processes of internal transport.

The department this research is doing research on is the internal transport department. This department does not have KPIs now because the performances are not analysed. This research will analyse the performance of internal transport and determine the KPIs. The determination of the KPIs is done by a systematic literature review. The knowledge goal of this research was: “To find a way to get access to the up-to-date performance information of the internal transport.” The research question that needs to be answered to achieve this goal is “Which KPIs are valuable in evaluating the service quality performance of the processes of internal transport?”. To solve this problem the phases of MPSM are used (Heerkens & van Winden, 2017). MPSM is a managerial problem-solving method that consists of seven phases. The phases tackled in this section are defining the problem, formulating the problem-solving approach, analysing the problem. The steps of formulating solutions and choosing a solution is done in Chapter 5, implementing the solution is not done during this research, but based on the expected impact the evaluating on the solution is done in Chapter 8.

During this process it is important to consider the SMART criteria (Specific, Measurable, Achievable, Relevant, Time-bound). There are a few reasons why the criteria are to create SMART KPIs instead of regular KPIs. SMART criteria are used to explore how to create, develop and achieve the goals. The criteria of making the KPIs Specific is because the goal should be clear and specific, otherwise it is hard to focus on the efforts or feel truly motivated to achieve it. It is important to have Measurable goals to track progress and stay motivated. Assessing progress helps meeting deadlines. It is important to have Achievable goals to be realistic and attainable to be successful. An achievable goal can identify previously overlooked opportunities or resources that can bring you closer to it. It is important to have Relevant goals to make sure the goal matters and align with other relevant goals. Make sure that the plans drive everyone forward and still achieve the developed goals. It is important to have Time-board goals because every goal needs a target date to create a deadline to focus on and something to work toward. This part of the SMART criteria helps to prevent everyday tasks from taking priority over longer-term goals (Hancock & Bell, 2020). There are some steps to develop a real-time monitoring and tracking system, obtained from the systematic literature review in Appendix E. The process that is done to create the SMART KPIs is explained in Figure 13. This process consists of six steps, where each step is a different phase of the process that is discussed next. What is important to clarify is that

this process is used in this research and is not what FruitMasters currently do, because they had no priority to collect data on the processes before, they did not create SMART KPIs before.

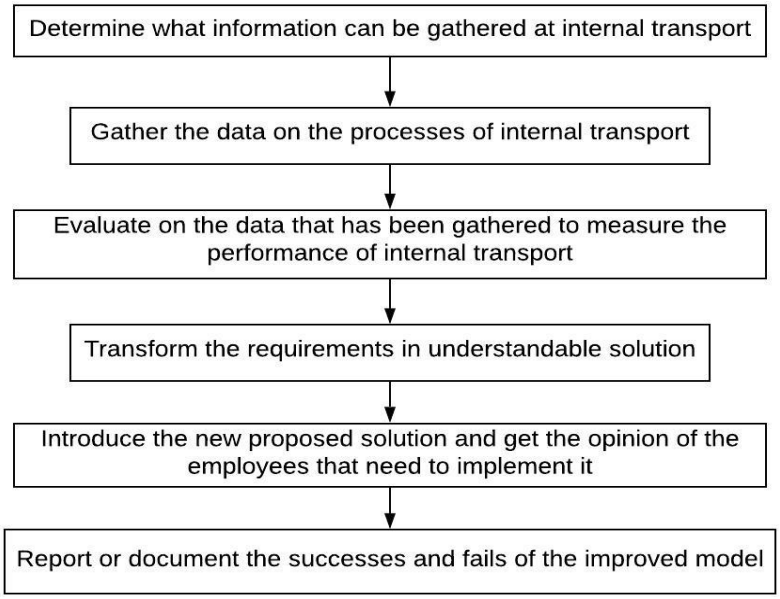


Figure 13 The process of creating SMART KPIs for internal transport of FruitMasters.

2.2.1 Business Requirement Analysis

This phase gathers information regarding business processes by interviewing employees with related job descriptions based on the involvement of their position at FruitMasters at internal transport. For the research question: “What do the employees that interface with the processes of internal transport, think of the current situation?”, I interviewed the employees that interface with the processes of internal transport. During the interview I asked about the general information about the internal transport of FruitMasters and the weak spots. Most of these weak points appear to be task assignments per day (TA), on-time delivery per day (OTD), availability per day (A) and order tracking ability per day (OTA) related. The KPI idle time per day (IT) is also added because of the action problem: **The idle time of the internal transport employees should decrease with 15%**. Currently the idle time is not measured yet but during this research it will be to analyse the occupation of internal transport. These key performance indicators are service quality performance indicators. To also make them measurable the following formulas are created:

$$TA = \frac{Completed\ assignment\ per\ day}{Total\ assignments\ per\ day} * 100$$

$$OTD = \frac{Completed\ delivery\ expectation\ per\ day}{Total\ assignments\ per\ day} * 100$$

$$A = \frac{Total\ requested\ carts\ that\ could\ be\ delivered\ per\ day}{Total\ carts\ requested\ per\ day} * 100$$

$$OTA = \frac{Total\ tracked\ orders\ per\ day}{Total\ orders\ per\ day} * 100$$

$$IT = \frac{Total\ idle\ time\ in\ hours\ per\ day}{Total\ working\ hours\ per\ day} * 100$$

These KPIs are specific, measurable, achievable, relevant, and time-bound, what makes them SMART. Collecting these KPIs during the research, shows the current situation of the research. The article Monitoring System Using GPS for Logistic’s Key Performance Indicator shows how the formulas should be created and this is used for these formulas (Girsang & Prabowo, 2019).

2.2.2 User Requirement Analysis

This phase is to obtain information from the process owner regarding the new proposed model. Currently the only data that is conducted during the processes of internal transport, are the rides from one department to another department filled with products. During the observation of the processes data for this research is collected. This data consists of data on the orders:

- The completed orders of each day, these are the total tracked order of today plus the rides that do not transport products that were executed.
- The completed delivery expectation of today, these are the expected deliveries per day.
- The total requested carts that could be delivered per day, these are the carts that could be delivered to the department when requested.
- The total carts requested per day, these are the number of requests for carts.
- The total tracked orders of today, these are the routes from one department to another department that are requested and noted down. The routes of the trailer that are noted are also considered here.
- The total orders of today, these are the total tracked order of today plus the rides that do not transport products that were executed and requested.

The collected data also consists of data on the verification rounds:

- Verification rounds where carts could be picked up. The reason why this is tracked is because it is inefficient the employee needed to drive across the entire company area, to find this cart and could have delivered it earlier to the other departments. These verification rounds were calculated by subtracting the requested number of orders from the total number of orders.
- Verification rounds where carts could not be picked up. The reason why this is tracked is because it is inefficient to drive across the entire company area, without being able to do something.

The reason why there are no KPIs on this data is because this data does not analyse the performance of internal transport, but it does analyse the performance of the other departments relative to the processes of internal transport.

The collected data also consists of data on the idle time of the employee of internal transport (the verification rounds where trailers could not be picked up are also taken into account here, because this can be seen as idle time):

- The total idle time of each day, these are all the periods of idle time added up.
- The number of periods of idle time there were, to know how often this occurs.
- Percentage of the day that is idle time, to see the impact of the idle time on the entire shift of internal transport.
- The duration of the periods of idle time, to know the size of the problem.
- The total working/research time of that day, or the tracked data time of that day, is also added here. The reason for this is to be able to calculate the KPI idle time per day.

The collected data also consists of data on the occupation time of the carts:

- The occupation time before the cart is picked up again at each department. Here need to be considered that the unload/load time is probably less than the occupation time,

because of the inefficiency where the employee will pick up the cart the moment he notices.

This data also has no KPIs because this data also does not analyse the performance of internal transport, but it does analyse the performance of the other departments relative to the processes of internal transport.

2.2.3 Evaluation analysis

Based on requirements analysis, the best method is chosen and transformed into suitable aspects evaluation. This phase is created by the evaluation of the company FruitMasters on the KPIs. The KPIs were approved to be used for this research, to analyse the performance of the processes of internal transport. In Appendix F, the collected data of the KPIs is shown and this data has been processed in Figure 14 to visualise the differences between that data. The following conclusions can be made based on the collected data of the KPIs. During the observation of internal transport for this research it is visible that all the completed delivery expectation of each day is the same as the orders of each day, but the completed orders are not. During the research there were 2 situations that created the changes in that data: the fact that internal transport was not available and the department needing the carts transported itself, which means that the transport was not done by internal transport and when internal transport was not able to deliver carts because they were out of it at the moment. The collected data during the observations on the number of times this transport was needed is shown in table 1.

Date	July 2	July 8	July 13	July 15	July 17	July 24
Number of times the cart was driven by the other departments during the observation	2	2	2	2	3	2

Table 1 The data on all times during the observation the other department needed to transport.

The second situation was also added to this data because it showed that internal transport could not deliver the expected amount of transports. This origin and problems of this situation are further explained in Section 3.1. What is also visible in Figure 14, is that the total requested carts (that could be delivered) and the total tracked orders of each day is way less than the amount of transfers that were done and the number of orders. This means that the tracking of the orders should improve and that not all transfers that were needed were actually requested, which also means the communication on this should improve, for further information see also Section 3.1.

In Appendix G the KPIs based on the data gathered of internal transport of week 27 of 200 till week 30 of 2020 are calculated in percentages. The KPI task assignments per day (TA), on-time delivery per day (OTD) and availability per day (A) shows that internal transport was working during the research optimally. The moments where the cask centre or the soft fruits/pear packing station decided to pick up the cart themselves and when all the carts were full made it that internal transport did not work completely optimally. The average of the order tracking ability per day (OTA) is 49,2%, which shows that only about half of the work is tracked by the employee of internal transport. The employee should track all its tasks to be able to completely analyse the situation and optimize it through the years when FruitMasters grows and changes. The KPI idle

time per day (IT) is on average during the day shift 39,0% and during the night 64,4%. This means that during the day 39,0% and during the night 64,4% of the time is not used. Section 2.3 will discuss more about the idle times that were observed during this research.

Besides the data on the KPIs, some other data was collected, starting with the data on the verification rounds. The data on the verifications rounds is shown in Appendix H. The data on these verification rounds are also shown in Figure 15. The verification rounds that were done where carts could be picked up shows the lack of communication between the different departments. If the communication were good, these verification rounds were unnecessary and internal transport could have been faster with picking up the carts. The employee would have been faster because he did not need to be driving across the company area before picking up the carts and because the possibility of the carts being done for a while before it was noticed is huge. Clear communication will improve the flow of the transportation of the carts and improve the efficiency of internal transport. The verification rounds that were done where carts could not be picked up is just idle time. Currently internal transport is in the need of these verification rounds because otherwise the employee will lose the overview of the situation. If the communication is done great, that will help enough for an overview of the situation and these verification rounds are no longer necessary. The total amount of verification rounds was 391 rounds, of which 325 rounds were verification rounds where carts could be picked up. This means that 83% of all verification rounds could pick up carts due to communication problems.

The evaluation of the data on the idle time is done detailed in Section 2.3. The last evaluation needs to be done on the data on the occupation time of the carts. The data on the occupation time of the carts is shown in Appendix I. This collected data has been visualised in the graphs below. What is interesting about this data is that it is overall known the forklift drivers have 30 minutes to load and unload the carts, but the graphs show that the occupation time is way more than the unloading/loading time. When looking at Table 2, the number of occupation times that were collected during the observation, most of these times took too long. Even though this research was done during the quiet times of FruitMasters, they still have the same problems of not being able to unload/load the carts in time. This problem is even bigger when it occurs during the busy periods, see Section 3.1. The cask centre is also the parking spot for the carts and because of that the occupation time is not problematic here.

Department	Cask centre	Apple packing station	Industry	Soft fruits and pear packing station	Expedi-tion	Cold store
Number of occupation times	118	174	44	87	92	119
Occupation times that took to long	73	139	44	74	60	71
Average occupation times collected	1:25	1:15	1:58	1:24	1:25	1:03

Table 2 Data on the occupation times that were collected during observation of this research.

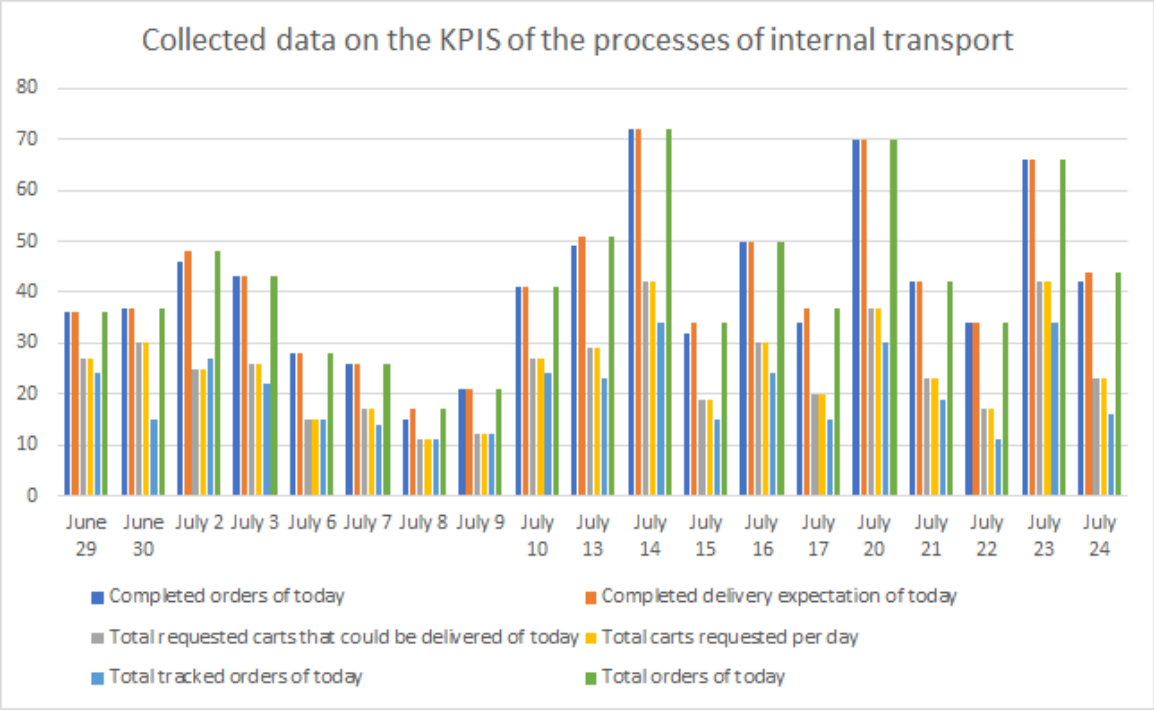


Figure 14 The collected data for the KPIs of the processes of internal transport.

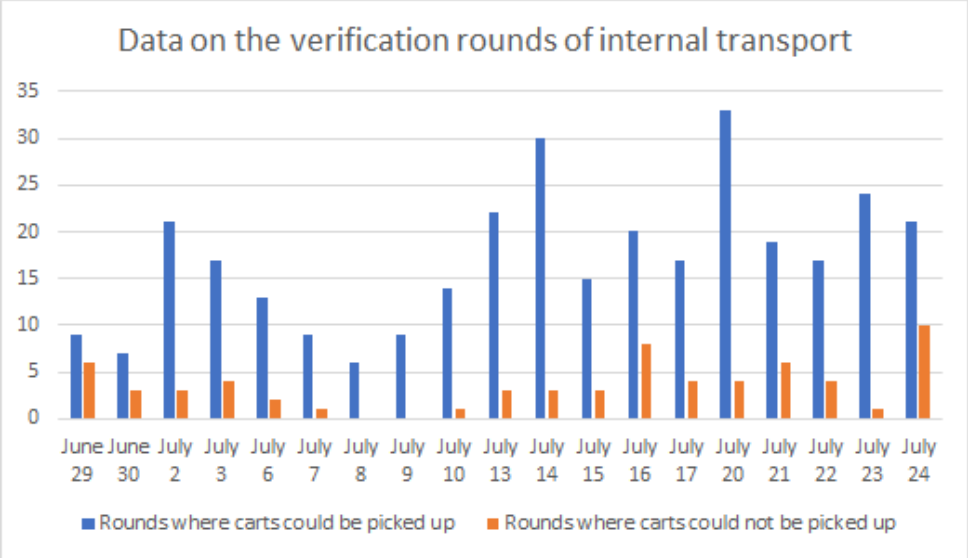


Figure 15 The collected data on the verification rounds of internal transport.

2.3 Idle times of the employees of internal transport

In this section the research question: **"What is the current idle time of the employees of the processes of internal transport the carts interface with?"** will be answered. More information on the idle times will be discussed in Chapter 3, but the current idle times of the employees of internal transport is part of visualising the current situation of internal transport at FruitMasters. Currently, the idle time is filled by doing nothing or talking with other employees. The verification rounds where no carts were able to be picked up is also considered as idle time. As already mentioned in Section 2.2, the verification rounds where trailers could not be picked up are also

considered and seen as idle time. The collected data on the idle time of the employee of internal transport are the following:

- The total idle time of each day, these are all the periods of idle time added up.
- The number of periods of idle time there were, to know how often this occurs.
- Percentage of the day that is idle time, to see the impact of the idle time on the entire shift of internal transport.
- The duration of the periods of idle time, to know the size of the problem.
- The total working/research time of that day, or the tracked data time of that day, is also added here. The reason for this is to be able to calculate the KPI idle time per day.

This data of the four weeks of observation has been put in Appendix J. This data shows all the useful information on the idle times of week 27 of 2020 until week 30 of 2020. In Figure 16, the distribution between the idle time and working time of this data is visualised. What is important to keep in mind is that on week 27,29 and 30 the idle time was observed during the day shift of internal transport, this day shift is from 6:00 till 15:00. Week 28 the data was collected on the night shift (and a tiny part of the day shift), the shift was from 12:00 till 21:00. The reason why I did not start collecting data during the usual night shift from 15:00 till 24:00 is because there is not much internal transport after 21:00. The departments that arrange most of the internal transport are closed after 21:00, which means it was more interesting to collect the data from 12:00 till 21:00 to get a real shift. Each day the employees have one hour of break time that is divided over 3 breaks during the shift. All information on the idle time will be discussed below. But a few things need to be taken into account, the observation of the situation was done during one of the most quiet periods of the entire year because the cold store is almost out of fruit from Dutch farmers and only fruit from abroad.

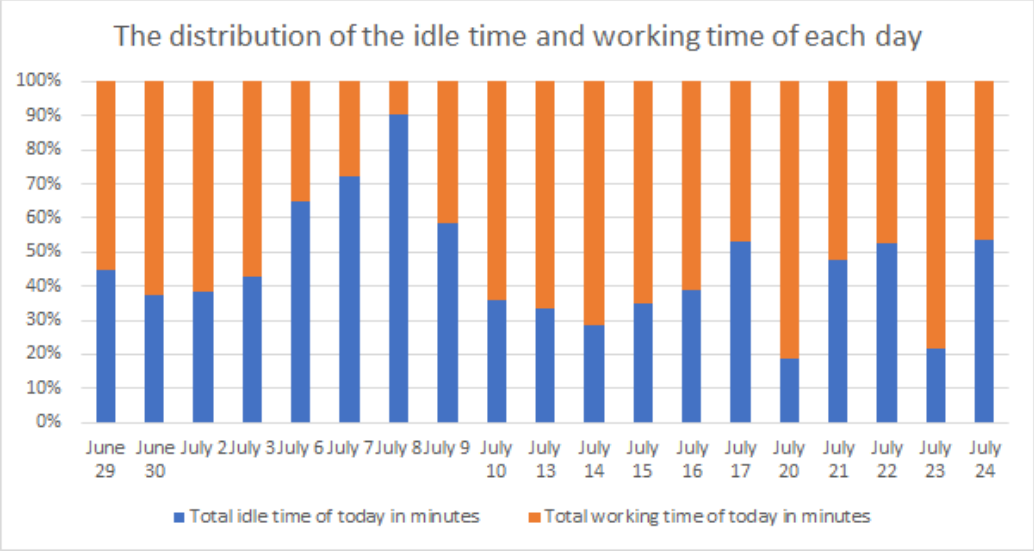


Figure 16 the distribution of the idle time and working time of the observed days.

2.3.1 The total idle time of each day

When looking at the total idle time of each day of the data at Appendix J and K, there are a lot of fluctuations in it. It is overall known that the night shift of internal transportation contains more idle

time than the day shift. First, when looking at the data of the day shift, the least amount of total idle time that was observed during these 4 weeks was 89 minutes. The most amount of total idle time during the day shift that was observed was 258 minutes. This is because the last 2 weeks, from 12 till 15 the day shift was done by the team managers of internal transport who took over internal transport. This outlier was created on a day where they were too busy with their own tasks to spend a lot of time on the internal transport. The average total idle time during the day shift was 184 minutes. Then, looking at the data of the night shift, the least amount of total idle time that was observed during these 4 weeks was 151 minutes and the most amount of total idle time was 433 minutes. The average total idle time during the night shift was 308 minutes. For an employee that works 8 hours (480 minutes) a day, the fact that during the day shift there is about 3 hours of idle time and during the night shift there is about 5 hours of idle time, are both not ideal, unless it is not possible to put this employee on other tasks.

2.3.2 The number of periods of idle time there were

The fact that the night shift has a larger total idle time each does not mean it has more periods of idle time than the day shift. In general, the average period of idle times is 13 periods per day, during the day shift this is 15 periods per day and during the night shift this is 8 periods per day. Combined with Section 2.3.1, this shows how there are more periods during the day shifts and that these periods of the day shifts are significantly shorter. There are less periods during the night shift and these periods are significantly longer.

2.3.3 Percentage of the day that is idle time & total working/research time

To calculate the percentage of the day that is idle time, it is important to keep in mind if the total working time of that day or the observed time might be different each day. This fluctuation is taken into account which means to calculate the percentage of the day that was idle time the following formula was used: Total idle time of the day in minutes / Total working time of today in minutes x 100. When calculating the average percentage of the day that is idle time, this is 45,7% in general. The day shift has an average of 39,0% and the night shift has a percentage of 64,4%.

2.3.4 The duration of the periods of idle time

The idle time as it has been discussed before, is a lot but the duration of the periods in which this idle time takes place is important to keep in mind. In general, the average duration of each period of idle time is 20 minutes, during the day shift it is 13 minutes and during the night shift it is 40. There are three weeks of day shift data and only one week of the night shift, which explains the distribution of these averages. The thing about these durations of the periods of idle time is the fact that they are quite short to work on other tasks. What is important to take in mind is that the employee of internal transport is most productive when he is right at the company area ready to respond to orders of the departments. The size of the idle times during the day shift shows that during the day doing other tasks is hard, but the size of the idle times during the night shift shows that there could be time for other tasks, if the employee is able to drop them when internal transport is requested. More information on this is discussed in Section 3.1.

2.4 Employees view on the current situation

In this section, the research question: **“What do the employees of internal transport processes the carts interface with, think of the current situation?”** will be answered. To collect the needed information to answer this research question, the data gathering method needed to be chosen. From the micro lectures of Hans Heerkens, the method of data gathering communication approach, with specific interviewing was chosen to use to answer this research question (Heerkens, 2020). The research is done cross-sectional, where the data has been collected at a specific point in time. The information and data that is gathered during the research is anonymous, to create an environment where the opinion of the employees is important and heard and implemented in the project. The communication approach that was used for this research question was an interview. For this research, a total of 11 employees are interviewed. They all interface with internal transport in a different way, but they all have in common that they communicate with internal transport because they need to deliver and/or receive products from other departments. In Figure 17, the departments that are involved are shown at the end the forklift drivers and the employee of internal transport that work at the workplace. This hierarchy shows who manages who and that the departments do not communicate with other departments but only work with interacting with the planners and the internal transport. The data on this research question is collected during the period from 16th of June till 24th of June and is referred to as the current situation.

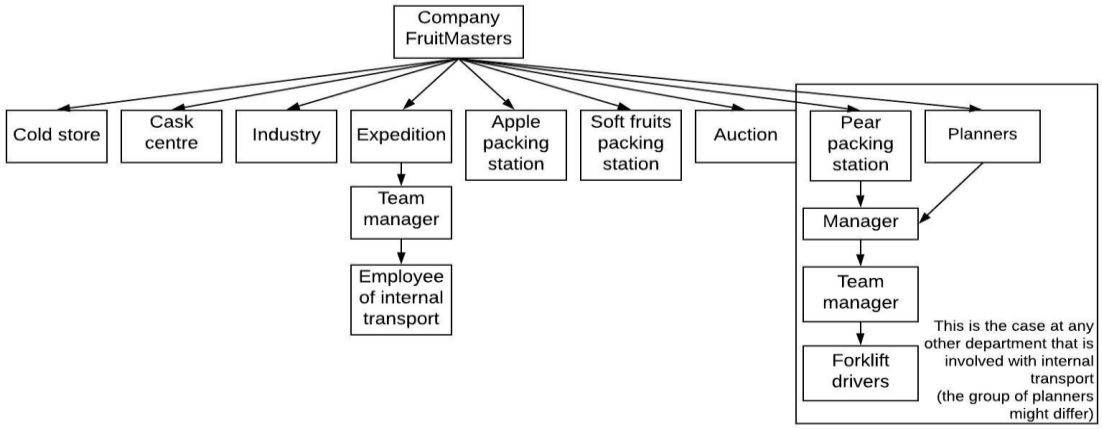


Figure 17 The department distribution where each department has its planners, managers, team manager and forklift drivers.

This interview was conducted for understanding the view of the employees on the situation. First, there were questions asked to understand the participation of the employees to the processes that will be tackled during this research. Afterwards, the questions that answer the research question: **“What do the employees of internal transport processes the carts interface with, think of the current situation?”**, are asked. The process on collecting the data to answer the research question included the following steps:

- Step 1. A short introduction on myself and the research that is done.
- Step 2. Asking what the jobs of the respondents are about and with what processes of internal transport they interface with.
- Step 3. Asking the general questions: “What are the receive and send streams of your department?”, “Is there already any data collected on the processes of internal transport

you interface with, I could be using during my research?" and "Do you have any suggestions I need to take into consideration during my research?"

- Step 4. Start asking the questions that are needed to answer the research question.

The questions that were important to understand what the employees that interface with the processes of internal transport were:

- What do you think of the current internal transport?
- What are the advantages of the current situation?
- What are the disadvantages of the current situation?
- How should an ideal situation look like, and which features, or components would be good to have?
- Have there been any attempts to improve the current situation already? If there have been attempts, what went wrong during these previous attempts? If there have not been attempts, what do you think the reason is there has not been any attempts to improve the current situation?

As you see these are only open questions, the reason why there is chosen to only use open questions is because this interview is done to hear everybody's opinion on internal transport. Open questions make sure that the respondents think about the internal transport and reflect on it. They will deliver opinions, feelings, and hand control of the conversation to the respondent (Straker, 2020).

All the responses of the employees have been processed in Appendix L. Each employee makes use of the processes of internal transport in a different way and has a different relationship with internal transport. Not all departments act like delivering, receiving, and requesting departments, the differences of the processes each role is visible in the visualisations of the processes of Section 2.1. Some departments request more internal transport because there are products that need to be picked up. The departments that receive more than they deliver have less communication with internal transport. This is because at all the processes the products are pushed to the receiving department. Each department has a different viewing point on the current situation. It is clear to see in the answers of the employees how different they look at the situation but there are some corresponding burdens that should be considered during this research. The conclusions that can be drawn from the responses of the employees are divided into 4 subjects by the 4 questions that will answer this research question. These subjects are the current situation, the burdens, the possible improvements, and the attempts that already have been made. For the current situation, the data that is collected is implemented in the text because in the end, it will show the size of the problem. How often the problem happens and the amount of time it takes for it to be solved will also need to be considered for the size of the problem.

2.4.1 The current situation

When looking at the processes of internal transport everybody agrees to the fact that it is fine now, but changes will help to optimize the situation. The size of the importance of these changes differs for each department. Each department is also involved in a different way to the internal process and it seems that influences the size of the importance of these changes. Their perspective on the situation helps understand the situation between the departments and makes sure where to focus during the observation. In the current situation, departments give a call to

internal transport to ask for an order, but when they are finished with a cart, this is not noted to internal transport. This creates a situation where internal transport needs to be doing a verification round where the carts are empty again. During the period of this research it is quite relaxed because they have almost run out of stock. This means that the inefficiencies that are happening are not bothering anybody now, but if this continues, it will create bigger problems during the busier periods, where each farmer will bring their fruits to stock up. Because of this, employees already see these inefficiencies as problems and want them changed, because during the busier periods, each part of the cycle will deal with the problem.

The only data that is collected from the processes of internal transport are the rides of internal transport from one department to another department. This data can give value to each of the problems because the more rides are done between two departments and when there is a problem there, the larger this problem is. This data, of week 25 of 2019 till week 24 of 2020, has been reviewed and the annual routes for each department are shown in Appendix A, but there are some notes on this data. First, the weeks 26 and 27 had no data because it was a holiday. Second of all, the data of weeks 39 and 40 has no supported data, this cannot be found, which means that there is also no data on which routes were done by the trailer and which routes were done by the cart. Also, the data was the same, which seems quite interesting/impossible. Finally, this data could have some minor mistakes because the data is collected by handwritten papers that were typed into excel and minor mistakes are easily made. Keeping these things in mind, the following conclusions can be made:

- When trips are done less than 10 times a year, they are exceptional. The problems surrounding these trips do not have an impact on the bigger picture and should not be taken into consideration during this research.
- Taking the above into consideration and the data from Appendix A, there are 42 common routes each year. The visualisation of these 42 routes is done in Appendix B and C where each route is visible in the in and outcoming transportations.
- Almost half of the transport from the packing station apples to the expedition commercial are done with the trailer. This is an improvement of the past, where these drives were done by car.
- The data collecting way is not efficient, the fact that the employee of internal transport needs to write everything down and another employee needs to implement it into an excel file. The data that is collected is only half of all data.
- The carts do not have bound parking sports, but most of the time they are parked at the same spots. In Figure 18, more explanation is given on the spots at the departments and at the company area. The cask centre does have standard parking spots for the carts 5 and 6.

Figure 18 The company area of FruitMasters with all parking spots where most commonly the carts are parked.

2.4.2 The advantages of the current situation

The advantages of the current situation are different for each department because they profit from internal transport all in a different way. The advantages that the departments mentioned are put in the following table to show how each action of internal transport is positive to the other departments.

Action of internal transport	The advantage towards the departments
Communication	The departments are all updated on when a cart is dropped off at their department.
	The departments can create a planning around internal transport.
	The departments get updated on the current situation through the communication with internal transport and know what to expect.
Transportation carts	All orders are done as soon as possible.
Other	Internal transport will always prioritise the internal orders that keep the primary processes ongoing.
	When problems are noticed by internal transport, these problems will be notified towards the employees that are able to solve them.
	Agreements that are made with internal transport will be fulfilled.

Table 3 The advantages of the current situation.

2.4.3 The disadvantages of the current situation

Because each department is involved in a different way to the internal process the current situation has different disadvantages for each employee. Some problems are burdens for multiple departments. The problems are:

- There is some lost time during the loading of the trailer, when the trailer is unloading the fruit at the expedition, the employees need to wait for the trailer to be back before they can continue loading it again.
- The carts that are loaded for a department, but the department is not ready to unload them yet. This cart can be used again for other departments when it is unloaded.
- The cold store closes at 5 o'clock, which means all the fruit that is needed at the hours after closing need to be at the packing stations before 5 o'clock.
- There is no employee for the second shift of internal transport and now employees of the cask centre or of the expedition or of the department that needs the products, will drive the reserve cart. These employees already have other tasks they will not be able to do, because of this.
- Unnecessary casks are sent retour to the cask centre after not being used and ordered back when needed the next shift or day. The cask centre is doing double work. The picking of these articles, the delivery and putting it back in the cask centre are tasks that easily could have been prevented.
- The situation is still inefficient because there are docks at each packing station where the finished product can be collected, but these are not used because all the transport goes through the expedition.
- There is no insight on where the carts are and that means the employees cannot estimate what the best time is to request the carts.
- There is no insight on what tasks are done by the internal transport department and what needs to be done by the internal transport department. It is impossible to supervise the situation and the situation cannot improve.

2.4.4 The possible improvements to create the ideal situation

Each problem can be solved by different solutions. It is important to take the opinion of the employees and their thoughts on the situation into consideration. They came up with the following improvements on the current situation to create the ideal situation.

- A second trailer at the apple packing station to create a circulation process.
- A second employee of internal transport to do the night shift.
- Packing stations only request the cask that is needed.
- Packing stations only request the number of products they can manage at that time.
- Clear communication between the departments and towards the trucks from outside.
- A possibility to let the trucks from outside pick up the finished goods at the packing stations themselves.
- An overview/visualization of the situation at internal transport.
- An online application with the internal transport tasks incorporated.

2.4.5 The previous attempts for improvements

The problems are not new to FruitMasters and they have tried to improve the current situation before. They have had an employee of internal transport to do the night shift in the past and they are looking for a new employee now. They are still working on that and it will improve in the future. Currently the packing stations only request the cask that is needed for the order of which the products need to be packed. Not all cask that is sent back is unnecessary, because when cask

needs to be cleaned, is broken, or was ordered as working stock, it is not a problem when it is sent back. When it could have been prevented if the employees that order the cask were up to date in what kind of cask the soft fruit enters in, because that cask does not need to be ordered. The reason why it is not attempted to change this situation is because the origin of the problem was uncertain first and detected during this research. This research will also create a visualization of the situation at internal transport which means they are looking at that already and it is still in progress. The reason why it was not done before was because it never was a prioritization before.

There are also some improvements suggested by the employees that have a reason they have not been applied before. The reason why there is no second trailer at the apple packing station, is because the current trailer is still new. The agreements on the trailer still need to be improved and clarified, when that is done there is a possibility to look at a possible second trailer. The communication between the departments is very important. Sometimes there seems to be some miscommunication between the commercial team and planning inbound. They know that this miscommunication happens and why it happens, but they do not seem to make changes because it does not happen a lot. The fact that it does happen sometimes should be a reason to make changes in the current situation because more departments suffer from this. The reason the docks at the packing stations are not used for trucks from outside to pick up the products is because of difficulties in the organisation and the availability of the docks. They have not looked at a way to implement an online application for internal transport because it is not possible to create an online application now because the tasks are still unclear. After this research it should be possible to look at an online application.

2.5 Summary

To answer the research question: **“What actions are done, what decisions and constraints are related to them and how the actions are related to each other, in the processes of internal transport the carts interface with?”,** the following will summarize this section. The actions that internal transport does is transport the carts and trailer from department to department, arrange or do cart maintenance, fruit weighing, battery replacement and communicating with the other departments. Decisions that are made at processes the carts interface with, these are decisions by internal transport and the other departments. Decisions are done in the communication of internal transport with the other departments, delivering a cart at a department, leaving a cart at a department, and checking the situation. Even though there is communication with the other departments, at the end the employee of internal transport will make the decisions. The constraints corresponding to the actions and/or the decision are limited. The relations in transporting the carts are the same for cask centre and cold store, the transport of carts is also the same at the apple preselection, soft fruits and pear packing stations and the industry department and lastly the transport of the trailer is the same for the apple packing station and expedition. The only department that stands out is the auction because the transport towards this department is different from each other department, but this is also less than 1% of all internal transport. What all observed transporting fruit actions have in common is that they are all push systems, where the process is controlled by the sending department. The transport of the pear packing station is suggested to be a pull system, but this is not observed because there was no transport from pears from the cold store during this research. The relation between the cart maintenance of internal transport and technical services is that they have the same goal, but there

is no further relation. The only relation the fruit weighing process has is that the trucks from outside also need to follow those steps when they bring in fruit. The battery replacement of the battery of the internal transport car is only done by internal transport and because of that there is no relation within this action. The relation that exists between the communication with the other departments is that they all respond the same way as shown in Figure 11. When looking at the relations between the different actions, there is only one relation and that is that internal transport is involved in all of them and executes them all. Internal transport could be the department that initiates the communication or the department that is contacted.

The research question: **"What are SMART KPIs of the internal transport processes of FruitMasters?"** will be answered to be able to improve the current processes of internal transport. The KPIs that have been created are task assignments per day (TA), on-time delivery per day (OTD), availability per day (A) and order tracking ability per day (OTA) related. These KPIs help to analyse the processes of internal transport. The data that is collected to measure these KPIs are: the completed orders of each day, the completed delivery expectation of today, the total requested carts that could be delivered per day, the total carts requested per day, the total tracked orders of today and the total orders of today. The KPI idle time per day (IT) is also added because the reality and norm of the action problem: **"The idle time of the internal transport employees should decrease with 15%"** are measured by the idle time. The data that was collected for this was: the total idle time of each day, the amount of periods of idle time there were, percentage of the day that is idle time, the duration of the periods of idle time and the total working/research time of that day. Furthermore, there was data collected on the verification rounds where carts could be picked up and not be picked up and the occupation time of the carts that are transported to each department. A lot of transportation that is done by internal transport was done without the request of a department, which means internal transport needed to physically notice the new status of the cart. This creates delay and unawareness of internal transport. The data that was collected during this time period on these points shows that a lot of communication is missing and calls for internal transport to lose time on driving across the company area to stay up to date on the situation. The unloading and loading of the carts take too much time and occupies the carts more than is supposed to be.

The action problem of this research was to decrease the current idle time. The current amount of idle time needed to be observed first and answering the research question: **"What is the current idle time of the employees of the processes of internal transport the carts interface with?"** will help with that. The data that was collected on the idle time as described above, is further explained here. The data collected on the idle time shows that during the day there is an average of 3 hours of idle time and during the night shift this is 5 hours of idle time. This is of course quite much, but when you look at the duration of each period during the day shift this is about 13 minutes and during the night shift 40 minutes. Currently, the idle time is filled by doing nothing or talking with other employees or doing verification rounds across the company area to check up on the situation and the status of each cart.

The research question: **"What do the employees of internal transport processes the carts interface with, think of the current situation?"** contains a lot of opinions and because of that the answers need to be checked and observed if their answers are actually telling the truth or if it

is their truth. The opinion of the respondents on the internal transport is received based on the following aspects: in general their opinion on the current internal transport, the advantages and disadvantages of the current situation, how the ideal situation should look like and what attempts there have been made. The employees are okay with the current situation but do know that some changes are required to make some improvements. The advantages are most on the fact that internal transport is clear on its intentions, its planning, the situation and when the internal order will be expected. The disadvantages are very specific to each department, but what the disadvantages do have in similar is that most of them have been problems for a while and until now, they have not been fixed. In the ideal situation there are enough employees, only necessary tasks are done, the tasks that are done should be visible and the situation should be visible. Some of the problems that have existed for a while have not been attempted to be fixed before when the origin of the problems was unknown. The problems that have been attempted to be solved, but did not work, will be investigated during the research.

2.6 Conclusion

To answer the research question: **“How is the current situation of FruitMasters?”**, the aspects that need to be taken into account are the actions that are done by internal transport, the KPIs to analyse the processes of internal transport, the idle time and the opinion of the involved employees. When looking at the actions done by internal transport, the process of each action can go very differently based on what the situation looks like and how the communication is towards the other departments. In the flowcharts each regular process flow is shown but not each department uses all the actions they are supposed to do. These actions with problematic situations will be investigated further in this report. Most struggles are created by bad or no communication because it creates uncertainties on the status of the carts and creates more work that needs to be done and could be prevented by communicating correctly. Because of this, the current situation based on its actions and procedures could improve to create a more positive impact on internal transport and the other departments. The data collected on the KPIs of internal transport show that also that communication is lacking and that to optimize the processes further in the future, all orders need to be tracked. Because of this, the current situation based on the KPIs is not optimal as Section 3.1 will further explain. The idle time differs a lot for each day and night shift and the uncertainties on the orders that come in at internal transport create a situation where they always need to be present at the company area to respond quickly. This creates short but a bit much periods of idle time. Because of this, the current situation based on idle time is not great because of the reasons that create the idle times as it currently is. The current situation, based on the opinions of the employees that are involved in the processes, differs per department. The interviews that were conducted show the problems the employees are aware of and these should be checked and considered during the research. The opinion of the employees is important because they need to adapt the recommended changes and because of that they need to be taken into consideration.

3. Bottlenecks

Chapter three is focused on the idle time of the employees of internal transport. This chapter will answer the research question: **“Where could the idle time of the employees in the current situation be limited?”**. The norm and reality of the action problem are measured in the idle time of the employees that are researched. The reality of the action problem was unknown before this research because the current idle time was unknown, which means to make sure the norm is reached, the reality first needed to be measured. The idle times of the employees of internal transport have been discussed very detailed at Section 2.3 where the research question: “**What is the current idle time of the employees of the processes of internal transport the carts interface with?**” was answered. This research question is also important in this chapter and the summary on this is written in Section 2.5. The bottlenecks and the limitations are needed to make sure improvements can be made to improve the reality and to reach the norm of the action problem.

3.1 Bottlenecks of internal transport

In this section the research question: **"What are the bottlenecks in the processes of internal transport the carts interface with?"** is going to be answered. A bottleneck is a problem that delays progress and processes. Looking at the places where the processes are slowed down, will show where improvements have the most positive impact. Section 2.1.1 shows some of these bottlenecks, but some of these problems were not the fault of the department that has the problems because the origin is somewhere else. Having most of the origins of the bottlenecks be somewhere out of the processes of internal transport is the reason why there was no process model used to determine the bottlenecks were. The problems that are discussed in this section will be assigned to the department that is responsible for the problem. The auction might not make a lot of use of internal transport but because it does suffer from internal transport through their hall, they are included because this problem should also be tackled.

During the interview for the research question, “**What do the employees that interface with the processes of internal transport think of the current situation?**”, the question: “**What are the disadvantages of the current situation?**”, refers to problems the employees notice and feel the need to mention. Here it is very important to keep in mind the size of the problem might not correspond to the actual size. When 90 percent of the time everything is going well, but 10 percent of the time you get annoyed by the problem, it is likely that you see the problem larger as it is. During the observation of the internal transport processes, these problems were kept in mind and it is observed how much these problems have occurred. During the observation period, there were also some problems detected that were not discussed by the employees during the interview. Below, these problems are organised per department because each department influences the internal processes, their bottlenecks also influence the internal transport. Each individual problem is discussed, explaining why it is a problem, why the problem occurs and its origin. Table 4 is created for a more clear overview on the bottlenecks, it delivers a short description on each bottleneck, specifies if the bottleneck was only notified by the employees, observed during the research or both, and assigns each of the bottlenecks to each department. The bottleneck that was only notified is probably mostly just irritations, as explained later, the bottlenecks that were only observed could also be tackled after notifying the employees but also

using other methods. The bottlenecks that were notified and observed could already been tackled before but have not been prioritized before or the origin was unknown.

Bottlenecks at internal transport	Notified, observed or both?
No employee on the trailer	Both
No employee for the second shift of internal transport	Both
No employee for the Saturday shift of internal transport	Both
Changing batteries is done inefficient	Observed
No insight on where the carts are	Both
No insight on the tasks of internal transport	Both
Bottlenecks at the apple preselection	Notified, observed or both?
Loaded carts cannot be unloaded yet	Both
The products from the cold store need to be delivered before 5 o'clock	Both
Not all products are collected from the docks at this building	Notified
No communication after finishing the tasks	Observed
Bottlenecks at the cask centre	Notified, observed or both?
Getting unnecessary cask retour	Both
Communication differs per employee	Both
Bottlenecks at the cold store	Notified, observed or both?
Not being able to drop off the carts	Both
Bottlenecks at the expedition	Notified, observed or both?
Loaded carts cannot be unloaded yet	Both
Bottlenecks at the auction	Notified, observed or both?
The internal transport delivers cask during auction hours	Both
Bottlenecks at the soft fruit & pear packing station	Notified, observed or both?
Loaded carts cannot be unloaded yet & communication differs	Both
Bottlenecks at the industry	Notified, observed or both?
Loaded carts cannot be unloaded yet & communication differs	Both
No communication after finishing the tasks	Observed
Bottlenecks at no specific department	Notified, observed or both?
It is unknown who takes over the tasks	Observed
No deadlines for internal orders	Observed

Table 4 The conducted bottlenecks of this research classified for each department.

3.1.1 Internal transport

The problems of internal transport are logically not ideal in the processes of internal transport. There are two problems this department has, that there is no employee to drive the trailer fulltime and that there is no employee for the second shift of the day. Ideally there should be 3 employees in the internal transport, but now there is only one. Now there is also no insight into where the

carts of internal transport are and what the employees are doing during the day. These are also two problems for other departments and employees when they need internal transport and/or need to supervise internal transport.

3.1.1.1 No employee on the trailer

During the research, the employees of the apple packing station and expedition need to load and unload the trailer and need to wait on the displacement of the trailer back to them, before being able to continue on it. When they did not have an extra employee for the trailer, the employee of internal transport that transported the carts also did the trailer. This is also part of the job of the employee of internal transport. When an employee takes over his job because there was not somebody assigned, this is also done by that employee. At the end of the research an employee was found and because of that this bottleneck was solved already.

Before the coronavirus, the unloading and loading was done by the employee of internal transport. This means when the situation changes back to a situation without corona, this problem will be solved because the employees of the packing station apples will not be responsible for this anymore.

3.1.1.2 No employee for the second shift of internal transport

Not having an employee for the second shift of internal transport is a problem on its own. After the morning shift, there is another employee assigned to the internal transport, but currently there is nobody hired to do the second shift of internal transport. Most of the time the team managers of the internal transport will do the evening shift. These are also employees of the expedition department, which means they will be doing other tasks at the same time and internal transport will not be as quick as during the day. At times when the internal transport is not reachable, because the employees that are assigned for it also have other tasks, the departments that need the products will drive the reserve cart. This happens at the soft fruit department sometimes, they have the reserve car in their hall which makes it easier for them.

The fact that there is no employee for the second shift of internal transport is most of the time also a problem because the employees that are engaged here have more tasks than internal transport. These employees already have other tasks they will not be able to do, because of this. This is negatively affecting their work because they need to do the tasks, they had no time to do that day, the next day. This creates an accumulation of work for these employees. This means that the origin of this problem is that there is no employee hired to do the second shift and because present employees are currently able to do it on the side there is no urgent need for a new employee. But when it gets busier, both jobs will get more tasks and it will not be able for only one person to execute all tasks and a new employee is urgent.

3.1.1.3 No employee for the Saturday shift

There is also no employee hired to do the Saturday shift of internal transport. Currently, on Saturdays it changes who will do internal transport. This could be one of the employees of the cask centre or one of team managers of internal transport that drives the cart. This means that the same origin as not having an employee for the second shift creates this problem, that no

employee is hired is to do this second shift. It is also creating the same problem because employees with other tasks are currently able to do it on the side, but this is also affecting their current job. There is no urgent need for a new employee but because it is affecting the other jobs it is a bottleneck that needs to be tackled.

3.1.1.4 Changing batteries

It has often occurred that there are not completely full batteries at the charging station. This problem most often occurs on Mondays what is an interesting concept when on Sunday all batteries have all time to be charged. There are two reasons why this might happen. The first reason might be that too many employees want to change their batteries at the same time and because there are not 22 batteries at the charging station, this means not everybody can pick up a new battery at the same time. The second reason might be that employees on Saturday do not change their batteries at the end of the day. The reason why this is such a problem is because this means that the full batteries stay at the charging station and the empty batteries stay at the forklifts and the cars and these empty batteries do not have the time to charge completely when the next full one is needed.

3.1.1.5 No insight on where the carts are

Not being able to get an insight on where the carts are results in different smaller problems that affect multiple employees. The origin of this problem is that all updates on the situation are done through communication in person or by the phone. No transportations are done in the system which means that only the employee of internal transport is up to date on the situation. The reason why this is a problem is because this also means that when this communication is missing there is completely no insight on the situation. Another reason why this is a bottleneck is because the employees of other departments that want to request carts from internal transport cannot estimate what the best time is to request the carts. This results in situations where all orders of the departments are done at the same time what delays the response time.

3.1.1.6 No insight on what tasks are done by the internal transport department and what needs to be done by the internal transport department.

The only data that is collected on the tasks that are done by internal transport is that at the end of the day, the employee will deliver a paper where all filled carts that have been transferred written on it. This data will be put into excel after that, but there is no vision on how long it took for the employee to deliver these carts, how fast his respondent time was and all of the other information that is useful to supervise him. Currently, it is impossible to supervise the situation and the situation cannot improve with this lack of data. The origin of this bottleneck is that all communication is not in a system and not enough information is collected on the processes of internal transport.

Why this is such a problem is because the team managers of internal transport have difficulties managing the employees of internal transport. The current processes can only be improved by collecting the needed information, as this research did. The only problem with this is the constant change and growth of FruitMasters, because on the long term it is not profitable to not be able to improve the processes because of lack of data collection.

3.1.2 Apple preselection department (& apple sorting and packing station)

For the internal transport department, the apple preselection department and the apple sorting and packing station are the same. The only difference it makes towards the internal transport is the person that communicates with them and the parking spot, but on paper it is the same.
The apple preselection department is one of the largest applicants of the services of internal transport. When looking at the data of week 25 of 2019 till week 24 of 2020, a total of 9432 drives are conducted and documented. Of these 9432 drives, 6760 drives were towards and from the apple preselection department. This means that 71,7% of the drives of that year were in coordination with the apple preselection department. 4573 of the 6760 drives (48,5% of the total number of drives) were from the apple preselection to another department and 2187 of the 6760 drives (23,2% of the total number of drives) were from a department towards the apple preselection. Looking at this data the conclusion can be made that problems that occur at the apple preselection have the most impact on the internal transport processes. The problems that occur at this department are that the carts that are delivered from another department cannot be processed at the preselection apples, the products from the cold store will need to be delivered before 5 o'clock and not all products are collected from the docks at this building but transported to the expedition.

3.1.2.1 Loaded carts cannot be unloaded yet

This problem occurs at different departments, this means departments have full carts, but they are not being unloaded because they are busy, or they did not notice that the cart at their department. The reason why this is a bottleneck in the processes of internal transport, is because this cart cannot be used for other departments when it is loaded.

When this happens at the preselection apple department, besides being a bottleneck for the processes of internal transport this is even worse than the other departments because the quality of the apples will decrease during the time outside. The largest problem here is that the durability of the product will decrease. This is not visible now, but every change in temperature has a negative effect on the durability of the apples. As a company that is also bad for business because customers are buying the products with a certain amount of expectation of durability. The current situation shows the amount of fluctuations in the temperature, what will decrease the durability and not fulfil the expectations of the customer.

The amount of decrease in quality depends on the weather conditions. If the temperature is hot or cold, it does not change the fact that every hour the apples are outside, the quality decreases. This is because when the weather is warm/hot, the apples will get a layer of water on the outside because they just came out of the cold store. This water creates a putrefaction process at the stem and at the blossom end of the apple. This means that mould could occur and at a long-lasting increase of the temperature, the hardness of the apple declines and hence the storage life. With pears however, it is desirable that the temperature of the pears is a bit increased, for instance up to 4 degrees Celsius, because a cold pear is extra sensitive to sorting damage, with apples this is less important and the optimal temperature is in between 2 and 4 degrees Celsius. When the weather is freezing and the apples stay outside for too long, the apples might freeze outside and defrost when they go inside. When that happens, the quality of the apples also

decreases. When it already takes 30 minutes to unload a cart, it should not be the situation that before unloading, the cart also already has been waiting outside for a while. This means that the occupation time should be equal to the unloading/loading times but that is not the situation.

The quality itself is checked on three different aspects: appearance, hardness, and sugar level. With the appearance of the apples, they look at the colour of it. The colour of the apple will stay the same as when it is picked if it is cooled. When the temperature increases for a certain amount of time, the colour will change in a negative way. The same counts for the hardness of the apple. The hardness of the apple will stay the same as when it is picked if it is cooled and once the temperature increases for a certain amount of time, the hardness decreases. This will create a not so nice texture of the apples. Last the apples are also checked on the sugar level, but this is the only factor that is not influenced by the temperature. Having these aspects of the quality of the apples checked is because it also indicates the profit that can be made off the apples.

This is also a problem because it occupies the carts of internal transport that could have been needed at other departments at that time. To underpin the size of this problem, in Appendix G is shown what the occupation time is before the cart is picked up again for each department is. The actual time it takes to unload/load a cart is +/- 30 minutes but all time that the cart stays untouched is also considered here. It needs to be taken into account that this time could have been less than stated in this appendix, but the carts were picked up again when the employee of internal transport physically noticed that the cart was ready to be picked up. It occurred sometimes that the cart was left at the industry department even when it was unloaded, but that only occurred when the cart was not needed at that time at a different location. It also occurred sometimes when a cart was left at the cold store when there was no place at the apple packing station. This is done because it is less bad for the quality of the apples to be in the shadow, under the awning than at the preselection apples in the sun.

The conclusion of this is that the termination of the refrigeration chain is never desirable and because of that it should be as short as possible for all the products.

When looking at the origin of this problem at the apple preselection, this department is responsible for the unloading of the carts. The managing of the employees should be done by the team manager. But there are more sides to this story. This means that the planning department called for the carts without good communication with the receiving department. There is communication based on the orders that are sent to the receiving departments, but it would only be good communication if the apple department communicated back. Communication comes from two sides and one-sided communication leads to complications as this example shows. When internal transport drops off the cart, they are only sometimes notified of that. Each employee has the following vision on the situation.

The team manager points out that there are only one of the five planners that prints the scan order at his office. He has tried in the past to get the scan orders from all of the planners, but he says: “It stops at a moment. I cannot keep trying for them to do their job.”. This is said after many times trying to get the printed scan orders in the past. When there was noted to him that the orders are also visible in the system, he noted that it takes another day job for him to be printing all of these

scan orders and he has no time to do so. The fact that he accepts that is not optimal, because that means the situation will not change if it is up to him.

The planners point out that everything is printed at the team managers place as far as they know. If they do not hear any comments, they expect the situation to be good. When they have an urgent scan order, they communicate with the employee of internal transport, but they admit this is not passed on to the team manager of the apple preselection. This is a small number of products and does not explain the many carts filled in front of the apple preselection. Even though this scan order does not get printed at the apple preselection department, it is in the system, which makes it visible for the team manager. Now, the course of the processes surrounding the carts at the apple preselection depends completely on the orders that are printed, or not. Because these printed orders show them the tasks that are coming, and these printed orders will always first go past the team manager. That is why they do not see the problem, but they should have communicated with the apple packing station if the orders came through. It is logical to think if you hear nothing, there are no problems but if the order did not come through there is not much to complain about.

The manager of the apple preselection and the apple packing station points out that there are 1 to 3 employees available at the apple preselection, but they have more work activities besides unloading and loading the carts. Some of the other work activities also need to be done under time constraints and that creates a situation where the carts will be left untouched. When looking at the planning of the employees that need to unload and load the carts, real planning is difficult because of the many changes during the day. The employees will just start and see what the day brings them. The priority of tasks is determined by the team manager. The employees on the forklifts are not traceable now. The only thing that is tracked are the scan orders that are scanned and in the system. The only other way to monitor the employees on the forklift is to visually look, but some employees on the forklifts are often found on different parts of the company area, doing nothing. Where the team manager is not up to date on everything, this makes it difficult to do his job. The manager was not up to date on this problem and because of that, this has not been tackled before.

Another possibility of why the carts stay untouched is because stickers need to be made, because the apples still need to be inspected by one of the inspectors. Now, when fruit comes in from FruitMasters Germany it is placed into the cold store without checking it in into the system that is used at the preselection apples. At the cold store it is checked in at the system called “Boxtel”, the preselection apples make use of the system called “Kanzi”. The reason why the system of the cold store is not the same as the system of the apple preselection is because the cold store needed a system that could communicate with the ERP system at FruitMasters Germany. The reason for this is because when the fruit of FruitMasters Germany is placed in the cold store, it is still in the system of FruitMasters Germany. There is also different fruit that needs to be inspected, but because for some reason when the inspectors were not at the cold store, the apple preselection has inspectors that will need to inspect it first, put stickers on it and then it can be unloaded. When it is replaced from the cold store to the apple preselection department, stickers on the pallets need to be made to check it also into the system of preselection apples and to label it at the same time.

Another possibility why the work is not done is because of lack of space or understaffing. When there is a lack of forklift drivers elsewhere in the process at the apple packing station, they are taken from the apple preselection. That is important because otherwise the necessary process will stop. Usually there is not really communication between departments to exchange employees on the forklifts. This results in a situation where the forklift drivers are sometimes at the company area waiting for their own tasks not being able to do tasks. In quiet periods like the period that has been observed there are less employees, but the workload fluctuates, and the help could be used at other places. The apple preselection department could use the help of forklift drivers during these days because the carts stay for a too long time at the company area. When looking at the distribution of the forklift drivers that are assigned to each department, it is interesting that all departments have 2 forklift drivers, except for the cold store that has 4 because of safety reasons and the cask center that has 1. The apple preselection department is in coordination with 71,7% of the drives of the data of week 25 of 2019 till week 24 of 2020 and is supposed to be processing all of these carts with (almost) the same amount of forklift drivers. There also used to be 4 forklift drivers at this department but when employees left, no new ones were hired.

The last situation that creates this bottleneck is when trailers from outside come in at a different time than expected, supply is up to date on that, but the apple preselection not. The reason why this is not done now is because it takes the supply department too much time / feels like too much effort. This could be added to the excel sheet that is used for the scan orders, but this is not done now, even though it would really help the situation. The fact that the tasks of unloading the trucks from outside might come at a time where the forklift drivers should unload/load the carts of internal transport, these tasks need to wait, and the trucks have priority. All these situations that are the origin of this problem will need to be tackled, which is done in Section 5.1.2.1.

When looking at this problem it might also be good to look at the departments where this does not happen. The problem does not occur at the cask centre. The cask center has its own two carts that only transport casks and one forklift driver that is assigned to the unloading/loading and prioritizes it. Not being able to unload the carts is when there are farmers picking up casks and they need to be prioritized, but when the cart is empty, it can stay at the cask centre. This means that the reason why the cask centre does not have this problem is because the internal transport does not need to pick up the empty carts and unloading/loading the carts of internal transport is prioritized by the forklift drivers. This problem does not occur at the cold store because they have 4 forklift drivers, which is enough to do all tasks and they do not put the pallets on the ground. This means that when they start loading/unloading a cart they will transport the pallets directly from location to location. They do this to prevent working double the work.

3.1.2.2 The products from the cold store need to be delivered before 5 o’clock

The cold store closes at 5 o’clock, which means all the fruit that is needed at the hours after closing need to be at the packing stations before 5 o’clock. The problem of this is that the internal transport of all products from the cold store needs to be done before 5 o’clock. This bottleneck was addressed by some employees of FruitMasters. This should not be such a huge problem when the unloading/loading is going fast, and internal transport is aware of this and able to respond fast. During the research this was not observed as such a problem even though the employees told it was, but because it did not occur during the research it is impossible to see how

this bottleneck should/could be tackled. The underpinning could have been the opinions of the employees but during this research was observed that these opinions differ a lot between different employees. This means it is hard to observe what the most objective opinion is, that is given. That is the reason why this bottleneck will not be used in Section 5.1.

3.1.2.3 Not all products are collected from the docks at this building but transported to the expedition

The situation is still inefficient because there are docks at each packing station where the finished product can be collected, but these are not used because all the transport goes through the expedition, according to one of the employees. This is a good point because it is more efficient to pick up the products at the source and not after an internal transportation. In the morning and in the evening when it is quiet the trailers do have time to pick the products directly from the packing station. But the problem is that it is not always possible to pick up the products here because it might be full here, there are only 2 docks what means that happens pretty fast, it might also be because the truck driver needs also products from the other packing stations and already needs to go to the expedition or it might be because the trailer will come a day after the products are packed which means they need to be stored at a different spot.
The origin of this problem with this is that there is not a lot of space at the apple packing station to keep the products before the trailer from outside comes when it is best for itself. This origin is unable to be tackled during this research and it is something that should be looked at in the future. When FruitMasters keep growing it might be smart to investigate the profits of expanding the space. Currently this expansion is not possible, also because there is still construction work at the company area, this bottleneck will not be used in Section 5.1.

3.1.2.4 No communication after finishing the tasks

As was written in Section 3.1.2.1, the apple preselection has difficulties with communicating. When the apple preselection is finished with unloading/loading the cart there is no communication towards the internal transport to update that employee on the situation. Because of that, this is the origin of this problem. That means that the employee of internal transport needs to be doing verification rounds to get updated on the situation. This takes a lot of time and because of that this problem should be tackled.

3.1.3 Cask centre

The cask centre is an important department because it delivers the cask that is needed at all the packing stations. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 2635 drives were towards and from the cask centre. This means that 27,9% of the drives of that year were in coordination with the cask centre. 1949 of the 2635 drives (20,7% of the total number of drives) were from the cask centre to another department which makes a lot of sense because the cask centre delivers most products to each department. 660 of the 2635 drives (7% of the total number of drives) were from a department towards the cask centre, this has probably all been cask that is not used anymore. 26 drives were internally done from the cask centre towards the cask centre, this has been cask that was stored in the cold store and sent back to the cask centre. The cask centre has its own two carts (carts 5 & 6) that are for 67,4% of the drives of the cask centre, used to bring cask towards the soft fruits and pear packing stations. For the

remaining 33,6% of the drives of the cask centre, other carts are used because the carts 5 & 6 cannot be used for the pallet crates and pallets because the balloon tyres cannot hold the weight.

3.1.3.1 Getting unnecessary retour

Unnecessary casks are sent retour to the cask centre after not being used and ordered back when needed the next shift or day. The reason why this is such a problem is because the cask centre is doing double work. The picking of these articles, the delivery and putting it back in the cask centre are tasks that easily could have been prevented.

The origin of why cask sometimes gets sent back to the cask centre is when the soft fruit is brought from the farmer in the crates called “EPS klap 13 zwart”. These crates will be used later in the process, which means less of these crates are needed. The crates that remain unused will be sent back to the cask centre. The employees that order the cask for the packing stations do not know in what kind of cask the soft fruit is arriving. The arrival of the soft fruit is not part of their work activities and because of that they have no insight on this.

3.1.3.2 Communication differs per employee

The amount of communication between the cask centre and the internal transport depends currently on the employee of the cask centre. There are employees who communicate everything with internal transport, but other employees of other shifts do not do that as well. The fact that the communication is not reliable enough to ensure the situation is clear at internal transport creates the situation where internal transport needs to be doing verification rounds to get an insight on the situation. This is problematic because it takes a lot of time and the communication might even decrease because of it. When you know that the employee is going to drive by in a few minutes, it does not have extra benefits to communicate the status. The origin of this problem is that communication is easily forgotten and when they do not get addressed on it, they will not change the situation.

3.1.4 Cold store

The cold store is responsible for delivering the cooled fruits to the packing stations. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 1595 drives were towards and from the cold store. This means that 16,9% of the drives of that year were in coordination with the cold store. 1289 of the 1595 drives (13,7% of the total number of drives) were from the cold store to another department which makes a lot of sense because the cold store delivers most products to each department. 108 of the 1595 drives (1,1% of the total number of drives) were from a department towards the cold store, this is fruit that has been inspected and the quality has been evaluated, but it could not be processed any further at the packing station. 198 drives were internally done from the cold store towards the cold store or from a department temporarily put in the cold store under the name of the department itself. This happens when fruit needs to be stored but at the packing stations there is not enough room, but the cask centre could also temporarily be storing some cask at the cold store.

3.1.4.1. Not being able to drop off the carts

This bottleneck means that the cold store started earlier with an order that cannot be dropped off at the receiving department because there is no room for the cart now. This is a problem because this means that the receiving department is first busy with unloading/loading the carts. The cart that is still at the cold store first will need to wait here and after that it might even need to be waiting at the receiving department. This is not profitable for the quality of the fruit on the cart as explained at Section 3.1.2.1.

The origin of this problem is because there were too many carts at the receiving department in the first place. The receiving department is not ready to process the number of carts that is incoming. This is because there is no communication towards the receiving department on the carts that are coming. There is sometimes communication after dropping the carts at the receiving department, but that is not even always the case.

3.1.5 Expedition

The expedition receives most products from the other departments because these products are ready to be picked up by the customers. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 4254 drives were towards and from the expedition. This means that 45,1% of the drives of that year were in coordination with the expedition. 769 of the 4254 drives (8,2% of the total number of drives) were from the expedition to another department, these are products that were delivered because they were not ready to be picked up by the customers. 3465 of the 4254 drives (36,7% of the total number of drives) were from a department towards the expedition, which is logical because all products that go to the expedition are ready to be delivered to the customers that will pick them up at this department and these are a lot of products. 20 drives were internally done from the expedition towards the expedition or from the expedition temporarily put in the cold store under the name of the department itself. This happens when fruit needs to be stored at the expedition but there is not enough room.

3.1.5.1 Loaded carts cannot be unloaded yet

Just as at the apple preselection, the expedition sometimes starts later with unloading the carts of internal transport. For the same reasons this is such a huge problem at the apple preselection, it is such a huge problem at the expedition. These reasons are that it is bad for the quality of the products on the cart and the long occupation of the cart. Section 3.1.2.1 shows more details on these reasons.

The origin of the problem is just a bit different because the situation is different here. One of the origins is that the expedition did not notice the cart because there was a mistake in the communication. This could mean that there was communication, but it was not reported to the employee that needed to unload/load the cart. When communication did not completely happen, they would not notice the cart because the forklift drivers only notice the cart when they leave the department. This means that the communication is very important because that is currently the only way that both the internal transport and the expedition get to know the new status on the carts. Unawareness of the status of the carts is the only cause of this bottleneck.

3.1.6 Auction

The auction is not very involved in the processes of internal transport. There are exceptional products needed from the other departments. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, only 86 drives were towards and from the auction. This means that 0,9% of the drives of that year were in coordination with the auction. The auction appears to not influence the internal transport. The carts that are dropped off at the soft fruits/pears packing station are also dropped off at the same spot where customers can pick up the products they have bought on the auction.

3.1.6.1 The internal transport delivers cask during auction hours

On Monday, Wednesday, and Friday there are auctions done where soft fruits are sold. After the auction, the customers will come towards the soft fruit packing station where they can pick up their bought fruit. This means the entire hall is filled with cars and trucks of the customers and there is no space for the carts of internal transport to be dropped off or to pick up. This is both a problem now for internal transport because they cannot park or pick up the carts that are needed inside the hall, or only after some adjustments of the customers products. This is also difficult because at the auction it is already really crowded. The customers have priority, they should not need to move and make place for the internal transport when this cask could have been delivered earlier on the day or later. The auction department prefers the cask to be brought before 12 o'clock or after 3 o'clock. When looking at the data that was gathered on problematic transport of internal transport of week 27 of 2020 till week 30 of 2020, Appendix M shows that of the 169 drives that happened during the observation between the cask centre and the soft fruits/pears packing stations, 30 of these drives were between 12 and 3 o'clock. This means that 17,8% of the observed driver between the cask centre and the soft fruits/pears packing stations were problematic. The data of week 25 of 2019 till week 24 of 2020 shows that 1548 of the 9432 drives were between the cask centre and the soft fruits/pears packing station, which is 16,4% of all drives. This shows the size of this problem and if the customers in this hall also suffer from this problem, this should be changed.

The origin of this problem is that the soft fruits/pear packing stations do not want too much cask at their working stock because there is a limited amount of space for that. When they do not have the cask that is needed, it needs to be brought to them because otherwise the essential process of the packing stations needs to stop, which is just not an option.

3.1.7 Soft fruit & Pear packing station

The soft fruit and pear packing station have the same reception area and because of that the orders are always noted down under the soft fruits packing station, by the current employee of internal transport. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 2419 drives were towards and from the soft fruits/pears packing stations. This means that 25,6% of the drives of that year were in coordination with the soft fruits/pears packing station. 572 of the 2419 drives (6,1% of the total number of drives) were from the soft fruits/pears packing station to another department. 1836 of the 2419 drives (19,5% of the total number of drives) were from a department towards the soft fruits/pears packing station, which is logical because most of the internal transport towards these departments is cask. 11 drives were internally done from the

department towards the same department or temporarily put in the cold store under the name of the department itself. This happens when fruit needs to be stored at the cold store when there is not enough room.

3.1.7.1 Loaded carts cannot be unloaded yet & communication differs

The problem also occurs at the soft fruits packing station department. The processes surrounding the soft fruits packing station department is already different than at the apples and pear packing stations. During this research there were no pears delivered. The soft fruit is delivered in the car/trailers of the farmers and customers pick it up in their own car/trailer. This process is now in the same hall as where the internal transport delivers the cask of the cask centre. It is a bit unorganized because the cars/trailers that come from outside are just placed where there is place. This creates a difficult situation for the internal transport where there is limited space. Beside the limited space during the auction hours, the forklift drivers take too long to start unloading/loading the carts.

The origin of the problem where the carts are occupied for too long is created by the lack of communication sometimes. It is the same problem as at the cask centre described in Section 3.1.3.2. The amount of communication between the cask centre and the internal transport depends currently on the employee of the cask centre. There are employees who communicate everything with internal transport, but other employees of other shifts do not do that as well. The fact that the communication is not reliable enough to ensure the situation is clear at internal transport creates the situation where internal transport needs to be doing verification rounds to get an insight on the situation.

3.1.8 Industry

The industry department takes care of all the industry fruit that were selected from the preselection apples and at the pears packing station. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 1084 drives were towards and from industry. This means that 11,5% of the drives of that year were in coordination with industry. 77 of the 1084 drives (0,8% of the total number of drives) were from the industry to another department, these drives were mostly back to the pear packing station and the apple preselection. 990 of the 1084 drives (10,5% of the total number of drives) were from a department towards industry, which were mostly industry apples transported from the apple preselection towards industry. 17 drives were internally done from the industry towards the industry which probably meant that the products needed to change from a cold store to another cold store.

3.1.8.1 Loaded carts cannot be unloaded yet & communication differs

The problem of having loaded carts at the industry department that are not being unloaded occupies the carts of internal transport longer than is supposed to be. The preselection apple department delivers industry apples to the industry department and there are also trucks from outside. Currently, the communication between the industry and internal transport differs a lot per employee of the industry department, there is good communication or none. The reason why this is such a huge problem is because when there is no communication both departments do not know what to expect. Industry does not know when apples are delivered by internal transport and

internal transport does not know when industry has time to unload the carts. This is a problem that seems to be not fixable through communication. Industry apples are delivered when apple preselection and internal transport, but these departments do not look at the weekly planning of the trucks from outside that need to be helped by industry.

The origin of the problem of not knowing when apples are delivered by internal transport is because it is not certain because the apples of farmers and trailers from outside will go through the preselection apples. Here are the types of the apples determined and only the apples that need to be packed directly will stay in the building and go to the apple packing station. The industry apples and will be delivered to the industry department. The expedition apples will go to the expedition department. The distribution of these apples will differ each load. This means that the stream of industry apples to the department will change each time. It happens that the department is not prepared for this stream and it will take a little bit before they can be unloaded. This depends also on the number of trailers from outside the industry department, because these will be helped before the carts are unloaded. The quality of the industry apples will not really deteriorate if it is too long on the cart, but internal transport still needs to wait on the cart.

3.1.8.2 No communication after finishing the tasks

Not all the carts that are ready to be picked up at a department, are called in at the internal transport. This creates a bottleneck in the processes of internal transport because the employee of internal transport does not know for sure when a cart is ready to be picked up. He needs to drive across the company area doing a verification round to check if the carts can be picked up. The verification rounds are unnecessary for the processes of internal transport when the employee of internal transport knows the exact state of the cart. Another reason why this is a problem for the processes of internal transport is because the carts could already be picked up earlier. It is unknown for how long the carts were ready, but if the employee of internal transport is up to date on the status of the cart, he can make the decision on what to do with it according to the situation at the moment.

The origin of no communication after finishing the tasks is because the employees of industry and internal transport do not like each other. This is not something that can be changed and because of that a solution should be excluding communication.

3.1.9 No specific department

The problems that are discussed in this section are not specific to one department because it is something that happens in different sizes at most of the departments that are involved in this research.

3.1.9.1 It is unknown who takes over tasks

The bottleneck is that it is unknown to the employees that finish a task, who will continue the process that was started here. It results in situations where processes stop halfway because the communication was not done great and now it is uncertain why is responsible for the rest of that process. The communication could improve between employees and departments.

The origin of this problem is that there is no overview on the entire situation. Now, departments do not take responsibility for employees that should be managed, because they are convinced that the employees know their job and do their job. When somebody has started on a task, they are also responsible for the transfer to the next employee.

3.1.9.2 No deadline for orders

Currently, there are orders that have no deadline given when they need to be done. This is not optimal because the orders could be done later when there is more time, there is no reason to do it now. This will only result in situations where during the day shift it might be very busy because unnecessary orders are also done and during the evening shift when it is more quiet there is nothing to do because the tasks that could have been done were already processed.

There used to be a deadline for all orders, but they do not take the time anymore to create these deadlines. When deadlines are created it is easier to work towards something and based on these deadlines you can evaluate the flow of the processes. When deadlines are not passed, what is the reason for that and when deadlines are passed you know everything is going well.

3.2 Limitation of internal transport

In this section, the research question: **“What are limitations of the processes of internal transport the carts interface with?”** will be answered. When looking at the processes of internal transport, there are limitations in three categories: equipment, people, and policy. These are internal limitations at FruitMasters and have a direct effect on the organisation (Landau, 2018). The limitations of the other departments that influence the processes and the flow of internal transport is part of the people that involve the processes of internal transport. The policy limitations are limitations because they limit the situation by unwritten statements where the employees follow through on. These limitations in the equipment, people, and policy of the processes of internal transport will be discussed on the current observed situation at FruitMasters. In Section 5.1, the changes that possibly need to be made in equipment, people and policy will be discussed.

3.2.1 Equipment

There is different equipment that is used during the processes of internal transport. Because this research is looking at all processes around the moving carts which means the unloading/loading of the carts. The way the equipment is currently used, could limit the ability of growth. If the limitations on the equipment are problematic limitations is the case, is discussed on all the different equipment.

3.2.1.1 Carts

There is a total of 10 carts at the company area of FruitMasters, but they differ on a few aspects. The carts with the numbers 1,2,3 and 4 are small carts, these carts fit a total of 12 pallet spots or 32 pallet crates. The carts with the numbers 5 & 6 are small carts with balloon tires and because of these tires these carts are only good for use of casks. These carts will switch between the cask centre and the soft fruits/pear packing station. These are also the only carts that have one closed side, to prevent rain on the casks and to prevent the wind from blowing the cask out of the cart.

Because these are also small carts, they fit a total of 12 pallet spots or 32 pallet crates. The carts with the numbers 7,8,9 and 10 are the large carts and are the best for use of the cold store products because they are the best to use for heavy products. These larger carts can fit a total of 14 pallet sports or 42 pallet crates. Cart 8 is the only cart without a hand brake, this means that this cart always needs two bricks around a wheel to work as a brake. This cart is also the only cart that does not have a rooftop, this means when fruit is on this cart, it is less protected for the weather conditions. Currently, all the carts are one for one taken for a check/reparation. Figure 19 shows cart number 9, that is filled with some pallet crates. On the back of each cart there is a different photo of fruit which makes it easy to also recognize the cart from behind. Cart 1 has an apple and a pear on the back, cart 2 has soft fruit with a cherry on the back, cart 3 has plums on the back, cart 4 has a Kanzi advertising on the back, cart 5 has pears on the back, cart 6 has strawberries on the back, cart 7 has soft fruit without a cherry on the back, cart 8 does not have a picture on the back, cart 9 has apples on the back and cart 10 has only cherries on the back. Figure 21 shows cart number 10, that is empty now. On the front of each cart the number of carts is written in a white number, except for cart 1, where the number has fallen off.

A limitation of the processes of internal transport is that there is a limit of 10 carts that can be delivered. This should not be a problem when the carts are unloaded and loaded fast, but that is not happening now. Buying more carts will not solve the problem because there is only one employee to deliver the carts at each building. Another reason why this is not solving the problem is because the fruit is not supposed to be out for a longer period of time because the quality will decrease during the time outside of the cold store (see Section 3.1). At each building there is also not more space to drop off more carts and there are not enough employees at a department to process more carts.

Figure 19 Cart number 9 filled with pallet crates.

Figure 20 Empty cart number 10

Figure 21 and 22 Carts 10, 7 and 8 with their numbers visible at the bottom. Cart number 8 has brick stones instead of the handbrake as visible in picture 22.

3.2.1.2 Electric cars

There are 2 electric cars that can do the internal transport by transporting the carts from building to building. They both run on batteries that can be charged at the charging station at the soft fruit/pear packing station. One of these electric cars is for use for the employee of internal transport during the day. The second electric car is originally a reserve car. When the soft fruits/pear packing station needs casks but the internal transport does not have time at the moment, an employee of the soft fruits/pear packing station or the cask centre will take the reserve electric car and transport the needed carts. Currently, there is no employee for the night shift and on Saturdays. This means that an employee of the cask centre will take the second electric car and do the internal transport during that time.

A limitation of the processes of internal transport is that there is a limit of 2 cars that can transport the carts with products to each department. The fact that there are only 2 electric cars should not be a problem, once the processes are aligned because there is only a limited number of carts to transport. In the past, with one employee on internal transport not being able to deliver carts occurred more occasionally. When carts are unloaded and loaded faster than the current situation, a smoother connection between the processes of internal transport and the processes of the other departments will arise and the limit of 2 electric cars will not be a problematic limitation.

Figures 23, 24 and 25 show the different sides of one of the electric cars, but the electric cars are the same.

3.2.1.3 Batteries

The cars that are used for the internal transport are electric cars, this means that they need batteries to drive across the company area. The charging station of these batteries is stored at the soft fruits/pear packing station. There are three kinds of batteries stored at the charging station. The largest batteries can be both used for the cars of internal transport as the forklifts of the employees of the other departments. These batteries are 80V 620Ah and there are always 14 of them at the charging station and 22 driving across the company area. During each day shift, the battery of the electric car of internal transport needs to be changed. The duration of the battery depends on the distance the car has travelled, but also the temperature has a lot of impact on that. When it is cold outside the duration of the battery is way less and it could need to be changed up to 3 times per shift. The batteries take 8 hours to charge.

A limitation of the processes of internal transport is that there is a limit of 14 batteries at the charging station. This is not a bad limitation on the equipment because there are more than enough batteries, if changing the batteries is done optimally. Unfortunately, there are some problems occurring with changing the batteries now which creates a situation where the batteries need to be changed more often, this will be further discussed in Section 3.1.1.4. It does take some time to renew the battery and the employee of internal transport does need to drive to the soft fruits/pear packing station to renew the battery, which needs to be considered. This is not something that can be changed because the batteries need to be recharged and changed somewhere and the location the charging station is at the moment is not a problem, even during the busy hours after the auction.

Figure 26 The battery in the electric car.

Figure 27 The charging station of all of batteries.

Figure 28 Two of the charging points and the equipment to charge the batteries.

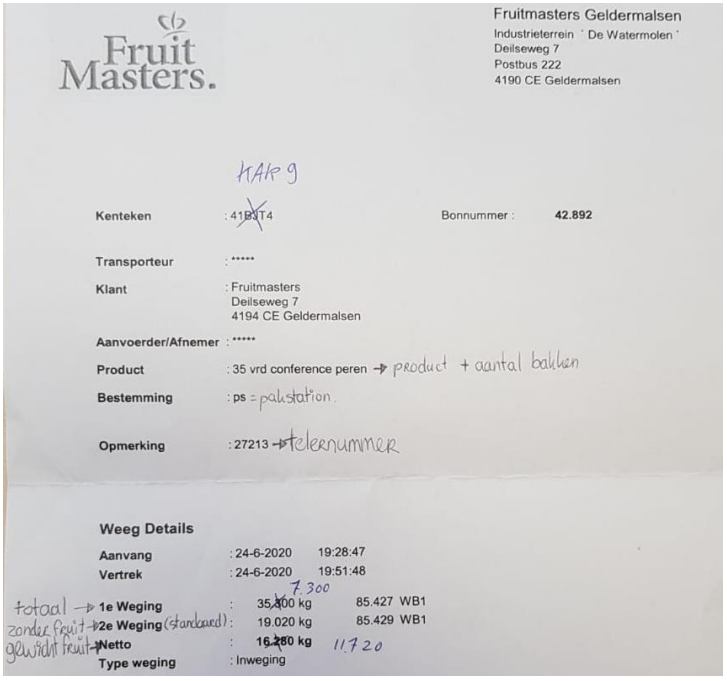
3.2.1.4 Weighbridge

This one weighbridge is for use for the chauffeurs of the trucks that bring and collect fruit to be sure how much they bring or take with them and also for internal transport that always needs to weigh the pears between the cold store and the packing station. The weighbridge is visible in Figure 29. The weighing of both the trucks and the internal transport is done in communication with the department expedition. The department expedition is responsible for collecting the data on the type of product, the number of boxes of this product, the farmer number (this is written on the sticker on the boxes), the number of the cart and the total weight of that cart. The weight of each cart does not differ each time and because of that the empty cart has a standard weight. Carts 1,2,3 and 4 are 6440 kg neat, carts 7,9 and 10 are 7300 kg neat and cart 8 is 8620 kg neat. When the reserve car is used to do this weighing, the weight of each cart will increase about 220 kg neat, but this does not happen very often. The trucks from outside do need to weigh their current zero position, because they might know the weight of their truck, but it changes depending on the amount of fuel that is in the truck. Figure 30 shows the Dutch instruction sign that explains that, and the expedition department will make it clear to the international chauffeurs. To officially

complete this process and for administration, the paper of Figure 31 is created. This paper contains all the information that is needed and concerns the situation. More detailed information on this process will be provided in Section 2.1.1.

A limitation of the processes of internal transport is that there is a limit of 1 weighbridge and the employee of internal transport needs to get in the lane when it is busy with trucks from outside. During the period of my research FruitMasters was almost out of pears because the new season of fruit will start at the beginning of September. This means that I did miss to see this part of the internal transport process but communicating with the employees of internal transport did really help create a clear understanding of this situation. Now there is no adjustment between arrival of the trucks from outside and the internal transport. The fact that it is very difficult to estimate when a truck arrives at FruitMasters does not help the situation but because during this research it was not possible to observe the process of internal transport weighing the fruit makes it more difficult to find the problems and solutions. The fact that there is only 1 weighbridge is a limitation that influences the internal process of transporting pears a lot. Improvements that can be made need to be researched when this occurs.

Figure 29 and 30 The weighbridge at the back of the company area with the Dutch instruction signs, the Dutch instruction sign that tells the trucks to weigh their empty truck beforehand.


Fruit Masters.

Fruitmasters Geldermalsen
Industrieterrein 'De Watermolen'
Deilseweg 7
Postbus 222
4190 CE Geldermalsen

HAP 9

Kenteken : 41[illegible]T4 Bonnummer : 42.892

Transporteur : *****

Klant : Fruitmasters
Deilseweg 7
4194 CE Geldermalsen

Aanvoerder/Afnemer : *****

Product : 35 vrd conference peren → product + aantal bakken

Bestemming : ps = palstation

Opmerking : 27213 → telernummer

Weeg Details

Aanvang : 24-6-2020 19:28:47
Vertrek : 24-6-2020 19:51:48

7.300
totaal → 1e Weging : 35.300 kg 85.427 WB1
zonder fruit → 2e Weging (standaard) : 19.020 kg 85.429 WB1
gewicht fruit → Netto : 16.280 kg 11.720
Type weging : Inweging

Figure 31 The weigh paper containing all the needed information on the incoming or outgoing fruits.

3.2.1.5 Air compressor

The air compressor is currently placed at the frontside of the cold store department, see Figure 32. This spot is easily reachable for the internal transport employees and this spot is not burdened by the carts and trucks under the roof of the cold store because the tires can be inflated at the front side of the cold store. The loose part with the air gauge is usually in the internal transport car to prevent people from outside taking it because this component was taken in the past when forgotten at the air compressor. Each cart should be checked on its tire pressure each week because it is to improve the durability of the material and is profitable for the transport of the products. Figure 33 shows the plastic-coated paper that is on the inside of the car of internal transport that shows the desired tire pressure because this is different for each cart. This paper is in Dutch because the employees that work at the internal transport are all Dutch.

Cart 8 is the only cart of which the tire pressure cannot be checked and adjusted by the employee of internal transport, but an employee of the technical services needs to do that because of the different connection. The instruction to put the loose cart on the handbrake is also written on this paper, but this should be clear to the employee of internal transport. It does happen sometimes it is forgotten, which creates dangerous situations.

Figure 32 The part of the air compressor that is visible from the outside.

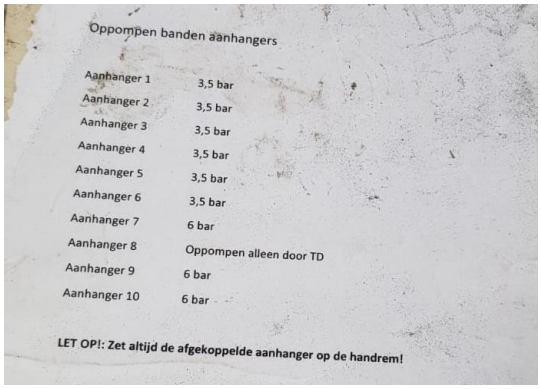


Figure 33 The list of desired tire pressure for each cart.

A limitation of the processes of internal transport is that there is a limit of 1 air compressor and cart number 8 needs to be checked and adjusted by an employee of the technical services. The fact that there is only one air compressor is not a problematic limitation because only one employee of internal transport needs to make use of this which means it is always available when needed. Each cart needs to be weekly checked on their tire pressure, which means checking 2 carts per day is enough and this makes it a small-time consuming task and done when there is time left to do so. The fact that cart 8 needs to be done by the technical services is a small limitation because there is not always enough space in front of the technical services to park the cart and drop it off and the technical services do need to have time to do so.

3.2.1.6 terminal trailer

The terminal trailer is also part of the internal transport. Ideally, a second employee would be on the terminal trailer during the dayshift. The terminal trailer is most for use between the apple

packing station and the expedition department. When a second employee is responsible for driving, unloading, and loading the terminal trailer a closed loop will arise which is profitable for the situation. There are moments where the trailer is used for different transportation where a large batch is easier transported by the trailer instead of the carts. Currently the transportation is done by the employee of internal transport or its team manager. When the employee of internal transport is transporting the terminal trailer, the unloading and loading is done by the department where the products are picked up or delivered to. When the team manager is transporting the terminal trailer, the unloading and loading is also done by him.

A limitation of the processes of internal transport is that there is a limit of 1 terminal trailer. This is not a problematic limitation because this terminal trailer is relatively new, since September 2019, and FruitMasters is still looking at its advantages. The data of the internal transport that was received was from week 25 of 2019 till week 24 of 2020, where 9432 drives took place. The terminal trailer is present since week 37 of 2019 and of the 7491 drives that took place between week 37 of 2019 and week 24 of 2020, 1745 drives were done by the terminal trailer. This means that 23,3% of the drives of these 39 weeks were done by the terminal trailer. Using the terminal trailer has its advantages and disadvantages that need to be considered. The fact that the terminal trailer fits 26 pallets, but 24 are always loaded because that is easier with the forklift, is one of the largest profits.

Figure 34 The terminal trailer of the internal transport of FruitMasters.

Figure 35 The terminal trailer at one of the two docks of the apple packing station.

Figure 36 The terminal trailer at one of the docks of the expedition.

3.2.1.7 Forklifts at the departments

Internal transport transports carts across the company area to departments that need the products that are being transported on these carts. The carts are unloaded and loaded by employees on the forklifts as you see one in Figure 37. There are two types of these forklifts, one type has 1 fork and the other type has 2 forks. The two fork forklifts are of course way faster in unloading/loading the carts but the problem with it is that it is also a larger forklift which makes it not possible to also drive into the packing stations. The two fork forklift trucks are used at the cask centre and for the crates of the farmers at the company area. These two fork forklift trucks make use of the same batteries as the car of internal transport. There are a lot of one fork forklift trucks at FruitMasters but the departments that are involved have on average 2 employees working on unloading/loading the carts. Except for the cold store, they have 4 because of safety reasons. The cask centre also does not have 2 employees, they have 1 because unloading/loading the carts is a priority of this employee and during the time left there are enough other tasks to do.

Figure 37 The forklifts that are used by the forklift drivers at the packing stations.

A limitation of the processes of internal transport is that there are 2 forklift trucks/drivers for each department, except cold store that has 4 and cask centre that has 1, to do the unloading/loading of the carts. This is an interesting limitation because the workload is not as evenly distributed as the employees and that this results into problems currently visible in the data of Appendix K, this shows how long it takes for a department to finish unload/load a cart and how long the carts are occupied. In Section 3.3.2.2, more details are given on this limitation because the forklifts go hand in hand with the employees that drive them.

3.2.2 People

The people that are involved in the internal transport are also divided into the people that do internal transport and the people that are involved in the processes of internal transport. People are a limitation which can reveal itself by lack of skills, personnel, and behavioural issues or in a way where there is a shortage of people.

3.2.2.1The employees of the internal transport department.

3.2.2.1.1 employee on the day shift

Now there is only one employee of internal transport. His health determines that he is only able to do the day shift from 6:00 till 15:00. This employee is only full-time assigned to the tasks of internal transport now. When this employee is sick or is having a day off, first his team managers try to take over his tasks and when they are too busy, a forklift employee of the department expedition is called in to take over the internal transport. The tasks this employee was assigned to at that time will be done by other forklift employees when possible and otherwise done later. Currently, the job of moving the trailer between the apple packing station and the expedition is also done by this employee when possible and otherwise by one of the two team managers of internal transport.

A limitation of the processes of internal transport is that there is a limit of 1 employee during the day shift. This is not a problematic limitation because one person should be enough to drive one car across the company area. The only real limitation that only having 1 employee during the day shift is when tasks come in at the same time and one task gets prioritised more than the other. This prioritising is unavoidable because the more important tasks need to be done first or the tasks that are more time-bound need to be done first. More information on this prioritising in Section 3.3.3.

3.2.2.1.2 During the research there was no employee assigned to the terminal trailer during the day shift

Having an employee on the trailer during the day will help create a consistent flow between the apple packing station and the expedition department. Besides decreasing the workload of the other employee of internal transport, it will decrease the workload of the employees of the apple packing station and the expedition. This is because this employee will be able to take over the tasks of loading and unloading the trailer him-/herself.

A limitation of the processes of internal transport is that there was no employee assigned to the terminal trailer during the observations of the day shifts. At the end of this research they did find a new employee to drive the terminal trailer which will help the situation a lot. Having the limitation of only having one employee is a growth from the situation that has been observed which means that this limitation is a positive limitation to the internal transport.

3.2.2.1.3 No employee assigned to the night shift

Now, people with other tasks will take over the tasks of internal transport, but they are not always immediately reachable because of these other tasks. When this employee is not able to help a department in time, the employees that otherwise need to wait on the cart will get the products themself. This is not always communicated towards the employee that was asked for delivering these products. This results in a situation where the employee of soft fruits/pear packing station is getting the cart that is needed or the employee of the cask centre brings it, and the employee of internal transport will stop his other tasks to drive a round across the company area that appears unnecessary. That communication misses sometimes and does save some time and work.

A limitation of the processes of internal transport is that there is currently no employee assigned to the night shift of internal transport. Because of this limitation, communication between the employees is even more important during the night shift. The limitation of not having an employee during the night shift means there is no employee at the company area driving around and only responding to tasks that have been communicated. When the communication lacks between the employee that does the internal transport and the employee with the request, both parties suffer. More information on the created situation in 3.1 Bottlenecks of internal transport.

3.2.2.1.4 No employee assigned to the Saturdays

During the Saturdays there is no employee to do the internal transport. Now, the cold store is also closed during Saturdays. When looking at the data of week 25 of 2019 till week 24 of 2020, of these 9432 drives, 1589 drives were towards and from the cold store. Here is the internal relocation of products by internal transport also considered. This means that 16,8% of the drives of that year were in coordination with the cold store. The workload during the Saturdays is in relation to the other days less, but there is still an employee needed. Currently, an employee of the cask centre or one of the team managers of internal transport are placed here. The reason why the team managers are asked on Saturday is because they will also transport the terminal trailer besides all the carts, and the employees of the cask centre will only transport the carts. The same problem as having no employee at this night shift occur during the Saturdays.

A limitation of the processes of internal transport is that there is currently no employee assigned to the Saturdays of internal transport. For the same reasons not having an employee during the night shift, not having an employee on Saturdays is a problematic limitation. This is because a Saturday looks the same as a night shift, less internal transport.

3.2.2.2 The employees of other departments that are involved in the processes of internal transport

The limitations of the other departments that influence the processes and the flow of internal transport will be discussed here.

3.2.2.2.1 Forklift drivers of each department

Each department where carts are requested and delivered, there are forklift drivers to unload and load the carts. All the unloading/loading process is done by forklift employees, Figure 18 shows one of these forklifts. There are some forklifts that have double forks, but these forklifts are also a bit larger and cannot be used at the rest of the packing stations. The cask centre does make use of these because they have the space. The amount of forklift drivers differs for each department. In Section 2.2, there was a look at how long it takes for a department to unload and load a cart, the following conclusion is created: Usually it should take about 30 minutes of unload/load time for each department, but only the average time of the cask center is beneath that with 28 minutes. The average unload/occupation times of the other departments should decrease to create a more ideal situation at the internal transport, but also for the quality of the products that are being transported. More about the work of the forklift drivers of each department is discussed below. All aspects of their work that create the current limitations are discussed.

There are two kinds of forklifts at the company area, ones with 1 fork and ones with 2 forks. The reason why not everybody makes use of the forklifts with 2 forks is because these cannot be used at the packing stations and inside each of the buildings because these forklifts are also larger in its scope.

At the cold store department there are usually on average four forklift drivers that have the tasks to unload and load the carts. These four forklift drivers are assigned to all the other tasks of the cold store, from cleaning the refrigeration units to the unloading and loading of trucks from outside. The priority lies at the unloading and loading of the carts, when a truck from outside had reported his visit, this truck gets priority but if this visit was unexpected, the internal transport still gets prioritised. The forklift drivers get managed by a small coffee meeting in the morning where that day will be discussed, more management is not needed, they see on their own what needs to be done and have self-discipline. This means that monitoring these employees is less needed. When problems do occur, they are pointed out during these meetings. Real feedback meetings happen sporadic but are not as needed because of the small coffee meetings. The communication between internal transport and this department is good according to both departments. When a cart is requested, delivered, and loaded there is communication from both parties to update each other on the situation. When a cart is empty, this is only not communicated towards internal transport. Adding that to the situation creates an ideal situation for each department. On average this department occupies the carts about 1 hour and 3 minutes with the fastest time being 3 minutes and the slowest time being 4 hours and 59 minutes. When you look at Figure 54 in Appendix K, it is visible that most of the time, the cold store unloads/loads the carts in between 15 and 30 minutes, just as it is supposed to be. The forklift drivers of this department do their best to never put the products on the ground, when something enters the cold store it is put directly on its place to make it one flow and to prevent double work. The forklift drivers improve their work directly when needed.

At the industry department there are usually one or two forklift drivers that have the tasks to unload and load the carts. These are two employees of industry, the manager, and an employee of the industry department. Besides unloading and loading the carts, they are assigned to the tasks of loading trucks from outside with industry fruit from the cold store and managing the industry department. The manager of course does not need to manage himself and the employee has direct orders to unload the carts when they arrive at the industry department. The communication between internal transport and this department is divided. Currently, the communication between internal transport and the manager is not present, but the communication between internal transport and the other employee is good. It is tried before to improve the communication, see Section 2.4.5. On average this department occupies the carts about 1 hour and 58 minutes with the fastest time being 32 minutes and the slowest time being 7 hours and 11 minutes. Especially at the industry department it is important to remember the occupation time is the time the carts were left at this department. Internal transport leaves the cart often here because it is a central spot at the company area which is practical when the cart is needed at a department nearby. When you look at Figure 50 in Appendix K, it is visible that most of the time, the industry department unloads/loads the carts in between 30 and 45 minutes, which is still more than it should be. At this department it is very visible that the quality of the communication differs for each employee, even though it should just be part of the job.

At the cask centre there is always one forklift driver that has the tasks to unload and load the carts. There is one forklift driver during the day and one during the night shift. This forklift driver is assigned to the entrance room of the cask centre, where internal transport and farmers come to deliver and pick up casks. This means that the priority of his work is evenly spread over unloading and loading the carts of internal transport and the cars of farmers. Furthermore, he will be order picking and work on other tasks inside the cask centre, and when time is left, he will help the other forklift drivers. The management is done by the shift leaders, but the forklift drivers know what they are supposed to do and usually also do it. When everything goes right, the shift leaders will be quiet but once things go wrong, they will do something about it. The communication between internal transport and this department is okay. Some employees communicate well because they even let internal transport know when a cart is done at their department but others a bit less, because they forget to report when carts are done. On average this department occupies the carts about 1 hour and 25 minutes with the fastest time being 3 minutes and the slowest time being 8 hours and 47 minutes. Just like the industry department, at the cask department it is important to remember that the unload/load times are the same as the time the cart was left at this department. The cask centre is also the parking spot for the carts 5 & 6 when they are no more needed. When you look at Figure 47 in Appendix K, it is visible that most of the time, the cask centre unloads/loads the carts in less than 15 minutes. The cask centre profits by having one forklift driver directly for this department which helps the situation a lot. The only thing that can improve the situation here is having an employee on internal transport in the evening and on Saturdays.

At the soft fruits packing station there are usually on average three forklift drivers that have the tasks to unload and load the carts. These three forklift drivers will only pick up this work when two forklift drivers of the pear packing station are not present. The forklift drivers of the soft fruits packing station are responsible for moving the cask and products of soft fruit, this means that once they observe a task, they will pick it up and start working on it. This means that there is no real management of these forklift drivers, there is only observed if everything is in the right place and if that is the case, there is no feedback on their work. These forklift drivers do not prioritise unloading and loading the carts of internal transport, they prioritise their work based on the orders and unloading and loading the carts are not a part of that. The communication between internal transport and this department could improve on some points. They only communicate when a cart is needed, but when they pick up a cart themselves, when a cart is unloaded or loaded again and ready to be picked up, they do not communicate towards internal transport. On average this department occupies the carts about 1 hour and 24 minutes with the fastest time being 5 minutes and the slowest time being 8 hours and 46 minutes. When you look at Figure 51 in Appendix K, it is visible that most of the time, the soft fruits packing station unloads/loads the carts in between 15 minutes till 1 hour and 15 minutes. At this department, the duration of unloading/loading differs a lot, what creates this large range in which the most carts are finished. The forklift drivers of this department are good at noticing the carts of internal transport but when the two forklift drivers of the pear packing station are not present, the unloading and loading is going to be slower. They could improve more when prioritising the unloading and loading more.

At the pear packing station there are usually two forklift drivers that have the tasks to unload and load the carts of cask, one for the day shift and one for the night shift. There is also one forklift

driver to do the unloading of the pears from trucks from outside and the carts of internal transport. Their tasks are clear and once the carts of internal transport are requested, they will be unloaded immediately. The request for casks will be done around 2 hours before it is needed, but sometimes emergencies are needed immediately. The forklift drivers work independently, and they will only be approached when there is a cask shortage because they are responsible for that. When a cart is empty and ready to be picked up by internal transport, this is most of the time communicated and otherwise picked up once it is observed by the employee of internal transport. The communication could improve a bit, but when communication has been difficult for a while, it is not weird to get weakened. The carts for soft fruits and pears were during the observation period only dropped off at the same spot and because the unloading/loading of the soft fruit products is also most done by the forklift drivers of the pear packing station, and because of that the data is meant for both departments.

At the apple preselection there are usually 2 to 3 forklift drivers that have the tasks to unload and load the carts. Besides that, they are assigned to other tasks inside of the apple preselection department. The management of these tasks are done by their team manager, this means the team manager creates a to-do list for the forklift drivers without a prioritising of some tasks. Real checking on the tasks of the forklift drivers is not done. A planning should be more ideal but according to the team manager that is not possible currently because at the preselection department it is unknown what products are about to arrive. The communication between internal transport and this department is not good according to both departments. When a cart is delivered at the apple preselection this is not reported to them, when a cart is done unloading this is not reported, when a cart is directly loaded after unloading it, there is no communication towards internal transport and when it is completely loaded this is also not communicated. This creates not an ideal situation where part of the delay of the unloading and loading is because of unawareness. More details on this are already discussed in Section 3.1. On average this department occupies the carts about 1 hour and 15 minutes with the fastest time being 4 minutes and the slowest time being 5 hours and 16 minutes. Where before it was discussed that the carts were also parked at the industry and the cask centre, this is not the case at the apple preselection. This means it took the forklift drivers 5 hours and 16 minutes to unload this cart, because after 4 hours and 30 minutes another employee heard how long this cart was already untouched and addressed this to the apple preselection.

On paper the apple preselection and the apple packing station are the same, but the situation at the apple packing station is very different and independent from the apple preselection. Most of the transportation of the apple packing station is done with the terminal trailer. Usually there is 1 forklift driver that is besides doing other tasks, responsible to load the trailer. The forklift driver responds fast and takes on average exactly the 30 minutes as it is supposed to be. On average this department also takes about half an hour to unload or load the trailer when the employee of internal transport does this. The reason why the data of Appendix K shows the average occupation time is 1 hour and 40 minutes is because the apple packing station is also the parking spot for the trailer. The communication between internal transport and this department is good according to both departments. Especially when looking at the trailer that is transported in between the apple packing station and the expedition. To request a new order at internal transport the apple packing station calls, and it works well.

At the expedition there is usually one forklift driver that has the tasks to unload and load the carts, when it is busier, there are two. Besides that, they are assigned the task to pick orders and when they are done with order picking there are other tasks like loading cars or trucks from outside and unloading from farmers. The management of these tasks are done by checking on the orders that have been done by each employee. This means that there is only a small insight in their work and the supervising could improve when there is more insight. The communication between internal transport and this department is good according to both departments. On average this department occupies the carts about 1 hour and 25 minutes with the fastest time being 10 minutes and the slowest time being 7 hours and 47 minutes. This slowest time shows is a great example because the employees only started unloading the cart after 1 hour and 15 minutes, but they have not called in as empty and because of that internal transport left the cart at the expedition. The forklift drivers of this department are good at unloading the trailer and can improve their work by unloading and loading the carts. When looking at the trailer at the expedition most of the unloading is done by the employee of internal transport. When this is not done by the employee of internal transport, a forklift driver at the expedition takes over that task. When you look at Figure 52 in Appendix K, it is visible that most of the time, the expedition unloads the carts in between 15 minutes and 30 minutes. This figure also shows how constant the unloading is done at this department and that there are not a lot of extreme outliers. The outliers that are there could also be there because the trailer could also be parked at the expedition, it just does not happen very often.

At the auction there are usually no forklift drivers that have the tasks to unload and load the carts, the forklift drivers of the pear packing station usually do this. During the research there was no cart brought to the auction and because of that there is no data on how long it takes to unload/load the carts at this department. In Section 2.1.3.1, was already talked about that last year there were only 86 of the 9432 drives requested by the auction, which is less than 1% and because of that not having a forklift driver is logical.

It is a limitation towards internal transport that all departments have 2 forklift drivers, except for the cold store that has 4 and the cask center that has 1. This is a problematic limitation because the amount of orders one department needs to unload/load, needs to be done by the same number of employees that get more orders. They are expected to deliver the same work, to unload/load the carts in 30 minutes bit this is not done currently and because of that this is a problem.

3.2.2.2.2 Team managers of internal transport

There are two team managers of internal transport, they switch weekly in day and night shifts, but they always make sure one of them is working. These team managers are responsible for managing internal transport and because of that when help is needed here, they are there to help or they make sure other employees help. Currently, the team managers are only able to track the work of internal transport by the full carts that are written down.

A limitation of the processes of internal transport is that there is a limit of 2 team managers. This is not a problematic limitation because this means that there is always somebody to be the team manager at that moment and help internal transport where needed.

3.2.2.2.3 The managers of each department

Each department has its own manager, that manager is responsible for its own department. Currently there is not a lot of communication between the different departments which is a loss because they could easily learn from each other. Where one department communicates after finishing a cart towards internal transport, another department does not do that. The occasionally returning reason for not communicating properly on everything is given that communicating does not always go easy with internal transport. When this communication is done correctly it has such a positive effect on the processes of internal transport and each department that needs internal transport. The managers could communicate more with each other to improve their own situation. Each department influences the other departments, which means a smoother flow at another department will help themselves. Currently each department is their own “island” and they work around each other. This means that there is also no overview on the entire situation.

What is also a limitation here is that the managers will only check up on the forklift drivers when there are mistakes made and when no complaints are made, no controlling is needed according to them. The employees on the forklifts know what their job is, and they are responsible to do it well. The fact that the occupation time of the carts is larger than it is supposed to be, should show that the forklift drivers need to be managed a bit more. The limited management of this part of the tasks of the forklift drivers is negatively affecting the internal transportation.

The missing management on the forklift drivers that need to unload/load the carts is a limitation of the processes of internal transport. This is a problematic limitation because the communication could make sure that there are less complications, carts get occupied shorter and internal transport could get the security of being up to date on the situation. Departments could probably learn from each other on how to improve the situation because some departments are able to fulfil the expectations more than others. No communication between the departments on this is for reason also a limitation.

3.2.3 Policy

The current policy is unwritten but there are some unwritten statements according to what the internal transport follows through on. The consequences of this policy are that it limits the processes of internal transport in a positive and a negative way. The unwritten policy has different aspects that will be discussed below.

3.2.3.1 Communication with internal transport

To communicate with the employee of internal transport, the employees of the other departments need to call or address him personally. Without the communication starting from the other departments, the employee of internal transport will not deliver or pick up any carts. This will only happen when he visually observes if a cart is ready to be picked up again or calls a department for clarification if a cart is needed or ready to be picked up. Currently, it is an unwritten policy, when a department is in need for the internal transport itself, they will call the employee. Otherwise it is a choice to communicate with internal transport or not.

The limitation of the processes of internal transport is that there is not enough communication between the different departments and internal transport which creates a delay on the processes and makes the situation cluttered for internal transport. This limitation is problematic because changes need to be made to prevent this delay from happening and make it easy to stay up to date on the situation.

3.2.3.2 Prioritizing of the requests

Currently, the policy is: when you request a cart first, you will get it first. Unless some specifics were delivered as at that moment where the department is requesting the cart for another moment that day. It also occurs a cart could not be delivered when a specific cart is requested but this cart is not available now. When there are no carts available the unwritten policy applies again where the first request will be helped first unless the priority is different. The priority is first determined by the employee of internal transport and after him, the team manager will communicate if some departments need to be prioritized.

A limitation of the processes of internal transport is that there is a limit of requests that can be fulfilled. This is not a problematic limitation because there is only one employee that needs to fulfil all requests and this one employee is able to process all the requests now. When this one employee can handle the requests, it is not problematic that there is a limit of requests that can be fulfilled. It is important to keep track of the growth of the requests and if the one employee of internal transport can process all of them. When the requests cannot be processed anymore, it is important to look at the origin of why the requests are becoming too much to handle.

3.2.3.3 Limit of carts per department

The is this unwritten rule where the maximum number of carts a department can receive is three carts. Each cart that is placed extra is only placed when the employee has other tasks than internal transport. Otherwise, each cart that is placed extra is unnecessary because the three carts that were already there will need to be unloaded/loaded first. Another reason for this unwritten rule is because there is no department that has the space to receive more than three carts. Also, no department has enough employees to unload/load more than three carts. A department also can miss the order in which the carts were placed which can result in a situation where the newest carts are processed before the older carts. When this happens with the fruit it is, besides being a burden for the processes of internal transport, not good for the quality of the fruit, see Section 3.2.2.

Limiting the maximum number of carts at a department to 3 is a limitation of the processes of internal transport that has a positive impact on the processes. Putting more carts at a department when the other carts are still not done unloading/loading the work stacks up. It does not help anybody because adding extra carts also means that the carts are occupied longer and cannot be used at another department that might need it sooner.

3.2.3.4 Changing batteries

The current policy to change the batteries of the cars and the forklifts, is to change them when they need a new one. This means that the employees will only change their batteries when they

are about to use it still afterwards. When a cart is empty, but an employee is going home, he/she will not pick up the full battery so his empty battery can be charged. This limits the amount of full batteries and creates a situation where employees need to pick up not completely full batteries, this is for all 3 types of batteries. This means that both the employee of internal transport and the forklift drivers are affected by this problem but because it is not pointed out before.

Not charging batteries when you are done using the forklift or the car of internal is a limitation of the processes of internal transport because in this way the batteries are not charged when there is time to do so. This is a problematic limitation because it is logical to only switch batteries when you need a new one and it needs to become a change of habit to switch when you are done. The problem with this is also that you will be switching the batteries to help the employee with the shift after you, this means they do not profit from this change directly. Everybody needs to make this change to make it profitable for every employee.

3.3 Summary

The bottlenecks that were observed during the research, are delaying the processes of internal transport will answer the research question: "**What are the bottlenecks in the processes of internal transport the carts interface with?**". At internal transport the bottlenecks are: not having enough employees for the night and Saturday shifts, changing the batteries only when they need a new battery, not having an insight on where the carts are and what tasks are done and need to be done. At the apple preselection department the bottlenecks are: having loaded cart that cannot be unloaded yet, the products from the cold store need to be delivered before 5 o'clock, not all products are collected from the docks of the apple packing station but transported to the expedition and no communication after finishing the tasks. The cask centre has the bottlenecks: getting unnecessary retour and the communication differs per employee. The cold store has the bottleneck: not being able to drop off the carts. The expedition has the bottleneck: loaded carts cannot be unloaded yet. The auction has the bottleneck: the internal transport delivers cask during auction hours. The soft fruit and pear packing stations have the bottlenecks: loaded carts cannot be unloaded yet and communication differs per employee. The industry has the bottlenecks: loaded carts cannot be unloaded yet, communication differs per employee and no communication after finishing the tasks. The bottlenecks that were not assigned to a specific department: it is unknown who takes over tasks and no deadline for orders.

The answer to the research question: "**What is limitations of the processes of internal transport the carts interface with?**" will be conducted when Section 3.2 is summarized. The three categories in which the processes of internal transport are limited are equipment, people, and policy. The equipment that is currently used in the processes of internal transport limits the internal transport, but that does not mean this is problematic. When the processes of the other departments are adjusted to the processes of transportation and communication is clear, there is enough equipment for the observed situation during this research. When the carts do not get unloaded/loaded faster and get occupied shorter, some equipment limitations can cause trouble, but this is not the origin of the problem and because of that the origin should be tackled first before changing equipment. When looking at the employees of internal transport, the largest limitation is the shortage of employees during some shifts. When looking at the employees of other

departments that are involved in the processes of internal transport, on average there are 2 forklift drivers available to unload/load the carts, except for the cold store that has 4 and the cask centre that has 1. These employees also have other tasks and responsibilities and internal transport is not always a priority, which is problematic for internal transport. The manager of these forklift drivers should improve the management to improve the reaction time when a cart is delivered. The unwritten policy describes the statements the employees follow through on. The limited amount of communication is a problematic limitation because it creates a delay on the processes and makes the situation cluttered for internal transport. How the requests are prioritized, and the carts limited are great limitations that internal transport profits off. Only changing the batteries when you need a new one is not optimal because then the batteries are not charged up to their potential.

3.4 Conclusion

To answer the research question: **“Where could the idle time of the employees in the current situation be limited?”**, the current idle time, the bottlenecks and the limitations of the processes of internal transport should be taken into consideration. The bottlenecks at internal transport show the origin of the idle time, because when problems occur at other departments, there are inefficient processes, there is nothing else to do than wait and when problems occur at internal transport this creates also a delay on the processes. In Section 3.1 all problems that occur at the processes surrounding the carts of internal transport were discussed. Merging the bottlenecks, the conclusion that could be made is that employees are needed, communication should improve, agreements are missing, and the current situation is also lacking an overview on the situation. Solving these bottlenecks will limit the amount of idle time. The equipment, people, and policy of the processes of internal transport also make sure the processes are limited, which means this also influences the idle time. The employees of the other departments could improve their own tasks, which will also improve the processes of internal transport. When the tasks of the employees of the other departments improve, the processes of internal transport flow will run more smoothly, and the idle time will also be limited by this. Not having a written policy means that everybody follows their own unwritten rules. Making agreements to create a written policy to change inefficient habits, will also decrease the problematic idle time.

4. Literature

Chapter four is focused on the literature that can be used for this research. The research question that will be addressed during this chapter is: **"What literature is available on visualisation of processes in a supply chain that is needed for this research?"**. When the data of the current situation of FruitMasters and the idle times of the processes and their bottlenecks and limitations are collected, it might be useful to look at theories on visualisation of processes in a supply chain. What limitations of visualisation need to be considered and comparing different theories on how generally processes of internal transport are visualised, is important. The literature that underpins this theoretical framework is shown in the legend of Appendix D and the systematic literature review in Appendix N. When the choice is made how to visualise the processes, the last literature that is needed for this research is on the improvements that can be made in the readability of the visualisation to show how the visualisation should be done.

4.1 Limitation in the visualisation of processes

In this section, the research question "**What are limitations in the visualisation of processes?**" will be answered. There are different limitations when a situation is visualized. The kind of visualisation that is used also has a lot of impact on these limitations. Visualisation limitations can be classified in cognitive, emotional, and social limitations. This research will focus on the cognitive limitations the general limitations and limitations by the kind of visualisation are discussed below. The visualisation that is used for the processes of this research are flowcharts made in the program Microsoft 365 Visio. The reason why this program is used is because at other places at FruitMasters they have also started to visualise which is done in Microsoft 365 Visio. The advantage of that is that the flowcharts can be easily used in their new ERP system Dynamic 365. FruitMasters is still working on implementing this ERP system and the visualisation of this research will help them do that. This ERP system has the advantage of being able to send work assignments to the employees. When the processes are visualised, this will be a profit in the future.

The general limitations of visualisation are:

- **The simplification of data.** One of the biggest draws of visualization is its ability to take a lot of data and simplify them to more basic, understandable terms. However, it is easy to go too far with this by trying to take millions of data points and confine their conclusions to a handful of pictorial representations. This could lead to unjustified conclusions, or completely neglect certain significant modifiers that could completely change the assumptions you walk away with (Alton, 2016). This is a limitation to prevent over-complexity of data that is too time consuming to produce. When the data is not simplified the visualisation might become too complex and time consuming to produce. Estimating the right amount of data that is needed is very difficult but needed (Bresciani & Eppler, 2008).
- **The human limitations of algorithms.** Any algorithm used to reduce data to visual illustrations is based on human inputs, and human inputs can be fundamentally flawed. A human developing an algorithm may highlight different pieces of data that are "most" important to consider, and throw out other pieces entirely; this doesn't account for all

companies or all situations, especially if there are data outliers or unique situations that demand an alternative approach (Alton, 2016).

- **Reliance on visuals.** This is more of a problem with consumers than it is with developers, but it undermines the potential impact of visualization in general. When users start relying on visuals to interpret data, which they can use at-a-glance, they could easily start over-relying on this mode of input. They may take their conclusions as absolute truth, never digging deeper into the data sets responsible for producing those visuals. The general conclusions you draw from this may be generally applicable, but you should not rely completely on them (Alton, 2016). This is a limitation to prevent a company from becoming technology/template driven (Bresciani & Eppler, 2008).
- **The inevitability of visualization.** Already, there are tools available to help us understand complex data sets with visual diagrams, charts, and illustrations, and data visualization is too popular to ever go away. We are on a fast course to visualization taking over in multiple areas, and there is no real going back at this point. To some, this may not seem like a problem, but consider some of the effects—companies racing to develop visualization products, and consumers only seeking products that offer visualization. These effects may feed into user overreliance on visuals and compound the limitations of human errors in algorithm development (Alton, 2016).

The only limitation of visualisation in the flowchart in Microsoft 365 Visio is that the desktop versions of Visio only receive updates every few years. The other limitations that Microsoft 365 Visio might have for other companies are not applicable to FruitMasters because all computers are working on Windows operating systems and when Visio is used on OneDrive collaborative editing can be used (Wright, 2015). Of course, Microsoft 365 Visio also has the same general limitations that occur when processes are visualised, but these limitations are there with each program that visualises processes.

4.2 Visualising the processes of internal transport

In this section, the research question: **“How are the processes of internal transport visualised?”** will be answered. The corresponding knowledge goal: “To understand the visualisation of the processes of internal transport”. The systematic literature review is added to Appendix N. The chosen core problem is **the processes around the moving carts have not been visualised**. The reason for this systematic literature review was, before being able to solve the core problem I needed to get some knowledge on visualisation.

A systematic literature review for this project is written in Appendix N. The content of the papers can contribute to this bachelor thesis. The requirements of visualising processes from the papers will be used during my visualisation. From this literature review we can conclude there are different ways to visualise the processes of internal transport. Each business process modelling technique has different advantages and disadvantages. First, when you start to visualise a process you need to determine what the strategy is. Second you need to collect all the activities that are done, all transitions and decisions that are made, and the conditions that need to be fulfilled before the decisions. The chosen core problem is: **The processes around the moving carts have not been visualised**. Before being able to solve this problem, I need to get some knowledge on

visualisation and because of that the knowledge goal of this systematic literature review was: "**To understand the visualisation of the processes of internal transport**". The corresponding research question was: "**How are the processes of internal transport visualised?**". All reviewed papers have a different way to relate to the core problem.

The first paper "Visualisation of (Distributed) Process Execution based on Extended BPMN*" (Momotko & Nowicki, 2003), talks about the requirements that are needed to execute the visualisation of a distributed process. The first requirement requires a process definition and process executions. The second requirement requires process instance information. The third requirement requires different visualisation of elements that have been, can be and will not be executed. The fourth requirement requires the current state of a process/activity instance. The fifth requirement requires process/activity delay indication. The sixth requirement requires activity criticality indication. The seventh requirement requires multiple activity performers. The eight requirement requires multiple activity instantiation. The ninth requirement requires loops in the processes.

The second paper "Smart Shopper: An Agent-Based Web-Mining Approach to Internet Shopping" (Liu & You, 2003), talks about the use of a data warehouse schema to integrate multiple objects features for visual information representation. A major advantage of using a data warehouse is being able to store data at different levels of granularity along different dimensions such as data type, time, etc. Thus, data warehouse systems require a lot of maintenance and management and because of that, this visualisation is not a good option for this bachelor thesis.

The third paper "Optimal Process Mining for Large and Complex Event Logs" (Prodel, Augusto, Jouaneton, Lamarsalle, & Xie, 2018), talks about a process model (PsM), an abstracted and simplified way to represent a real process. An advantage of this notation is to be simple to represent and straightforward to interpret. Nodes represent tasks in the process. Arcs, connecting the nodes, represent ordering relations upon the tasks. No theoretical knowledge is required to read a model, unlike Petri nets and BPMN. Models with higher complexity necessarily have higher replay ability as they allow for more traces. Hence, maximizing replay ability and minimizing the complexity are contradictory objectives.

The fourth paper "Unleashing the Effectiveness of Process-Oriented Information Systems: Problem Analysis, Critical Success Factors, and Implications" (Mutschler, Reichert, & Bumiller, 2008), talks about the entire lifecycle of a process, from de design, to the implementation, to process enactment, to process diagnosis. They show how to visualise the process that happens when answering a research question and everything that needs to be considered. For my research it might be helpful to visualise the research questions in the same way.

The fifth paper "Business Process Analysis and Optimization: Beyond Reengineering" (Vergidis, Tiwari, & Majeed, 2008), talks about the different classification of business process modelling techniques. The techniques that is used for the business process modelling of this research were plain graphical representations (flowcharts) that were initially developed for software specification. These simplistic diagrams depicted a business process, but most of the time without using a standard notation. These techniques are useful for fast and informal process representation, but

they lack the necessary semantics to support more complex and standardized constructs. Although visual inspection of diagrams tends to be highly subjective, these diagrams are still widely used in business process environments. The unbeatable advantage to visually depict the flow of a business process in a way that no technical expertise is required is very appealing to the business analysts. Even advanced and more sophisticated modelling techniques are influenced by this perspective, and they support apart from formal semantics and a visual representation of the modelled processes.

The sixth paper “Modelling Strategic Decisions Using Activity Diagrams to Consider the Contribution of Dynamic Planning in the Profitability of Projects Under Uncertainty” (García-Fernández & Garijo, 2010), talks about the specific business process modelling technique that will be useful in this research, called the unified modelling language (UML). To create UML activity diagrams, first a strategy needs to be defined as a concrete plan of action. Second, all the activities need to be gathered if they are parallel with other activities and together with all the possible transitions or decisions that are made. Conditions that need to be fulfilled before the decision needs to be considered. Last, time needs to be considered when implementing the activity diagram of a strategy in a simulation environment.

4.3 Literature on visualisation

This section investigates in how to make the visualisation of the flowchart of the processes surrounding the carts easily readable. In this section the research question: **“What improves the readability of the visualisation of the processes surrounding the carts?”** is answered. Flowcharts can be effective and efficient to visualise processes, but they can also be confusing and even misleading if not properly prepared. The following five steps make sure that the flowcharts of this research will be clear and useful for FruitMasters (Stannard, 2020).

The first step is to use consistent design elements. The elements in a flowchart should be clear and giving each element a different use clarifies. The program that is used to visualize the processes in this research is Visio by Microsoft Office. Visio by Microsoft Office has its own categorisation of shapes for basic flowcharts. Making use of Visio will make it easier for FruitMasters to implement the processes in the ERP system they are working on setting up. This ERP software will be used to support the processes inside FruitMasters. Appendix D shows the legend of all basic flowchart shapes/elements that were used for the visualisation of the internal transport processes in this research. Besides basic flowchart shapes, function flowchart lanes were used. These function flowchart lanes create a layout environment that contains all the people that are involved in the process. All actions that are performed are written down at the department that performs the action. Extra information that needs to be added to the process is added outside of this layout. Most elements are obvious, but this clarification will help with following the flowchart easier. The colours that were used will also help making process step clearer, because when actions are problematic, they are coloured red in this research to emphasise the problem.

The second step is to keep everything on one page. When a diagram becomes too large to fit on a page, it is advisable to divide into multiple charts and connect them with hyperlinks. Breaking a large flowchart into a collection of smaller ones, makes the flowchart effective and efficient.

Through the use of hyperlinks in flowcharts, a flowchart will become a summary of detailed steps or sub-processes (Stannard, 2020). In the flowcharts of this research this is done through adding the start/end element and referring to another process with the use of numbers. This element will show the reader that a sub-process happens inside this process and the flowchart with the number and description will show that sub-process.

The third step is to let the data flow from left to right and from the top to the bottom. Structuring a flowchart form left to right makes the information easier to read and comprehend. In the flowcharts of this research that was the base of the flow of each flowchart. It does appear sometimes that not following this step to make sure the flowchart is kept clear and easy was more important.

The fourth step is to make decision symbols organised. It might be difficult to follow the decision symbols because this symbol breaks the left-to-right rule. But as explained in step one, the elements should be clarified. Using regular action symbols also as decision symbols will only confuse the reader.

The fifth step is to place return lines under the flow diagram. Since the reader naturally reads text from the top of the page down, it is logical that return lines should be placed under the flowchart rather than above (Stannard, 2020).

The fact that FruitMasters currently has no visualisations on the internal transport processes means that the only visualisation that is made on the current situation are the visualisations of Section 2.1.1. The visualisations here are done based on the processes that were observed during this research. When the processes are visualised with the recommended changes in Chapter 6, the same shapes and layout is used.

4.4 Summary

To answer the research question: “**What are limitations in the visualisation of processes?**” the following will summarize this section. The first general limitation of visualisation is the simplification of data, because the data that is processed into the visualisation needs to be selected, just what is needed. The second limitation is the human limitations of algorithms, any algorithm used to reduce data to visual illustrations is based on human inputs, and human inputs can be flawed. The third limitation is reliance on visuals, because of the first two limitations, making conclusions based on the visuals may be generally applicable but you should not completely rely on them. The fourth limitation is the inevitability of visualization, because of the user friendliness and the clarification it gives to a process, visualisation is inevitable. These limitations always occur at process visualisation. The process visualisation of this research is done in the program Microsoft 365 Visio. The only extra limitation that is added because of the use of this program is that the desktop versions of Visio only receive updates every few years.

Answering the research question: “**How are the processes of internal transport visualised?**” will help understand the reasoning behind the visualisation of the recommended changes. There are multiple literature papers that create all different aspects of how processes of internal transport are visualised. This literature shows requirements that are needed to be executed for the visualisation of the processes. These requirements are the basis of information collection that

is needed for the visualisations. For the visualisation of the processes a process model is chosen. An advantage of this notation is to be simple in representing and it is straightforward to interpret. The specific process model that was chosen was the use of flowcharts. The unbeatable advantage to visually depict the flow of a business process in a way that no technical expertise is required is very appealing to the business analysts.

The research question: **“What improves the readability of the visualisation of the processes surrounding the carts?”** explains the reason for the visualisation as it is done in Section 2.1. The visualisation makes use of consistent design elements for the actions, decisions, start/end, connecting line, sub-action, used databases, documents, data and device clarification. The visualisations show sub-processes through hyperlinks, the data flows from left to right from top to bottom, the decision symbols are made organised and last the lines return under the flow diagram.

4.5 Conclusion

To answer the research question: **“What literature is available on visualisation of processes in a supply chain that is needed for this research?”**, the information from the other three research questions that were answered in this section will answer this question, because it contains all needed literature. During this research it is very effective to use flowcharts to visualise the processes surrounding the carts. Flowcharts are a process model, what is an abstracted and simplified way to represent a real process. An advantage of this notation is to be simple to represent and straightforward to interpret. No theoretical knowledge is required to read a model. Besides knowing what the best way is to visualise the processes, it is important to know the limitations of it. It seems that more limitations come paired with the fact that the processes are being visualised at all and not with the program Microsoft 365 Visio. With the advantages outweighing the disadvantages, this is not a problem, but always important to keep in mind. The literature on how processes of internal transport are visualised also shows that the flowcharts created in Microsoft 365 Visio is optimal and a very effective way to visualise the processes. The way processes are currently being visualised is organised, user-friendly and can be directly implemented in their new ERP system. When talking about the literature that is available on improving the readability of the visualisations, all steps that need to be done during the visualisation will create clear visualisations.

5. Solution approach

Chapter five is focused on the development of the improvement plan. This chapter will answer the research question: **“What solutions can be implemented in the internal transport of FruitMasters?”**. When the current situation is documented and the bottlenecks are detected, solutions to improve the reality can be determined. The limitations of the processes and the vision of the employees of FruitMasters need to be considered when creating a solution.

5.1 Recommended changes

When looking at Section 3.1, all problems that occur are discussed. Taking these problems into account, this section will answer the research question: **“What changes need to be made to improve the current situation of FruitMasters?”**. To tackle the bottlenecks the following process is done for each bottleneck. It started with using the 5 Whys technique, which is an in-depth problem-solving tool where after describing the problem you keep asking why this problem is occurring. Keep asking “Why?” at each step until reaching to the root cause. The root cause is the origin of the bottleneck that provides a starting point for resolving the issue (Mugridge, Swift, & Jackson, 2016). How the bottleneck should be tackled depends on the type of bottleneck it is. Most bottlenecks occur because of one of two root causes: processes or people. The bottlenecks that occurs because of poor communication, unclear prioritization and/or lack of integration should be solved through boosting the speed of the information moving through the company. Making sure the assignments and lines of reporting are clear is also important here. When bottlenecks occur because of low capacity there are two choices: invest in long-term recruiting or outsourcing (Joshi, 2018). Each bottleneck will separately be discussed, with the recommended changes that could be implemented and the knowledge that underpins the positive impact of these changes.

5.1.1 Short term changes

5.1.1.1 Internal transport

Hiring an employee for the transportation of the terminal trailer during the day shift has already solved the first bottleneck of internal transport and because of that it will not be discussed here.

5.1.1.1.1 No employee for the second shift of internal transport

This bottleneck has a quick fix because there is a whole job that needs to be done and hiring a new employee will solve the problem. This will solve the problem because the employees that were currently assigned to this second shift can return focusing on their own job again. The problem was the extra workload for these employees and the new employee can remove the extra workload. This employee might even help more, because as you see in Section 2.3, the employee of internal transport will have time to help elsewhere if the situation is as it was during this research of course.

5.1.1.1.2 No employee for the Saturday shift

This bottleneck also has a quick fix because just as for the second shift, hiring a new employee will solve the problem to focus on the internal transport on Saturdays. This might be an employee

working on the internal transportation during another part of the week, but that is up to FruitMasters to decide.

5.1.1.1.3 Changing batteries

The current unwritten policy is to change the batteries when they are needed, see Section 3.2.3. When all batteries are empty on Saturday, there are not enough full batteries on Monday to pick up. When all batteries are changed after a shift is finished, more batteries can be charged and the problem of not having enough full batteries will not occur again. The managing should be done by the departments the employees work for, because the employees currently do not take responsibility to make changes. Another way to solve the problem for internal transport is to reserve one of the batteries at the charging station for internal transport, but charging batteries at the end of the shift will immediately solve the problem for forklift drives which makes it more efficient.

5.1.1.2 Cask centre

5.1.1.2.1 Getting unnecessary retour

The problem of the unnecessary retour is that the employees that order the cask for the packing stations, currently have no insight in what kind of cask the soft fruit is arriving in. This should be changed because if there is insight in what kind of cask the soft fruit is arriving in, the cask centre does not need to do double work. This means that the change that is recommended to be made, that the employees that request the cask at the cask centre need to consider what kind of cask the soft fruit arrives in. This means that they should get insight on this.

5.1.1.3 Auction

5.1.1.3.1 The internal transport delivers cask during auction hours

The problem is that currently the carts of the cask need to be brought to the soft fruits/pears packing station where also the cars and trucks from the customers are after the auction. This problem could be solved by changing the location. The best part is that there are currently constructions at FruitMasters where they are creating a new spot to drop the carts for the cask of the packing stations. This means that it is okay to ask for Fust during the auction hours because the auction will not suffer from it, when the location is changed.

5.1.1.4 No specific department

5.1.1.4.1 It is unknown who takes over tasks

To create an overview on the entire situation where all tasks are in the system, it could become possible to see who was the last to work on a task. When the transfer to the next employee is not done right it is clear in the system who should be talked to, to ask where the misunderstanding was created by. This means that when somebody gets a task to put some products somewhere at the company area, this employee also knows who will pick these products up. That is because if there seems to be nobody to continue this task, somebody needs to be assigned and this should be communicated to their team manager. When all tasks are in the system it will also make the job of the team managers to supervise the employees way easier.

5.1.1.4.2 No deadline for orders

When orders are placed at internal transport in the system as was suggested before, see Section 5.1.1.5, there should be a possibility to plan orders into the future. What that is an option, the option to add a deadline to an order should also become a feature. That will solve this bottleneck and help the manager manage their employees easier. What is also profitable to the situation when deadlines are added to the internal orders, internal transport will be able to create a clear planning. Internal transport was used to use a to-do list as the daily planning but having deadline of the internal orders gives internal transport the possibility to create a correct planning. When this planning is created the other departments can contact internal transport to get this planning and be able to utilise it to determine new deadlines for the internal orders that did not have deadlines before. These deadlines could be adjusted to the idle time of internal transport. This will directly reduce the idle time of internal transport and spread the workload of internal transport. Spreading the workload of a shift assures more that the internal orders will be delivered on time when the departments need them. When deadlines are placed, the receiving department is also a bit more able to predict when the carts are delivered and can assign the forklift drivers to unload and load the delivered cart after delivery.

5.1.2 Long term changes

5.1.2.1 Internal transport

5.1.2.1.1 No insight on where the carts are

The changes that are recommended to create a clear insight on where the carts are is to implement the communication in the system. This could be done by also taking over a part of the routine the forklift drivers currently have when they unload/load a cart. When a forklift driver unloads or loads a cart, the products are changing from their location which means the cart itself also needs to be scanned. When the carts are also scanned to change the status of the cart, it is clear to each employee that wants an update on that cart what the status is. This means that the process of the scanning starts at internal transport, the employee will pick up a cart and scan it as picked up and this should change the status in the system into “picked up”. The employee that requested the cart knows that the cart is coming. When the cart is delivered at a department it should be scanned again and the status should change into “dropped off”. The receiving department should receive a notification on this to become aware of the situation and can start on unloading/loading the cart. When this department starts in that task, they should scan the cart and the status should change into “in progress”. This should be a sign for the receiving department that there is going to be a cart in approximately half an hour at their department to be processed. This also means that the receiving department has about half an hour to assign the forklift driver that has time or needs to create time, they should get a notification about this. When the cart is done at the department with unloading/loading it should be scanned again and the status should change into “done”. Internal transport is then ready to take the cart to another department or to remove it and put it onto the company area, a notification should have been sent about this. When it is brought to another department, the same process will follow as described above. When it is brought to the company area and the cart is dropped off internal transport should scan it again and the status should be “done”. When each status change is made it is very important that the location is also added to know what department just executed that task. When communicating with internal transport is difficult or easily forgotten, as it appears to be, adding the tasks of

scanning the cart after the status has changed is a quick task that clears the process a lot and will solve the problem and remove the bottleneck at various departments, as will be discussed at multiple other departments. How this should be visualised is shown in Appendix O.

5.1.2.1.2 No insight on what tasks are done by the internal transport department and what needs to be done by the internal transport department

This research already helped a bit with this bottleneck because knowing what internal transport does in certain situations already helps to get a clear understanding on what internal transport does. The only thing that is missing is that this research does not give insight on when these tasks are done and how they are executed. The change that is recommended at Section 5.2.1.3, will also give the team managed insight on what internal transport currently is doing. The system should show when tasks are executed by internal transport and what tasks were executed. The tasks that are not related to the transport of the carts could also be added to the system. When cart maintenance is done, the location of the air compressor should be in the system and changing the status to “in progress” at this location shows that that task is done. When fruit weighing is done, the location of the weighbridge should be in the system and changing the status to “in progress” at this location should show that that task is done. Battery replacement does not involve any carts, but it is a small task that is done and could be done in between the tasks that are in the system. When the batteries are changed at the end of each shift, as suggested at Section 5.1.1.3, the battery changing is done routinely and could be a bit more tracked. When it is cold and more batteries need to be changed this is not valid, but during the observation, on average it took 10 minutes to change the batteries which is not a lot of time that cannot be tracked during the day. Less communication between the departments is needed only requesting a cart, which should also be added to the system. What should be added here is the time these requests are needed. When the requests are in the system other departments can also see what tasks are coming for internal transport and keep that into consideration. When these requests are done, an order could be attached to it to also be profitable for the department that gets the cart afterwards because they could see at what time the cart is planned on arriving at their department. Communication in person or through the phone might still be needed sometimes, but you will never lose that and that is no problem. How this should be visualised is shown in Appendix O.

The changes that are recommended above will also make sure that the data that is needed to track all processes is collected. This means that the processes can be improved at places that were not detected during this research. When the company growths, the processes can adapt to the ideal situation.

5.1.2.2 Apple preselection department (& apple sorting and packing station)

5.1.2.2.1 Loaded carts cannot be unloaded yet

This bottleneck has at the apple preselection multiple origins that need to be tackled. The first origin that was described in Section 3.1.2.1, was that there are communication problems. The fact that all employees from the different departments have a different view on this situation shows enough that the communication is not good as it currently is. The changes that were recommended in Section 5.2.1.5 put the statuses into the system will help the apple preselection, because the communication from the other departments are less needed by this. The orders

made by planning should be added to the system and both visible for the internal transport and the employees of the apple preselection. When the statuses of the carts are in the system the inspectors also have a clear insight into when they are needed and will be able to respond faster. The origin of the problem of not having enough forklift drivers is very easily fixed by hiring a new employee. When the tasks will be getting tracked and the conclusion is made that it is still too much work for forklift drivers there might be looked at another new employee. I could also understand FruitMasters when they first look at the improvements the other recommended changes are creating before hiring another employee, but this research does recommend looking really into this. The last origin of this bottleneck is that the supply department is up to date on the times the trailers from outside come in, but the apple preselection is not. Supply should take the time to give the apple preselection insight of that, to save time later at this department. This would help the internal transport through a faster response on the trailers from outside, meaning faster back to the carts of internal transport.

The one habit of the cold store, the apple preselection might learn from is to never put the pallets at a spot they are not supposed to be at. It happens sometimes that the apple preselection wants to unload the carts a bit faster, or occupy the carts at least shorter, by transporting the pallets from the carts to outside of the preselection. This only causes extra work which ensures that the forklift drivers are getting more tasks.

5.1.2.2.2 No communication after finishing the tasks

Currently, there is no communication between the apple preselection and the internal transport and because of that the internal transport is not updated on the status of the carts and need to verify the situation himself. By the changes of putting the statuses of the carts in the system, that is described in Section 5.2.1.5 will also solve this problem.

5.1.2.3 Cask centre

5.1.2.3.1 Communication differs per employee

The real problem is that the lack of communication that happens sometimes creates a situation where there is no reliable insight on the situation. The recommended changes of Section 5.2.1.4 shows solutions to this problem. The changes of updating the status on the carts will make sure that the insight on the situation that the employee of internal transport has is reliable. It will also make sure that both parties are completely up to date on the situation. When making this change it is very important to monitor the adaptation of this situation.

5.1.2.4 Cold store

5.1.2.4.1. Not being able to drop off the carts

The receiving department needs to be up to date with the carts that are to be sent towards the department. By the recommended changes of Section 5.2.1.5, the system will be containing the status on the carts and the updates on what the other departments are working on. What is most important to solve this bottleneck is that the changes will also give the receiving department insight on what is coming towards them and the delivering department could see what the situation is at the receiving department. When the delivering department sees the tasks increasing it might be even more profitable to help the receiving department with the unloading/loading first before

loading an extra cart. That depends on the other tasks the cold store needs to be doing but loading the cart in this situation should not be a priority considering the possible decrease of the quality of the fruit.

5.1.2.5 Expedition

5.1.2.5.1 Loaded carts cannot be unloaded yet

The only reason why the carts are not being unloaded directly after the delivery of the carts is because the forklift drivers were unaware of the situation. Again, the changes that were recommended at Section 5.2.1.4 also takes care of this problem. When the cart is delivered at the expedition the cart should be scanned and the status of the cart should change into “dropped off”. The receiving department should receive a notification on this to become aware of the situation and can start on unloading/loading the cart and that will solve the problem of being unaware of the situation.

5.1.2.6 Soft fruit & Pear packing station

5.1.2.6.1 Loaded carts cannot be unloaded yet

The problem of the limited space at the soft fruits/pears packing stations will already be solved when the new pear packing station is done. In the new situation, the internal transport will drop the carts off and pick up on the other side of the building, where there is enough space to do so. There is in the same way lack of communication between the internal transport and the soft fruits/pears packing stations as between the internal transport and the cask centre. Because of that the changes that were discussed at Section 5.1.3.2, are the same in this situation. The lack of communication that happens sometimes creates a situation where there is no reliable insight on the situation. The changes of updating the status on the carts will make sure that the insight on the situation that the employee of internal transport has is reliable. It will also make sure that both parties are completely up to date on the situation. When making this change it also is very important to monitor the adaptation of this situation.

5.1.2.7 Industry

5.1.2.7.1 Loaded carts cannot be unloaded yet & communication differs per employee

Industry does not know when apples are delivered by internal transport and internal transport does not know when industry has time to unload the carts. To solve the bottleneck of loaded carts not being unloaded start with industry knowing when there is a cart. This could go through communication but because that does not seem to work here, the solution of Section 5.1.1.4, where the location is put into the system and industry gets a notification when the cart is dropped off at industry will help with that. The problem where internal transport does not take the trucks from outside into account, should also be necessary. Where departments should be able to plan tasks into the future, it should become possible for industry to also block out blocks on when trucks from outside

5.1.2.7.2 No communication after finishing the tasks

Also, to solve this bottleneck the solution mentioned in Section 5.1.1.4 will be used. This is because the communication on the status of the cart is not needed when it is put into the system.

This also seems like a solution where both departments could agree on because they both benefit from it and they do not need to talk to each other.

5.2 Employees opinion

To create a proper implementation plan, the employees that need implementing the solutions, need to be convinced by the solutions. That is why this section will answer the research questions: **“What do the employees of internal transport processes the carts interface with, think of the solutions?”** to make sure the solutions will be implemented. To answer this research question, the employees that were interviewed earlier, are interviewed again. The process of this having interview included the following steps:

- Step 1 - a short summary of the results of this research,
- Step 2 - pointing out the bottlenecks that need to be addressed,
- Step 3 - explain the effect of these bottlenecks on each department and especially the effects on the department from the respondent,
- Step 4 - explain what solutions will solve these problems and why they will solve the problems,
- Step 5 - ask questions to collect the opinion of the respondents on the solutions that were just explained,
- Step 6 - ask for further tips after hearing the problems that currently occur.

In the summary that describes the results of this research, the explanation of this interview was also added, as is visible below.

My research started with listening to your opinions on the situation. During these interviews, the bottlenecks that were already noticed by the employees were collected considered during the observations. The data to underpin the bottlenecks that were indicated and observed was collected. Some of the bottlenecks that were indicated were not really observed during the research and because of that no improvements were made for these. All bottlenecks that were detected during the research will be listed, followed by the effects of these bottlenecks, and ending with the changes that could be made to solve them. After that, questions on your opinion on these solutions and suggestions for further improvements are asked.

To point out the bottlenecks the summary of the research question: "**What are the bottlenecks in the processes of internal transport the carts interface with?**" from Section 3.3 is used. The effects of the bottlenecks are described for each department as described below.

How these bottlenecks effect the internal transport:

- The employees that need to take over the tasks of internal transport need to stop their own work that still needs to be done.
- When the employee needs to switch the battery, he is only able to pick up half full batteries and needs to switch the batteries more often because of that.
- Needs to drive the entire time across the company area to get entirely updated on the situation.
- The team managers of internal transport are not able to supervise the work of the employee of internal transport.

- The carts are occupied for a very long time and these carts cannot be used at another department because of that.
- Multiple orders that are requested at the same time after not being able to do something for a while before that.

How these bottlenecks effect the apple preselection:

- All orders of the cold store need to be done before 5 o'clock and internal transport needs to be able to do all of this before 5 o'clock.
- The packed products are not picked up efficiently which creates extra tasks of transporting the products across the company area before the customers pick it up.
- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the cask centre:

- The employees need to do double work because they need to pick casks and send it to the packing station and put it back to the cask centre when it is returned without using it.
- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the cold store:

- The carts stay at the cold store and the fruit is already outside what is not good for the quality of the fruit.
- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the expedition:

- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the auction:

- The employees of the auction need to consider that the internal transport is also determined to drive through the crowd, and this disturbs these employees.

How these bottlenecks effect the soft fruits/pears packing stations:

- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the industry:

- The carts do not directly get picked up when they could be what means that this receiving department also needs to wait a bit longer for the cart.

How these bottlenecks effect the entire situation:

- When the unfinished task is found there is no way found who was responsible for not finishing this task and the employee that found the unfinished task needs to take time to contact the manager to investigate where this problem started.

The solutions will solve these problems and why they will solve the problems were explained by the summary of the research question: **"What changes need to be made to improve the current situation of FruitMasters?"** from Section 5.3.

The questions that will be asked to collect the opinion of the respondents on the solutions were:

- What do you think about the solution in general?
- What do you think about the solution specific towards your department?
- What is good about the solutions that were recommended?
- What could improve the solutions that were recommended?
- After hearing about the bottlenecks of the processes of internal transport, do you think something that is not mentioned before could help improve the situation?

The results of these interviews are written down in Appendix P. The participants of this interview were a team manager of internal transport, the manager of the cold store, two shift team managers of the cask centre and one of my supervisors. Each respondent has a different relationship with internal transport which makes each answer different and useful. Each question that was asked will be discussed separately.

5.2.1 What do you think about the solution in general?

When looking at the answers and combining the answers the employees that responded to the questions the following conclusions were made. The solutions are nice, where some solutions are great on short-term and some solutions are great on the long-term. It is important that the solutions improve the coordination between the departments and the clear planning gives more peace of mind which will result in fewer waiting times. This means that the employees were overall satisfied with the solutions.

5.2.2 What do you think about the solutions specific towards your department?

When looking at the answers and combining the answers the employees that responded to the questions the following conclusions were made. The solution to decreasing the returning cask will be a good solution to a part of the cask, but we cannot out rule the cask that is requested because the incoming fruit might be more that what is in the order and that means they need more cask. This means that a bit more cask always needs to be ordered and that might return. Registering all flows in the ERP system would certainly offer a solution in terms of "managing" internal transport. This also improves monitoring, which is currently not possible live. Picking up a full cart immediately and returning an empty cart in front of it can work more efficiently, now they must wait in between because they do not know when an empty cart will arrive. This means that the employees were also overall satisfied with the solutions that were possible to solve the problem or decrease the problems when completely solving the problem is not possible.

5.2.3 What is good about the solutions that were recommended?

Overall, they were satisfied with the solutions but the specific advantages that were created by the solutions are the following. We give deadlines but are not always met, but there is no tracking of it possible. The aim is to improve that the flows will improve internally, and the departments will improve work together. The solution regarding the battery is a quick win that can be realized

quickly, and it prevents frustrations. Hiring a second person for internal transport to fill the team is a tactical move that provides more confidence at the requesting departments in relying on the internal transport and prevents extra work. Concluding that the solutions seem to create structure that is important and will create the correct occupation and the flows will improve.

5.2.4 What could improve the solutions that were recommended?

The solutions could be improved when the occupation of the car is done right. New employees that should be hired according to the recommendations, should be suitable for the job. When these employees are not suitable, they are useless, and it sometimes seems that it is only a side issue.

5.2.5 After hearing about the bottlenecks of the processes of internal transport, do you think something that is not mentioned before could help improve the situation?

Even though the solutions look good in general, besides starting at the beginning with a staff where internal transport consists of two permanent people who are on duty alternately day or evening, in addition there must be spare people who are being able to fill in like this and then their own work could be done by someone else. This research has been done during the summer holidays and making sure there are enough spare people is important because when it comes to internal transport, the employees also need a certificate to drive the trailer. When an employee fills in it must be an employee that is suitable to do the job. When they also still need to do their own job afterwards the problem is just relocated to a spot it might be a smaller problem, but it is still a problem.

5.3 Summary

The research question: **“What changes need to be made to improve the current situation of FruitMasters?”** will address the improvements that were conducted during this research. First, it is important to remember that these changes are recommended by this research and it is up to FruitMasters to decide what to do with this.

The first recommendations are hiring employees for the second shift of internal transport and for the Saturday shift, because currently employees with other tasks need to double their workload to also do the tasks of internal transport. The batteries of the car and the forklifts need to be changed when they are done with their shift, not when they need a new one, because then more batteries get charged and no employee is required to pick up a half charged battery.

The status of the carts need to be added into the new ERP system to create an insight on where the carts are located and when they can be picked up again, because this prevents verification rounds when the situation is clear in the system. This change should also notify the departments where the carts are dropped off because that will also make sure that each department is updated on what carts need to be processed and they could respond faster. When these departments are also done with the carts, they should update the status because then communication is less needed, and it should become more efficient. The advantages of adding all this data into the system there is not as much communication needed because this will become the communication. The managers could also check the system if this communication is done right to make sure this

change is adapted to the situation. The status of the carts will also show departments if they should already load another cart, because if a department already has 3, more carts are useless, which means they could do other tasks first and load the cart at another moment.

Besides the status of the carts, orders from the other departments should also be added to this system where they can plan orders for the future, this should be done to prevent other problems from happening like too little room for storage and too much workload. It should also become possible for the industry to put into the system when trucks from outside are coming because this is a notification towards internal transport that at that time, they cannot process internal transport. When the workload can be reduced by an appropriate distribution this should be done. The other tasks of internal transport should also be added to the system by adding the locations of the air compressor and the weighbridge, because this makes it easier for the team manager to supervise the employee of internal transport. All this data that is put into the system also should be collected to analyse the processes because otherwise the processes cannot be optimized.

The employees that order the cask from the cask centre should get insight on what cask the fruit is entering to prevent ordering extra cask. Changing the location after the pear packing station is done with the construction will prevent the trouble the auction has with internal transport during auction hours. When deadlines are added to the orders, the managers can manage their employees easier. This will also show who was the last to work on a task and who was responsible for taking over the task to prevent tasks from stopping halfway.

The opinion of the employees on the recommendations shows the usefulness of them. The research question: **“What do the employees of internal transport processes the carts interface with, think of the solutions?”** will show this usefulness. The employees were overall satisfied with the solutions that were represented. The small- and long-term solutions that will improve the situation seem feasible and useful. The employees see the profits off them which also means that they are open to changing their habits and implement the recommendations, which is even more important than having just good solutions. The recommendation of having spare people who can fill in the job like this and whose own work is easily done by someone else was given by the employees.

5.4 Conclusion

To answer the research question: **“What solutions can be implemented in the internal transport of FruitMasters?”**, the information from the two research questions of this section will answer this question. The recommended changes are summarized to the following 2 lists of recommendations. The first list is about the effective short-term recommendations of this research:

- Hiring an employee for the second shift of internal transport.
- Hiring an employee for the Saturday shift.
- Change batteries of the car when a shift is done.
- Hiring an employee as an extra forklift driver for the apple preselection, IF after the adaption of the other changes the occupation and/or the unloading/loading time is still too much because of understaffing.

- Letting the apple preselection adapt the habit of not putting the pallets at a spot they are not supposed to be at.
- Give insight in the cask the soft fruit is entering in to prevent extra cask retour to the cask centre.
- During the auction hours, all internal transport to the soft fruits/pears packing stations needs to be delivered through the entrance at the pear packing station at the other side of the building.
- Add a deadline to all orders, for clear planning and management, and to create shorter occupation times.

The second list is about the effective long-term recommendations of this research:

- Implementing all internal orders in the new ERP system that could implement the executive department, the executive employee, the status of the cart, the current location, the receiving location, and the time when this action started.
- Implementing in the new ERP system all the remaining tasks of internal transport.
- Add the deadlines of all the orders in the new ERP system.
- Track all data that is collected by the new ERP system to be able to improve the processes of internal transport even more.

The only recommendation that needs to be added that was indicated by the employees is to have spare people that can do internal transport and his/her tasks are still done by other employees. That sums up all the recommended solutions that should be implemented into the visualisation of the internal transport processes.

6. Visualisation of all processes surrounding the carts

Chapter six will be used to answer the main research question, to explain and substantiate the recommendations towards FruitMasters. This means that this chapter will answer the research question: **"How should a visualisation of the processes of internal transport look like at FruitMasters?"**. In Section 2.1.1, the processes of internal transport are already visualised as the current situation is. There were some inconveniences that could have been tackled by the changes that are made to the processes. Transporting the carts and the terminal trailer, cart maintenance, fruit weighing, battery replacement and communication with the other departments are all tasks that are done by internal transport. The processes of transporting the terminal trailer, cart maintenance and battery replacement show no major problems but the changes that are made will also affect these processes. The processes of requesting and delivering the empty carts, requesting and delivering the filled carts, picking up a cart, weighing the fruit and the communication with the other departments do have some problems and these problems will be tackled by the recommended changes in this chapter. Section 5.1 shows all recommended changes that are implemented in the flowcharts that were already created in Section 2.1.1 and they will change each situation.

The literature of Section 4.1 should be considered during the entire research. In this chapter the literature of Section 4.2 should be considered. All theory of the systematic literature of Section 4.2 will be discussed below to underpin the choices that are made in this chapter to create the visualisations of the ideal situation. The visualisation of Section 2.1.1 already makes use of the literature of Section 4.3 and this chapter will do the same.

Visualising a process starts with determining what the strategy is. Second you need to collect all the activities that are done, all transitions and decisions that are made, and the conditions that need to be fulfilled before the decisions, but there is more to this. There are requirements that are needed to execute the visualisation of a distributed process. The first requirement requires a process definition and process executions. At the beginning of each flowchart, under the title of the process, the process definition is explained, and the process executions will be in the additional text. The second requirement requires process instance information what is added to each visualisation. The third requirement requires different visualisation of elements that have been, should be and will not be executed. The visualisations that are done in Section 2.1, are all action that have been executed currently. The actions that are added to the processes of this chapter are the actions that should be executed. The actions that were in the processes of Section 2.1 but are not in this chapter will not be executed after the recommended changes. The fourth requirement requires the current state of a process/activity instance, see Section 2.1. The fifth requirement requires process/activity delay indication, those are shown in Section 3.1. The sixth requirement requires activity criticality indication, this is done by simplifying the processes and only using short sentences in the figures. The seventh requirement requires multiple activity performers, these are all the departments that are involved in each process that is visualised (Momotko & Nowicki, 2003).

The paper "Optimal Process Mining for Large and Complex Event Logs", talks about a process model (PsM), what is an abstracted and simplified way to represent a real process. An advantage

of this notation is to be simple to represent and straightforward to interpret. Nodes represent tasks in the process. Arcs, connecting the nodes, represent ordering relations upon the tasks. No theoretical knowledge is required to read a model, unlike Petri nets and BPMN. Models with higher complexity necessarily have higher replay ability as they allow for more traces. Hence, maximizing replay ability and minimizing the complexity are contradictory objectives (Prodel, Augusto, Jouaneton, Lamarsalle, & Xie, 2018). These are all good reasons why a process model is also chosen to use for the visualisation of the processes of this research.

The technique that is used for the business process modelling of this research were plain graphical representations (flowcharts) that were initially developed for software specification. Flowcharts is a specification in the process models that was used in this research. These simplistic diagrams depicted a business process, but most of the time without using a standard notation. The notation that was used in the flowcharts of this research are explained in Appendix D. The unbeatable advantage to visually depict the flow of a business process in a way that no technical expertise is required is very appealing to the business analysts. Even advanced and more sophisticated modelling techniques are influenced by this perspective, and they support apart from formal semantics and a visual representation of the modelled processes (Vergidis, Tiwari, & Majeed, 2008).

6.1 Processes of requesting and delivering the empty carts

When looking at the processes of requesting and delivering the empty carts, in both processes there were multiple problematic situations during the processes the employee of internal transport could end up at. Section 2.1.1.1 contains Figure 4 and 5 that show the current transportation processes of requesting and delivering an empty cart at internal transport. Figure 38 and 39 are the improved situations of Figure 4 and 5 where all recommendations were added and changed the entire process. One problematic situation is still possible, where all carts could be occupied at the departments. This situation could be prevented by the visualisation of the situation where the statuses of the carts are put in the ERP system and the tasks can be tracked. Adding the actions of scanning the cart when it is received and when it is done at a department will solve this problem. It will also solve the problem of not having communication after being done with a cart. Real communication might not be needed anymore, just a small action of updating the status of the cart. This results in a situation where the verification rounds are not needed anymore. It will make sure that the receiving department can anticipate. This anticipation will reduce the occupation time of each cart to and each cart will be faster empty and transported to the next department. The only problem that is still there is when the receiving department can anticipate it could still occur they are busy and do not have time to start unloading the cart and the cart is occupied longer than it is supposed to be. When this situation occurs, it shows that there are more tasks for the number of employees and more employees are needed. Because of this, it is very important to track the processes and keep track of the bottlenecks that keep occurring, but the changes that might be required after implementing the recommended changes of this research are difficult to predict. Besides that, the changes will also help the managers with monitoring and managing the processes of the employees. When managing becomes easier, the productivity of the employees will also increase.

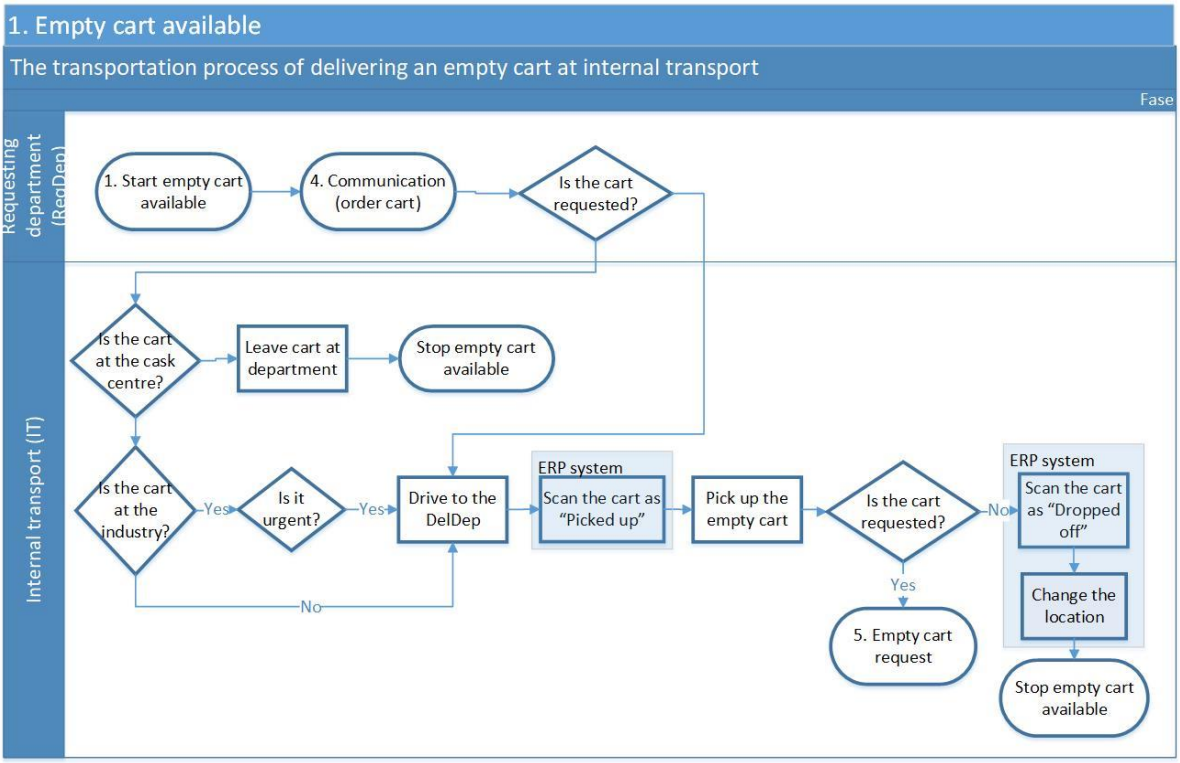


Figure 38 The transportation process of delivering an empty cart at internal transport.

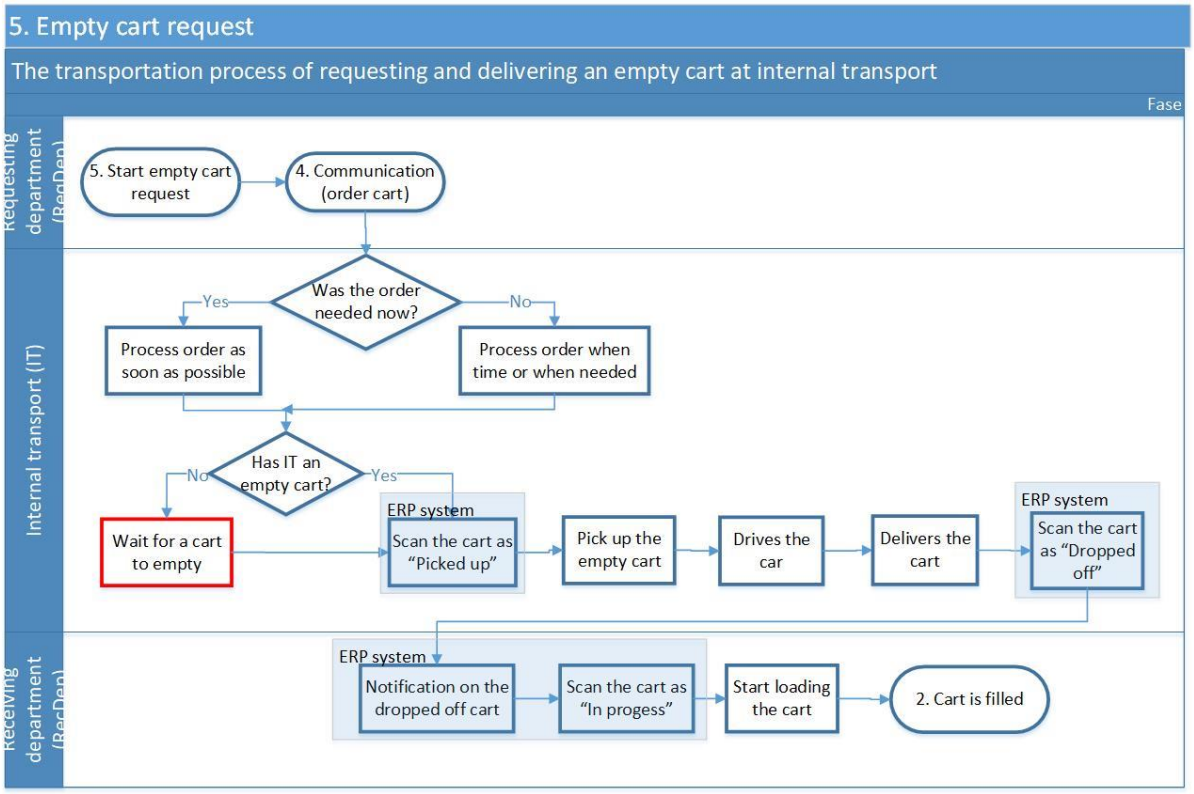


Figure 39 The transportation process of requesting and delivering an empty cart at internal transport.

6.2 Requesting and delivering the filled carts

In Section 2.1.1.1 was already visible that the communication improved during this process and there were fewer problematic situations. The changes of Section 5.1 simplify this process because less decisions need to be made and the situation will become clearer and more organised. Checking if the cart could be dropped off at the receiving department is since there could be no space to drop off the cart. This is the same problem that was described in the process of requesting and delivering an empty cart where in the current situation it is very difficult to determine if the problem of occupying the carts too long is going to be solved completely. This uncertainty requires this problematic situation to stay in the flowchart. The same reason why this problem could still occur is the same as at the process of requesting and delivering an empty cart, where the receiving department is busy and does not have time to start unloading the cart and the cart is occupied longer than it is supposed to be, which shows staff shortage. This also shows the importance of tracking the processes to improve the processes.

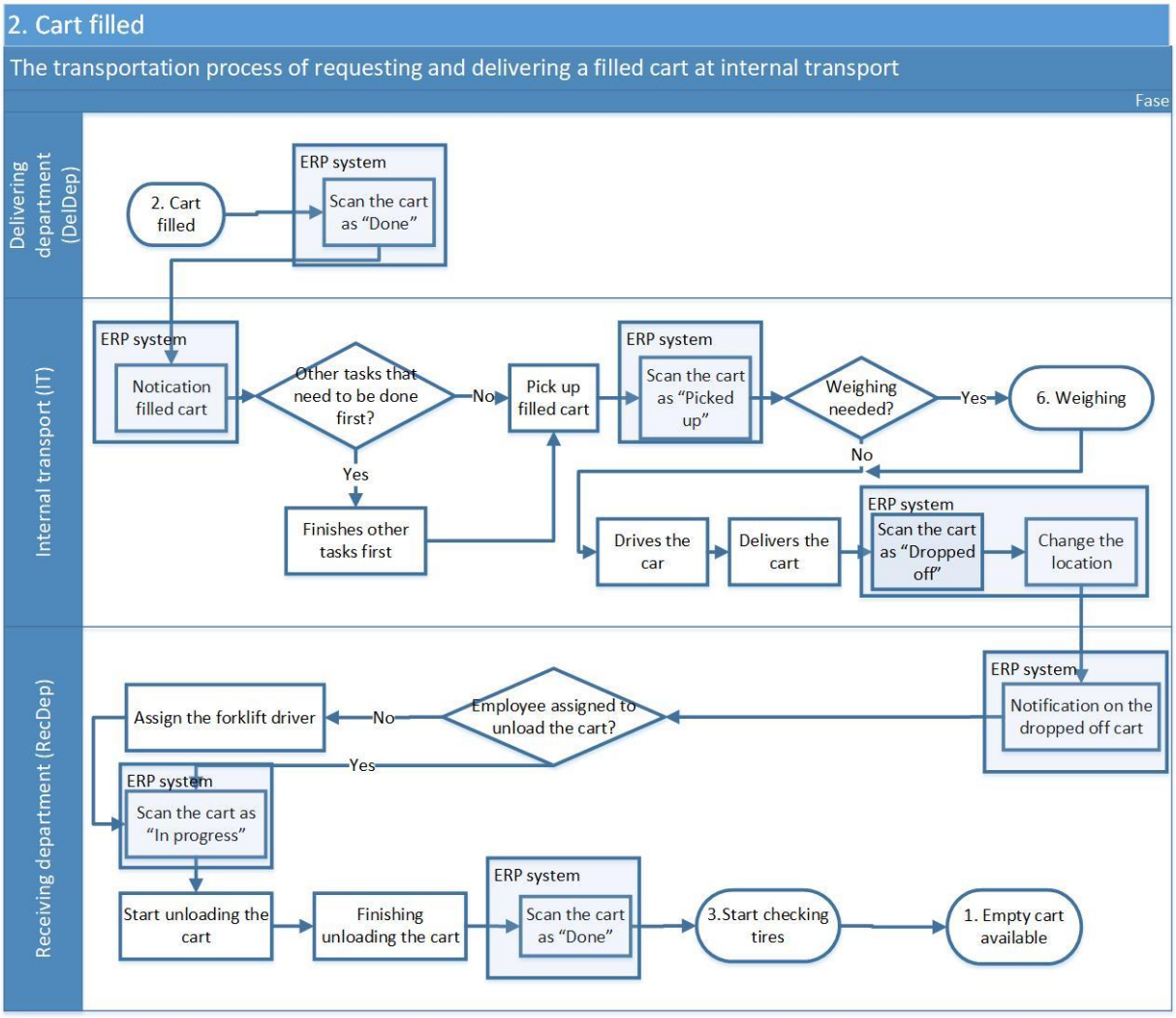


Figure 40 The transportation process of requesting and delivering a filled cart at internal transport.

6.3 Weighing the fruit

As discussed in Section 2.1.1.3, the amount of trucks from outside that also make use of the weighbridge is out of our control and even though it might be a bottleneck, this will not be tackled in this research. The changes that were made to Figure 9 and creates Figure 41 improves the process and the situation. There were only changes done to the communication because actions are required to be done in the ERP system.

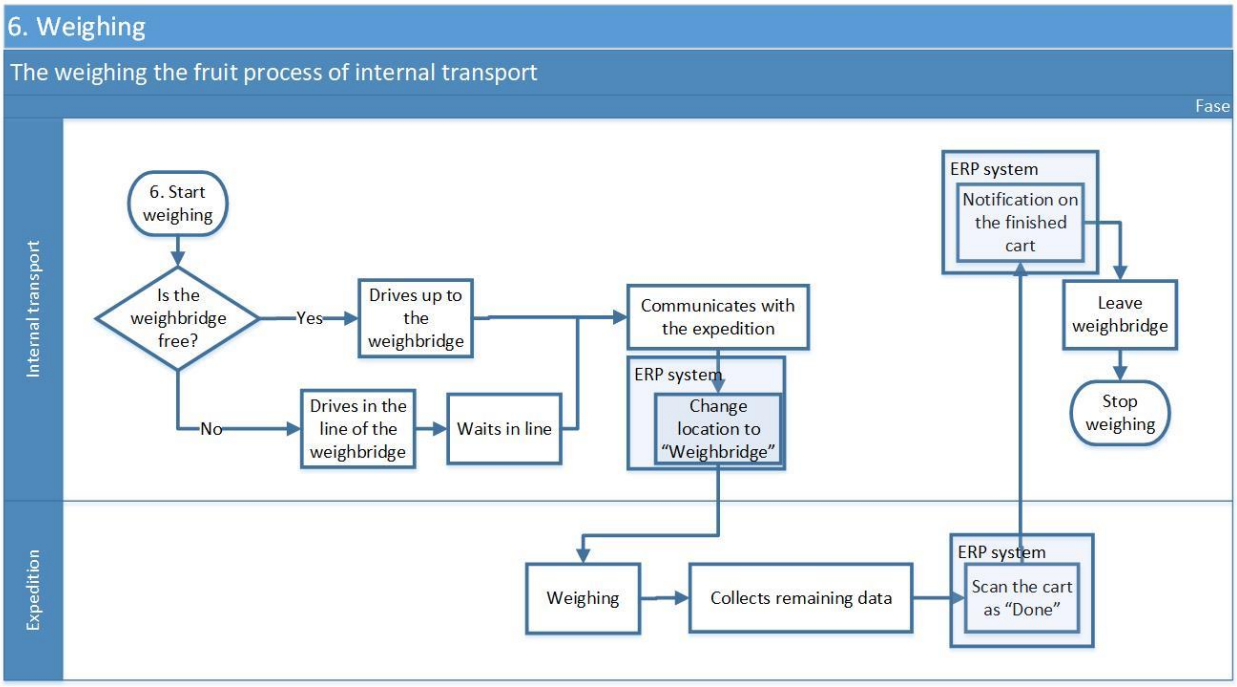


Figure 41 The weighing the fruit process of internal transport.

6.4 The communication with the other departments

There are a few differences between the current communication process of internal transport with the other departments that is visible in Figure 11 and the improved process that is visible in Figure 42. This is because some of the communication is replaced by the actions in the system and the communication that is still present is because there are questions. The communication that occurs when there are questions will always occur because there is a reason for the department to start communicating what will benefit their situation.

6.5 Transporting the terminal trailer of internal transport

The only changes that have been made in the transport process of the terminal trailer of internal transport, is that all communication is going through the new ERP system. Besides the different communication, the only problem that needed to be solved, was having a permanent employee on the terminal trailer. Solving this problem will help take off the extra workload some employees got. Solving this problem also means that all decisions disappear from the process and it only

consists of actions. When the coronavirus is over the actions of loading and unloading the terminal trailer could also be added to the process and a closed circulation could be created here.

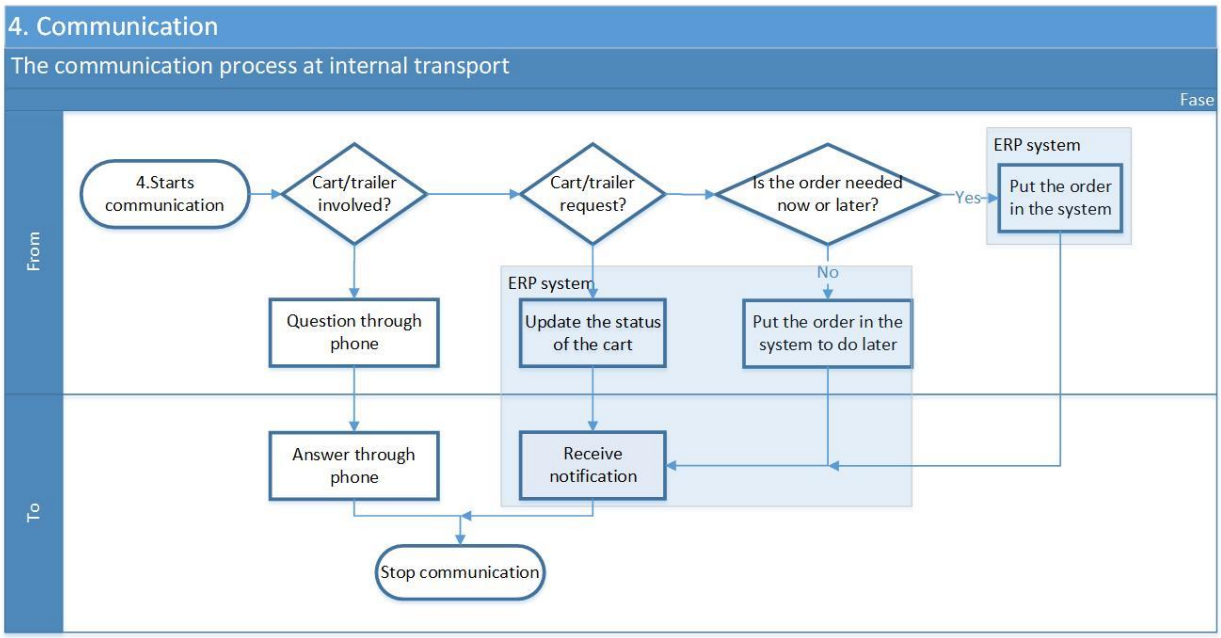


Figure 42 The communication process at internal transport.

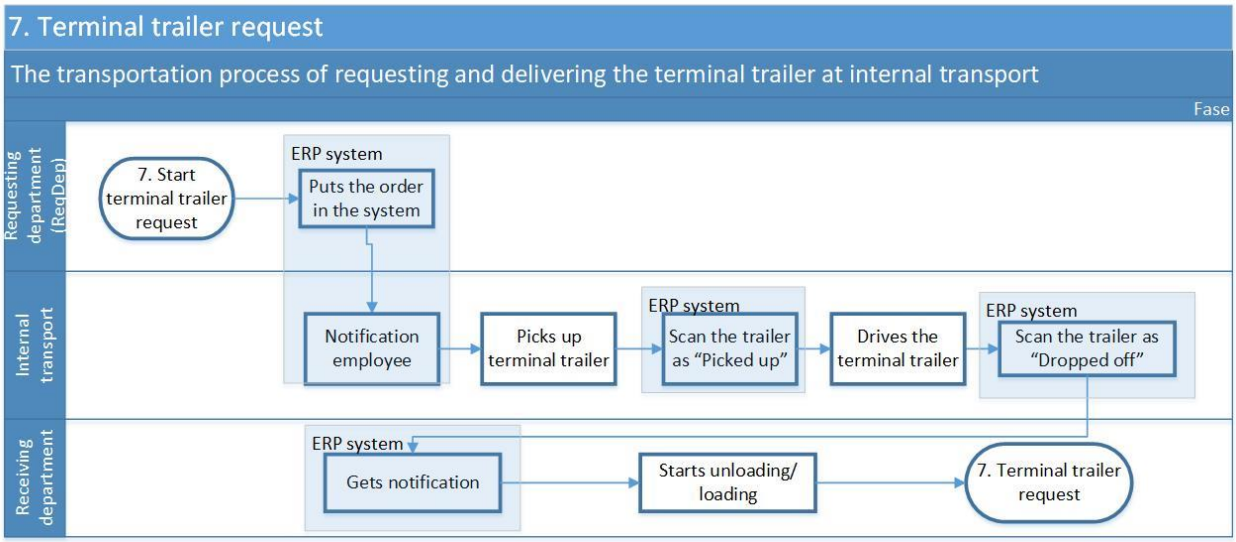


Figure 43 Transporting the terminal trailer of internal transport.

6.6 The battery replacement of the battery of the car of internal transport

The only change that has been made to this process itself is that the status on the requests can be checked in the new ERP system to be updated on the orders of the other departments. The timing of the process on the other hand should be placed at the end of each shift. This needs to be done to put the full batteries into the car and the forklifts and to make sure that the other

batteries are also fully charged, and no half full batteries need to be picked up. Adapting that change will solve the only problem that was occurring at this process of needing to pick up a half full battery.

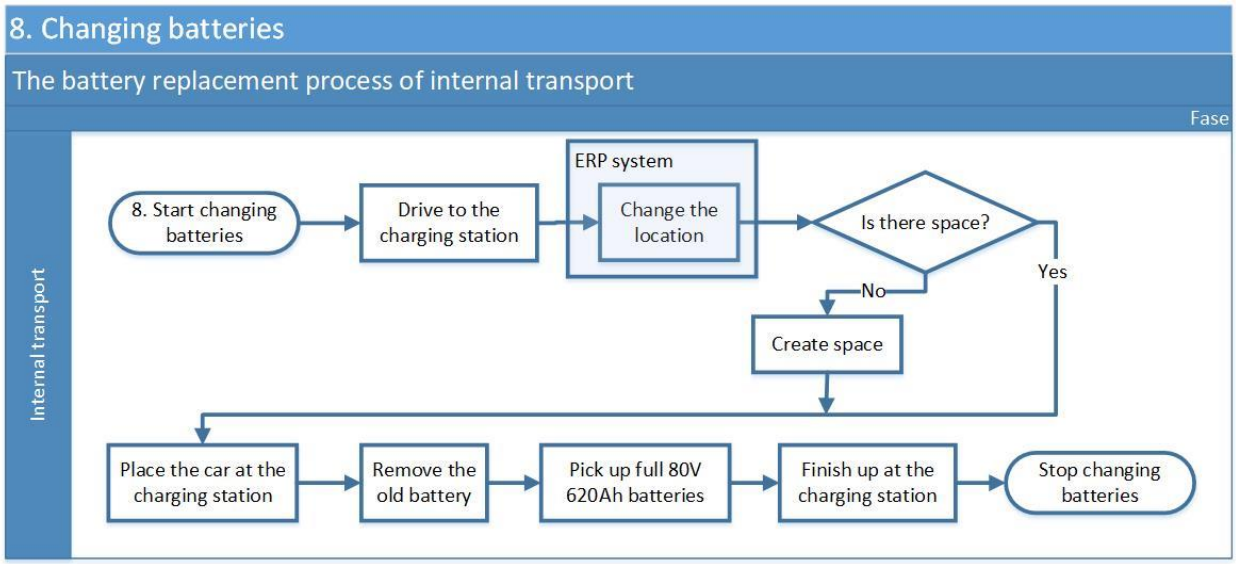


Figure 44 The battery replacement of the battery of the car of internal transport.

6.7 The cart maintenance of inflating the tires of the carts

There are no real problems at the process of checking the tires, as visible in Figure 45, but because of the recommended changes that were added to the other processes, the new ERP system should also be added to this process. For this process that means that the status of the carts should be updated when an update is possible, and the location should be changed when the location is changed. It should become as easy as it is explained here to really make sure that this change is added to the routine of the employees for everybody's profit.

6.8 Summary and conclusion

There was only one research question this chapter and because of that the summary and the conclusion are combined. This research question was: **"How should a visualisation of the processes of internal transport look like at FruitMasters?"**. The changes of Section 5.1 are added to the visualisations that were done in Section 2.1.1. The bottlenecks that were in the visualisation of the current situation were removed by the changes that were made. The only possible problem that could not be ruled out is that all the carts could be occupied. There are changes made to prevent this situation, but it depends on the number of tasks in the future and the number of employees that are available to process these tasks if the situation will occur. When this problem occurs, they should be noticed because the processes should be tracked all the time. The changes in communication that were implemented in the ERP system will make the tracking of these processes easier. When the processes are tracked, the processes can improve even more. The visualisation of the processes of internal transport should implement the recommendations to become more efficient.

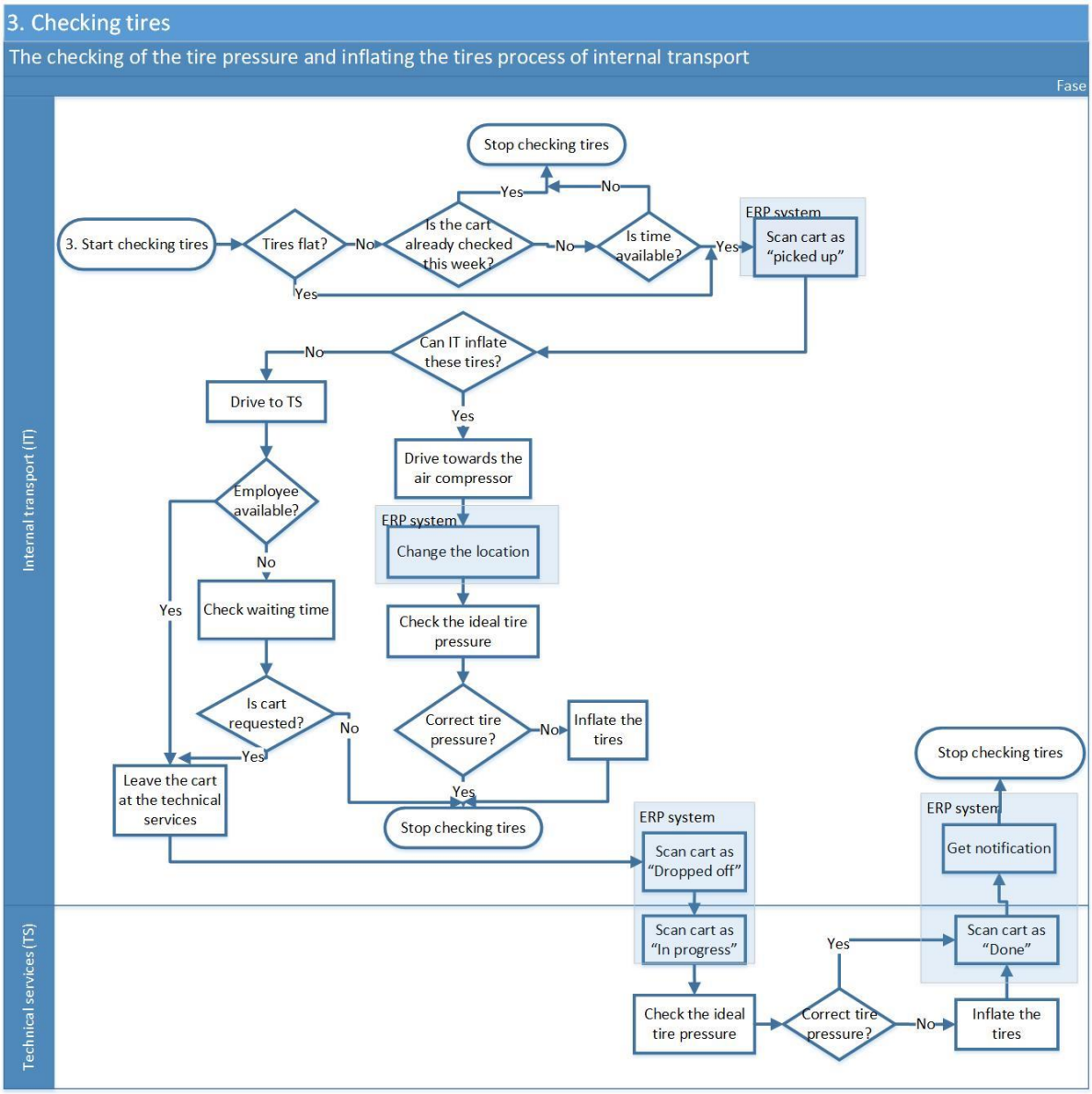


Figure 45 The cart maintenance that involves inflating the tires of the carts.

7. Evaluation on research

Chapter seven will reflect on the research and evaluation of the solutions that are to be implemented. The research question that will be answered in this chapter is: **"What improvements will be made after implementing the solution?"**. After applying the solution, it is important to reflect on the new situation and conclude on relevant insights/lessons learned.

7.1 Insights and recommendations

In Section 5.1 the recommendations were explained on what will improve the current situation. To really be able to apply these recommendations, the opinions of the employees that were gathered in Section 5.2, need to be considered. In Section 5.2 one of the employees also recommended that needs to be considered to have spare people that can do internal transport where his/her tasks are also still done by other employees. Besides the interview that was conducted in that section, to answer the research question: "**What are the predicted insights and recommendations after applying the solution approach?**" another survey was done.

7.1.1 Insights and recommendations employees

To determine the likelihood of success of the recommendations the Unified Theory of Acceptance and Use of Technology (UTAUT) method was used (Venkatesh, Morris, Davis, & Davis, 2003). This method tackles all aspects of the opinions of the employees on the recommendations of this research. During the survey development, this method was the base of the survey. The 6 variables that were used for this method in the interview are:

- Performance expectancy (PE) shows the expectation that using the changes will help the user in improving their job performance.
- Effort expectancy (EE) is the variable that shows the expected usability of the changes.
- Social influence (SI) is the variable that shows the expectation of the belief of the respondent on how the other employees will implement the changes.
- Facilitating conditions (FC) shows the expectation that the organisational and technical infrastructure is implemented to support using the changes. The recommended long-term changes are implementing changes to the new ERP system. How it precisely will look is difficult to predict and because of that, it is up to FruitMasters to contrive how to implement the recommendations on that and the facilitating conditions will not be used much in the interview.
- Behavioural intention (BI) is the variable that shows the intention to work with the changes and accept them in the daily operations.
- Use behaviour (UB) is the variable that shows the way the users will work with the changes.

Prior to the survey, a 15-minute presentation was given to inform all employees on the results of the research. The presentation and commentary that was given is shown in Appendix Q. After the presentation, a question round was held. When all questions were answered, the employees filled in the survey, which is shown in Appendix R. Both the presentation and the evaluation form were given in Dutch. The participants of this interview were the previous manager of expedition, the

current manager expedition (the manager switch happened during this research), one team manager internal transport, the manager pear packing station, the manager cask centre, the manager cold store, employee internal transport and an intern. Each respondent has a different relationship with the internal transport department which makes each answer different and useful.

The survey consisted of open and closed questions. Each open question that was asked will be discussed separately and each closed question had a five-level Likert scale. The answers the participants could give were strongly disagree, disagree, neutral, agree and strongly agree. The strongly disagree had a score of 1 and the strongly agree had a score of 5. This concludes that the values between 1 and 2 are negative feedback, the value 3 is neutral feedback and 4 and 5 are positive feedback. The results of the interviews are put into Appendix S.

Question	Minimum value	Maximum value	Mean	Standard deviation
1 - PE1	1	5	1,75	1,389
2 - PE2	1	4	2,43	0,976
3 - FC1	4	5	4,88	0,354
4 - FC2	4	5	4,50	0,535
8 - FC3	4	5	4,88	0,354
9 - FC4	4	5	4,75	0,463
10 - BI1	4	5	4,50	0,534
11 - SI1	3	5	3,88	0,991
12 - BI2	3	5	4,63	0,744
13 - SI2	4	5	4,88	0,354
17 - BI3	4	5	4,43	0,534
18 - BI4	3	5	4,29	0,756
19 - SI3	3	5	3,88	0,835
20 - EE	2	5	3,75	1,165
21 - EE	3	5	3,88	0,835
Average performance expectancy	1	4,5	2,07	1,223
Average effort expectancy	2,5	5	3,81	0,981
Average social influence	3,3	5	4,20	0,884
Average facilitating conditions	4	5	4,75	0,440
Average behavioural intention	3,5	5	4,47	0,629

Table 5 Evaluation form results (Note that the question numbers are not consecutive because the open questions numbers are left out of this table).

In Table 5, the summary of the closed results is shown. The mean value shows the average opinion of the employees and the standard deviation shows the difference between the opinions of the employees. The higher the standard deviation is, the participants agree less with each other. The outcome of the means and the standard deviation are shown in Figure 46. As visible in Table 5, none of the closed questions contains user behaviour questions, but those are implemented in the open questions.

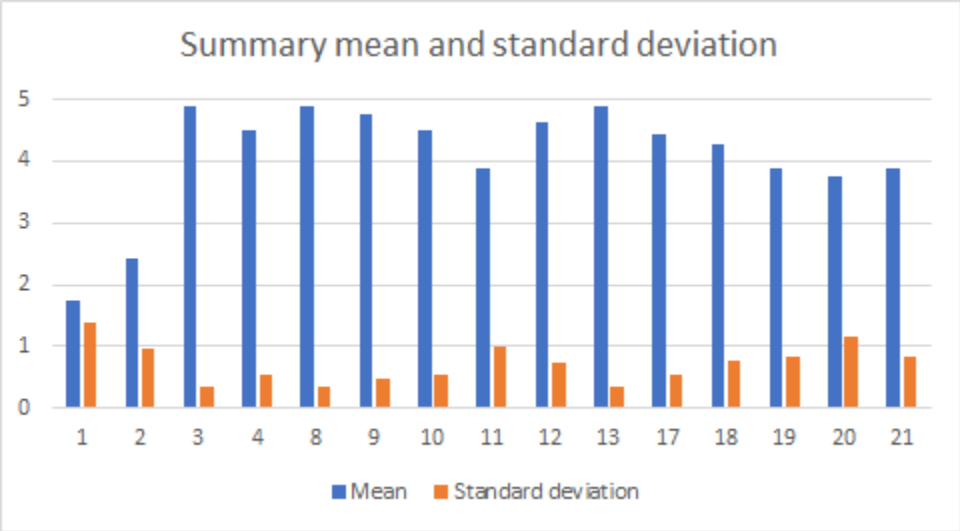


Figure 46 Means and standard deviations

7.1.1.1 Performance expectancy

First of all, the indication that was previously concluded that the values between 1 and 2 are negative feedback, the value 3 is neutral feedback and 4 and 5 are positive feedback does not apply to the first two questions and works in the reverse. This is also the reason why the reliability of respondent 5 is questionable because each answer was 5, I completely agree.

When looking at the answers to the performance expectancy questions, this is the variable the employees differ the most with their opinions. Despite the changes in opinions, the average of the responses show that they do expect that using the changes will help the user in improving their job performance. They agree the most that no useless changes are recommended, but also agree that a bit more changes are required. After my presentation, some employees stayed, and we concluded that all details that are described in this report are required to show the employees the size of each problem. The report will also show the detailed version of the recommended changes on which the employees that stayed were convinced that will convince the employees even more. That is also visible in the open questions where they answer that they want more information on how communication will improve, which is written in the report. What is funny though, the manager of internal transport told me the communication did improve during my research and kept improving after I was not working at the company area anymore. This is positive because it shows that the employees that were approached during the research did take another look at their own communication towards internal transport and realised, they could improve it more. The reason why this is even optimal, is because changing habits and behaviour is the most difficult, the fact that it already shows it is possible is even more positive towards the future. This means that

reflecting on their behaviour and being critical might be just as useful as the recommendations, and if this research took care of that, nu further improvement is needed here.

One employee did mention that the improvements to the planning should be further explained in the recommendations and because of that, that has been added. Another suggestion was to use the economical value to underpin the recommended changes and that is a great suggestion. Unfortunately, there was not enough time to implement the economical value of the changes to this research. That could have been a good foundation but because of the limited time, this research makes use of explaining all the problematic effects and the product quality as a foundation.

7.1.1.2 Effort expectancy

These questions are about how easy it is to implement the changes. The average of the effort expectancy questions was 3,81 which shows the employees opinion is in between neutral and positive. This is understandable because habits are always difficult to change. Despite the employees not being confident changing their habits is going to be easy, the observation that was done in Section 7.1.1.1, where habits are already changing, does help making it more persuasive. Having employees that also take initiative to start changing really helps here.

7.1.1.3 Social influence

The social influence shows the belief of the employees on how the other employees will implement the changes. All responses here were neutral or positive and not having one of the employees question the commitment of all the other employees is wonderful and is great for the relations between the employees. One of the respondents answered the questions of the disadvantages of these changes with “Everybody needs to adjust the changes”. Having all this positive feedback from the respondents that are convinced themselves and have faith in the commitment of the other employees leaves this variable at a great note.

7.1.1.4 Facilitating conditions

This variable is mostly about how the long-term changes will be implemented into the new ERP system. Because the ERP system is still quite new and the employees that are involved into the processes of internal transport are not responsible for this, the facilitating conditions could only be about the research and its recommended changes. Primarily, these questions also represent if the information is conveyed correctly. The employees agree on this the most of all variables because each answer was either a 4 or a 5, the average was 4,75 and the standard deviation was only 0,440. This means that the information was understandable, clear, and coherent.

7.1.1.5 Behavioural intention

The behavioural intention shows the intention to work with the changes and accept them in the daily operations. The average behavioural intention the respondents gave was 4,47 with a standard deviation of 0,629. The minimal value of the average behavioural intention was 3,5 and the maximum value was 5. This means that on average there was only positive feedback. When looking at all the answers on all the behavioural intention questions all answers were neutral or positive. The conclusion that is created by the responses was that the employees have the intention to work with the changes and accept them in the daily operations.

7.1.1.6 User behaviour

Use behaviour is the variable that shows the way the users will work with the changes. The other variables need to be good according to the respondents for this variable to be good. The other variables need to be good because then the responses need to be convinced the recommended changes are good and will be adapted. During the presentation before the evaluation form, the short- and long-term changes were introduced. To adapt the changes the current habits, need to be changed. In the open questions the employees wrote down that they know that they need to make changes. The fact that the employees realise that they need to change is one step to the right direction. The realisation change is needed is the first step of changing habits. Adding the deadlines to the internal orders makes the management easier and the second step of changing habits is great management. The last step is of course changing the changes into the new habits. The employees were enthusiastic about the approaches of this plan and that is how they will work with the changes.

7.1.2 Insights and recommendations research

Besides the insight and the recommendations of the employees, the insights and recommendations that were gained from the research are also needed to answer the research question: "**What are the predicted insights and recommendations after applying the solution approach?**". There still might be situations where research is required but adapting the recommendations will help easier research because of the extra data collection that will be done.

When looking at the bottlenecks, the first comment that needs to be addressed is the fact that employees were up to date on some of the problems. The fact that these problems also were already happening for a very long time is problematic. The employees in the workplace are always the first ones to notice problems and when nothing is done about it, nothing will change about it. When data on the processes is collected, the kind of the problems that were observed during this research could be detected on a regular basis. The data will underpin the problems employees might encounter and convince FruitMasters to adapt changes to improve the situation. Another insight that was created during the research is that employees only have one talk a year about how they are doing. This research recommends there should be more talks about the problems the employees observe and when more talks are created to really do so, they can also show their growth throughout the year and see the problems disappear.

It is uncertain whether the problems are not tackled because of miscommunications, but it is certain that most of the problems occur because of communication struggles. It is okay to rely on communication to get tasks done, but if it appears to keep creating problems, replacing it by tasks in the new ERP system will help. This recommendation is relevant for the situation of FruitMasters as it has a strong impact on the other processes and the quality of the fruit, as discussed in Chapter 5. As the profit of a company is determined by the products that are sold, all precautions should be taken to preserve the fruits as good as possible. Solving problems that are not directly related to the quality of the fruit but have a major impact on it, is mandatory.

The bottlenecks that were out of reach of internal transport were left out of this research, but in these situations could use some research to optimize the processes of internal transport even

more. The first situation is the uncertainty of the amount of trucks from outside that also make use of the weighbridge and come around when they want to. This means it is out of our control when they arrive, but how to respond to this is in our control. What the best way is to respond to this situation should be determined during a period when this situation occurs, because it did not during this research. The second situation is the uncertainty of the amount of trucks from outside that arrive and unload at the apple preselection. Currently, the apple preselection has difficulties with handling those trucks and the internal transportation at the same time. The recommendations of this research will help this problem but when it comes to the result that that is not enough, it is recommended that this problem is taken more seriously, and extra research is required. The last situation that is also out of our control is when orders are placed and should be done. Currently, some communication is lacking here, mostly because the communication that is used here is one-sided, which is already a problem itself, and removing the required communication here and replacing it with actions in the new ERP system will already help. Problems that still occur here have a direct impact on the rest of the processes and should be limited. When extra research appears to be needed after implementing the recommendations, that should be done.

To summarize the recommendations the following action plan is created:

- Start with implementing the short terms recommendations
    - This means that for the second shift of internal transport an employee should be hired.
    - This means that for the Saturday shift of internal transport an employee should be hired.
    - Internal transport and the forklift drives that also make use of the 80V 620Ah batteries need to create the habit of changing the batteries after ending their shift.
    - The team managers of internal transport need to check at the end of each shift if the habit of changing the batteries at the end of a shift is created.
    - The team managers of the forklift drivers that also make use of the 80V 620Ah batteries need to check at the end of each shift if the habit of changing the batteries at the end of a shift is created.
    - Letting the apple preselection forklift drivers adapt the habit of not putting the pallets at a spot they are not supposed to be at.
    - The team manager of the forklift drivers of the apple preselection need to check if the habit of not putting the pallets at a spot they are not supposed to be at is created.
    - The employees that request the cask of the cask centre at the soft fruits/pear packing stations gets insight in the cask the soft fruit is entering.
    - Internal transport should create the habit to deliver during the auction hours at the back entrance of the soft fruits/pears packing stations.
    - Let all requesting departments add deadlines to all internal orders.
    - Internal transport will create a planning with the deadlines of the internal orders.
    - The receiving departments should improve the management of the forklift drivers after receiving a cart of internal transport.
- If after the adaption of these changes the occupation time is still too much because of understaffing.
    - Hire an employee as an extra forklift driver for the apple preselection
- Start with implementing the long terms recommendations

    - Put the processes of internal transport and the processes surrounding the moving carts into the new ERP system
    - Add orders with the executive department, the executive employee, the status of the cart, the current location, the receiving location, and the time when this action started. This information should also be updated when there is a change made.
    - Add the deadlines of all the internal orders in the new ERP system.
- Track all data that is collected by the new ERP system to be able to improve the processes of internal transport even more.

Through the last step of this action plan where all data is collected by the new ERP system new bottlenecks could be detected and tackled. This means that the last step of this action plan takes care of the further improvements of the future after implementing these recommended changes. There are no numbers added to each task because it is okay to not start at the top, but this research does recommend starting at the top because some of the top changes might already solve the bottlenecks that originally had other recommended changes.

7.2 Summary

The summary of Section 7.1.1 and Section 7.1.2 will answer the research question: "**What are the predicted insights and recommendations after applying the solution approach?**". When looking at the problems that occurred during the research, some problems were already identified by the employees but not tackled. To collect the opinions of the employees on the insights and recommendations, a presentation about this research, the bottlenecks that were detected, what the solution approach was and what changes are recommended and what impact they will have on the situation, was given. After this presentation, the employees filled in an evaluation form where they were very satisfied with the results. They would like to read the more detailed information, which will be given after the end of this research. The evaluation form shows that after applying the recommendations, the employees are convinced that the changes will have a positive effect on the current situation. This research recommended that also after applying the solution approach and problems still occur, that the employees observe should be heard and FruitMasters should put in the effort of solving those problems. After applying the solution approach, the bottlenecks that were out of reach of internal transport that were left out of this research, could use some research to optimize the processes of internal transport even more.

7.3 Final conclusions

Considering the insights, recommendations, and the conclusions after applying the solution approach will answer the research question: "**What improvements will be made after implementing the solution?"**. The research questions of this chapter show that the recommended changes of Section 5.2 will improve the current situation. Section 5.2 has both short and long terms recommended changes. All changes have a different impact on the current situation, will solve different bottlenecks and will all create improvements at the process of internal transport and at the processes surrounding the moving carts of internal transport. The expected impact of the recommended changes is obtained by the prediction of tackling and removing the bottlenecks. This means that the expected impacts are the reverse of the bottlenecks. In Section

7.1.2 the action plan that was requested by the employees after the survey of Section 7.1.1 shows how the recommended changes should be implemented into the current situation.
The expected impact of the short terms recommended changes will be:

- No employees need to do extra work
- Filled batteries when needed
- No unnecessary cask sent retour
- No problems/irritations at the auction hall
- Clear planning through the deadlines.
- Easier management on the orders through the tracking of the deadlines
- Shorter occupation time

The expected impact of the long terms recommended changes will be:

- More insight in the situation and the statuses of the carts
- Notifications on the statuses of the carts
- Easier management on the actions of the employee of the internal transport
- Easier management on the actions of the forklift drivers of each involved department
- Clear improvements on the performances of the processes of internal transport
- Shorter occupation time

These are all different effects on the current situation and will improve the current situation all in a different way. What is corresponding to all impacts of the recommended changes is that it will improve the current situation for internal transport. When the situation improves, the idle time of internal transport will decrease. This means that all recommended changes have their own impact of solving the action problem where the idle time of internal transport needs to decrease with 15%. If the total idle time really decreases with a total of 15% was not possible to observe because this research was not able to implement all recommended changes. This research did already have a positive effect on the situation because the employees already started to improve their own work. When the real recommended changes are also adapted the situation and will create more improvements, the decrease of the idle time of internal transport with 15% is very reasonable.

7.4 Personal evaluation on this research

Last adding my personal evaluation to this research and the report in this chapter:

I am content with the results of this research. I learned a lot during this research and most progress was done during the observation of the situation. Sometimes I did not like to look at all the bottlenecks and problems that were occurring because of the negativity but being critical was very important during this research. It felt really satisfying after talking to multiple employees when I was looking for the origin of a bottleneck to find the real problem. I felt very welcome what was nice because even though my research was all about finding problems of the employees it also felt like they did appreciate my comments and my feedback. I learned a lot from this research and grew in my research skills, communication skills, planning skills and interviewing skills. I am proud of this report because it really feels useful towards the company and the employees of FruitMasters also noted it is useful. I have put a lot of time and effort into this research, but it was all worth it.

8. Conclusions

This chapter concludes the conclusions based on each research question, the main recommendations are summarized and the further research that is recommended outside the limitations of this research. This chapter will give the finalization to the solution of the action problem of FruitMasters, where the idle time of the internal transport employees should decrease with 15%. This chapter will answer the research question: "**What will decrease the idle time of the internal transport employees with 15%?**", to solve the action problem.

8.1 Conclusions on research questions

At the end of each chapter, a conclusion is created after answering each research question. What each research questions value was towards this research will be determined through answering the research question: "**What are the conclusions on the main research questions answered in this research?**". Each chapter had its main research question that was answered by the research of the smaller research questions. Each of these main research questions will be discussed shortly.

The research question of Chapter 2 was: **"How is the current situation of FruitMasters?"**. This chapter shows that based on the processes surrounding the carts, the data collected on the KPIs and the idle time of internal transport and the opinions on internal transport, the current situation could improve. The current processes surrounding the carts have been visualised some actions contain problematic situations and other bottlenecks are outside of these processes. The data collected on the KPIs of internal transport show that also that communication is lacking and that to optimize the processes further in the future, all orders need to be tracked. The idle time differs a lot for each day and night shift and the uncertainties on the orders that come in at internal transport create a situation where they always need to be present at the company area to respond quickly. The current situation, based on the opinions of the employees that are involved in the processes, differs per department. Some departments have more bottlenecks than other departments but because they influence each other, solving the problems at one department will also help other departments.

Chapter 3 underpins Chapter 2 with more data on the bottlenecks at the processes surrounding the carts and the limitations of the processes of internal transport that need to be taken into consideration and to explain the current idle time. To solve the action problem: **The idle time of the internal transport employees should decrease with 15%**, the research question: **"Where could the idle time of the employees in the current situation be limited?"** is answered. The conclusion that is made here is to tackle the origin of the bottlenecks and to keep the limitations of internal transport in mind. This means that employees are needed, communication should improve, agreements are missing, and the current situation is also lacking an overview on the situation. When the tasks of the employees of the other departments improve, the processes of internal transport flow will run more smoothly, and the idle time will also be limited by this. Not having a written policy means that everybody follows their own unwritten rules. Making agreements to create a written policy to change inefficient habits, will also decrease the problematic idle time.

To underpin this research with literature, in Chapter 4 the research question: **"What literature is available on visualisation of processes in a supply chain that is needed for this research?"**, is answered. The literature that was required on visualisation of processes was the choice on what kind of visualisation this research should use, how it will be used and what limitation should be considered. During this research it is very effective to use flowcharts to visualise the processes surrounding the carts. Flowcharts are a process model, what is an abstracted and simplified way to represent a real process. An advantage of this notation is to be simple to represent and straightforward to interpret and no theoretical knowledge is required. The visualisation of this research is done in the program Microsoft 365 Visio. The limitations of visualising are general always applies to all forms of visualisation and need to be taken into consideration.

In Chapter 5 the recommended changes are the solutions that will improve the situation surrounding the moving carts. The research question: **"What solutions can be implemented in the internal transport of FruitMasters?"**, is answered through summarise up all recommended changes. There are short- and long-term recommendations. The short-term recommended solutions consist of hiring more employees where required, change batteries at the end of a shift, adapting more effecting habits, giving insight in what cask the soft fruit is entering in, change the parking spot during auction hours and last add deadlines to all orders. The long-term recommended solutions consist of implementing all internal orders with additional details, all remaining tasks of internal transport, all deadlines to the new ERP system. The last recommended solution is to track all data that is collected by the new ERP system to be able to improve the processes of internal transport even more. The recommendation that was indicated by the employees is to have spare people that can do internal transport and his/her tasks are still done by other employees. That sums up all the recommended solutions that should be implemented into the visualisation of the internal transport processes.

The recommended changes of Chapter 5 that could be implemented in the visualisations of Chapter 2 create the visualisations of Chapter 6. The research question that was answered through making these visualisations is: **"How should a visualisation of the processes of internal transport look like at FruitMasters?"**. The bottlenecks that were in the visualisations of Chapter 2 were removed by the changes that were made. There are changes made to prevent that all the carts are occupied, but it depends on the number of tasks in the future and the number of employees that are available to process these tasks if the situation will occur. The changes in communication that were implemented in the ERP system will make the tracking of these processes easier. When this problem occurs, they should be noticed because the processes should be tracked all the time.

The solutions were not implemented in this research, but the predicted improvements are discussed in Chapter 7. To answer the research question: "**What improvements will be made after implementing the solution?"**, the respondents from the FruitMasters survey and the research have its own vision on what the improvements will be. The solutions have all different effects on the current situation and will improve the current situation all in a different way. With an action plan the respondents are convinced that the solutions will create the improvements that are suggested by this research. The improvements from the short-term solutions are that no employees need to do extra work, there are filled batteries when needed, no unnecessary cask

is sent retour, no problems/irritations at the auction hall, clear planning through the deadlines, easier management on the orders through the tracking of the deadlines and shorter occupation time. The improvements from the long-term solutions will be more insight in the situation and the statuses of the carts with notifications on the statuses of the carts, easier management on the actions of the employee of the internal transport and the forklift drivers of each involved department, improved performances of the processes of internal transport and shorter occupation time. This research did already have a positive effect on the situation because the employees already started to improve their own work. When the real recommended changes are also adapted the situation and will create more improvements, the decrease of the idle time of internal transport with 15% is very reasonable.

8.2 Recommendations

During this research unfortunately there was not enough time to implement any of the recommendations. This means that no recommended changes of this of this research were implemented during this research, the only changes that took place were stimulated by the research itself. This is because the employees were engaged during this research and informed and interviewed on the bottlenecks, and this stimulated them to change their behaviour to improve the current situation. This also means that the persuasiveness of this research is based in its reasoning, explanations, and the opinions of the employees on the conclusions. That data will come to a theoretical conclusion and answer the research question: "**What are the conclusions on the situation after applying the solution approach?**". This means that to answer the research question, it is important to keep in mind that this is all hypothetical. The conclusions made based on the reasoning of the recommended changes, the observed origins of each bottleneck were tackled. This does mean it might happen that the origins that were observed were not the real reasons these bottlenecks occurred and then it might not solve the problems. The conclusions made based on the reasoning of the recommended changes are combined with the conclusions made based on the explanations. The reasoning and the explanations were created based on the observations during this research. The employees that are involved in all these bottlenecks never disagreed to the origins of the bottlenecks and the explanations that were added here convinced them on the importance of the changes that need to be made. They also did not agreed on all of the origins, just some, but it is understandable it might be hard to admit to the problems they create and hearing all the effects these problems have on the rest of the departments. The conclusions made based on the opinions of the employees is that a good action plan and the commitment of the employees will convince the employees about the positive effects of the recommendations. This creates the overall conclusion that hypothetically the situation will improve after applying the solution approach.

8.3 Further research

The limitations of this research create the boundaries of this research and for further optimalisation of the situation, more actions need to be taken. This section will answer the research question: "**What further research is recommended by this research?**". Besides the actions that are involved with implementing the solutions, there are also actions recommended for further research on the processes of FruitMasters that will improve the situation. There are

some processes at FruitMasters that already require further research according to this research, but it was not in the scope of this research. If after implementing the recommended changes the situation does not improve, further research is also recommended. Section 7.2.1 already discussed the situations where research is recommended out of the research scope and the further research on internal transport is recommended. The exact research will be discussed here.

8.3.1 Research out of the research scope

The situations on which it is already known that further research is required, involve the uncertainty of the trucks from outside and require the weighbridge and/or have the destination of the apple preselection.

One recommended research investigates the situation with the uncertainty of the amount of trucks from outside that also make use of the weighbridge and come around when they want to. This means it is out of our control when they arrive, but how to respond to this is in our control. Further research is recommended when this situation occurs because it did not during this research. Further research is recommended on the process of the expedition department that takes care of the main actions of the weighing on the weighbridge. Additionally, research on the process of internal transport that also makes use of the weighbridge might be useful and should be added to that research. The process of the expedition department on the weighing is currently also not visualised what is a good base to this research as the visualisation of the processes of internal transport was the base of this research.

Another recommended research investigates the situation with the uncertainty of the amount of trucks from outside that arrive and unload at the apple preselection. Currently, the apple preselection has difficulties with handling those trucks and the internal transportation at the same time. The recommendations of this research will help this problem but when it comes to the result that that is not enough, it is recommended that this problem is taken more seriously, and extra research is required. Further research is recommended on the processes of the apple preselection of the forklift drivers because at all the processes of these employees the flow could improve. When the flow of these processes improves, the internal transport will also improve, and the other departments will also benefit from these improvements.

8.3.2 Research on internal transport

The entire year of FruitMasters consists of busy and quiet periods. This research was done during one of the quiet periods which means that all observations, research, and conclusions are based on that period. After adapting the recommended changes, the entire situation will change both because of the changes that are done, and a busy period will start. Currently, some communication is lacking, mostly because some communication that is used is one-sided, which is already a problem itself, and removing the required communication here and replacing it with actions in the new ERP system will already help. Problems that still occur here have a direct impact on the rest of the processes and should be limited. When extra research appears to be needed after implementing the recommendations, that should be done. Further research is recommended on the agreements that are made, how they are processed and how the processes between the different departments are aligned after the changes. The purpose of this research

should be to check on how the recommended changes are adapted, how they improved the situation and what could be improved more. This research is important to keep improving the situation and adjust it where necessary. When the employees do not notice any bottlenecks after adapting the changes, this research is not required. The research is only required when problems keep occurring and the employees are best at judging the flow of the processes.

8.4 Summary

The conclusions that are made on the main research questions of this research will answer the research question: "**What are the conclusions on the main research questions answered in this research?**" of Section 8.1. Currently there are bottlenecks in the processes surrounding the moving carts. When the origins of these bottlenecks are tackled, the situation will improve and decrease the idle time of internal transport. Besides the underpinning that is done on the recommended changes, the respondents of the FruitMasters survey are convinced on its improvements. The recommendations are implemented in the visualisations that are done based on the literature research. This research did already have a positive effect on the situation because the employees already started to improve their own work during/after the research. When the real recommended changes are also adapted the situation and will create more improvements, the decrease of the idle time of internal transport with 15% is very reasonable.

In Section 8.2 the conclusions after the recommendations answered the research question: "**What are the conclusions on the situation after applying the solution approach?**". The persuasiveness of the conclusions of this research question are based on the reasoning, explanations, and the opinions of the employees. The solution approach was based on tackling the origins of each bottleneck. The reasoning why these are the origins of each bottleneck was explained very detailed in Section 3.1. The employees agreed with this and the opinions of the employees were also that the situation after applying the solution approach will be improved. Changes are needed to reduce the bottlenecks and they are convinced that the recommended changes will make sure of that.

Further research that is recommended in Section 8.3 by this research is discussed and logically answers the research question "**What further research is recommended by this research?**". There is research recommended on the processes that are aligned to the trucks that enter FruitMasters from outside both at the weighbridge and at the apple preselection department. These researches are required because this research observed that problems that occur here should also be tackled in the future. When all communication problems are solved after adapting the recommended changes, no further research here is required. When there are still communication problems after the changes, there should be more research on the origin of these problems and what should be changed to improve the situation.

8.5 Conclusion

The last conclusion of this research will show how this research will solve the action problem. The research question that is to be answered here is: "**What will decrease the idle time of the internal transport employees with 15%?**". To answer this research question we look at the

recommendations that are done in this research. The short-term recommendations consist of hiring more employees where required, change batteries at the end of a shift, adapting more effecting habits, giving insight in what cask the soft fruit is entering in, change the parking spot during auction hours and last add deadlines to all orders. The long-term recommendations consist of implementing all internal orders with additional details, all remaining tasks of internal transport, all deadlines to the new ERP system. The last recommendation is to track all data that is collected by the new ERP system to be able to improve the processes of internal transport even more. The recommendation that was indicated by the employees is to have spare people that can do internal transport and his/her tasks are still done by other employees. Besides these changes, further research might be required to decrease the idle time of the internal transport employees with 15%. This research need to be done at bottlenecks that are not in the processes surround the carts but do create bottlenecks in these processes. The research that is recommended is research on the processes that are aligned to the trucks that enter FruitMasters from outside both at the weighbridge and at the apple preselection department. Solving these bottlenecks and solving the bottleneck of this research will all together decrease the idle time of the internal transport employees with 15%, according to this research and the opinions of the employees of FruitMasters.

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Appendices

Appendix A the annual data on each route of the carts and trailer from week 25 of 2019 till week 24 of 2020

In the two tables below the data of the routes is shown. The following legend will explain the flow of each route. Besides the numbers that are already in use to describe the departments, abbreviations are used to clarify them even more.

1 = CC = Cask centre
2 = PSA = Packing station apples
3 = I = Industry
4 = PSSF = Packing station soft fruits
5 = PSP = Packing station pears
6 = E = Expedition
7 = A = Auction
8 = CS = Cold store
9 = CTC = Packing station apples where the apples go from cell to cell

When a route happened less than 10 times during the last year, these routes were exceptional, and these routes are not considered in the two tables below. The top 5 most often routes are marked in the table of the routes with the carts and in the table with the terminal trailer it is obvious that the terminal trailer is most used between the packing station apples and expedition.

Carts	To								
From	1-CC	2-PSA	3-I	4-PSSF	5-PSP	6-E	7-A	8-CS	9-CTC
1-CC	26	516	12	**1175**	188	39	12	0	0
2-PSA	164	112	**923**	0	13	**1694**	16	67	0
3-I	31	26	17	0	0	0	0	0	0
4-PSSF	373	12	0	0	0	0	0	0	0
5-PSP	39	60	28	0	0	42	0	0	0
6-E	40	**612**	0	0	28	20	0	17	0
7-A	0	0	0	0	16	0	0	0	0
8-CS	0	**876**	10	15	296	55	0	12	11
9-CTC	0	0	0	0	0	0	0	0	0

Trailers	To								
From	1-CC	2-PSA	3-I	4-PSSF	5-PSP	6-E	7-A	8-CS	9-CTC
1-CC	0	14	0	0	0	0	0	0	0
2-PSA	0	0	10	0	0	1544	14	0	0
3-I	0	0	0	0	0	0	0	0	0
4-PSSF	0	0	0	0	0	0	0	0	0
5-PSP	0	0	0	0	0	85	0	0	0
6-E	0	54	0	0	0	0	0	0	0
7-A	0	0	0	0	0	0	0	0	0
8-CS	0	18	0	0	0	0	0	0	0
9-CTC	0	0	0	0	0	0	0	0	0

Appendix B the maps of FruitMasters where all incoming internal transportation of products at each department are visualised.

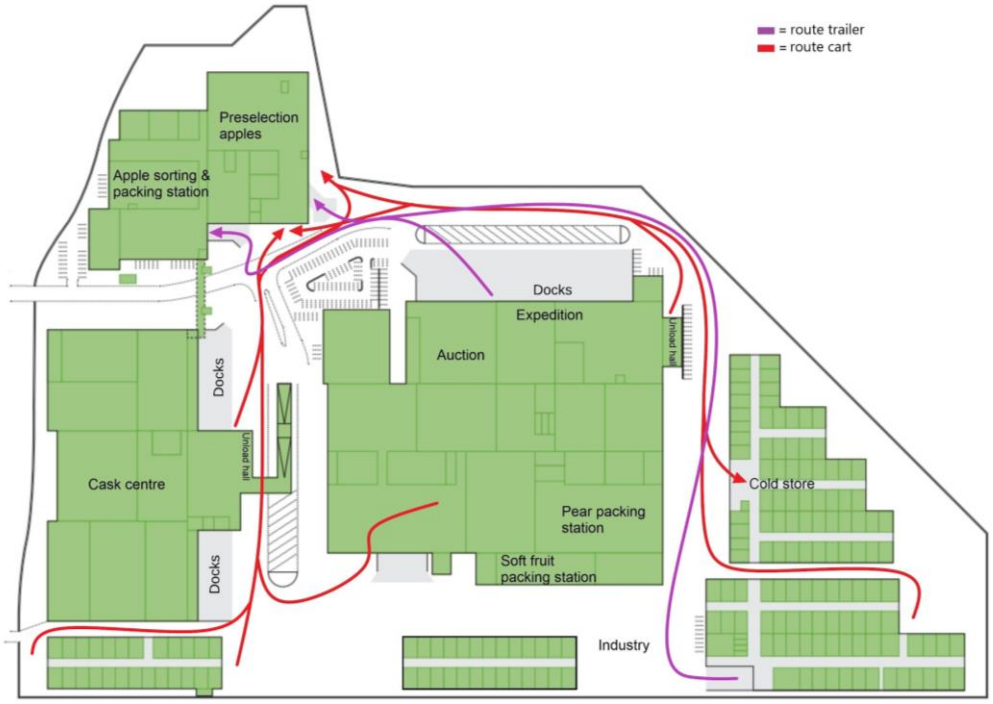
In the maps that are used in this appendix and Appendix C the maps of FruitMasters where all outgoing internal transportation of products at each department are visualised, the choice was made to not show the size of the transportation flows in the thickness but in the description. The reason for that was because the range of the flows go from 1694 to 10, which makes it difficult to estimate the size of transportation flow according to the thickness.

Incoming internal transport at the cask centre department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the soft fruits/pears packing stations occurred 373 times, the flow from the apple preselection/packing stations occurred 164 times, the flow from the expedition occurred 40 times, the flow from pear packing station occurred 39 times and from the industry occurred 31 times. The routes from the cask centre towards the cold store or industry is when the cask needs a place to be stored, what is done at these departments, this flow occurred 26 times.

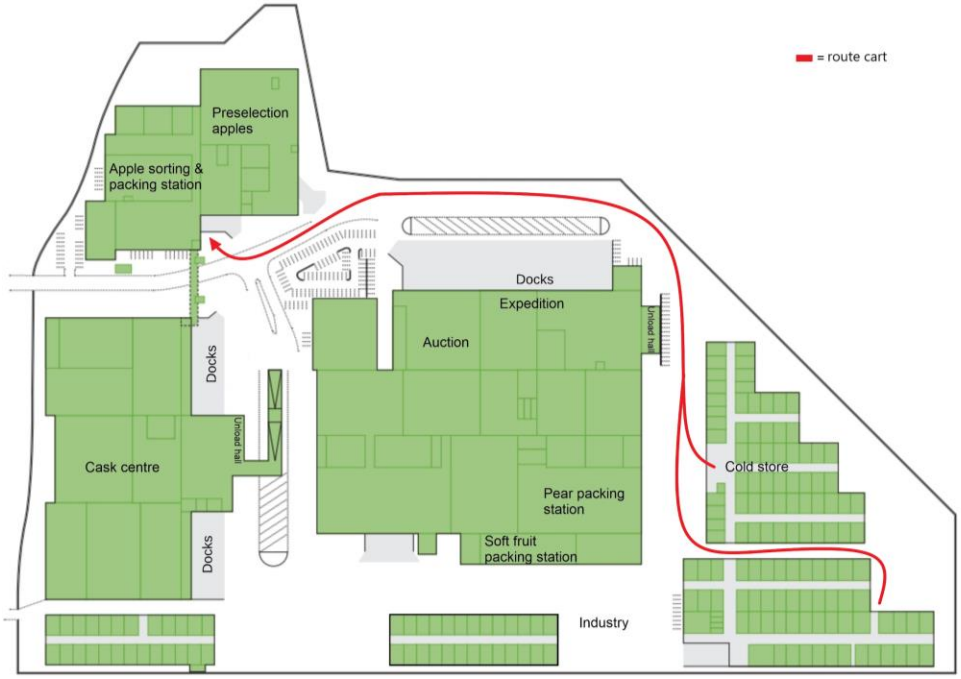
Incoming internal transport at the apple preselection department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from cold store with the carts occurred 876 times, the flow from expedition with the carts occurred 612 times, the flow from the cask centre occurred 516 times, the flow from the pear packing station occurred 60 times, the flow from the pear packing station with the trailer occurred 54 times, the flow from the industry occurred 26 times, the flow from the cold store with the trailer occurred 18 times and from the soft fruits packing station occurred 12 times. The route from the apple packing station towards the cold store is when the apples need a place to be stored, what is done here, and this flow occurred 112 times. What exactly went towards the apple preselection instead of the apple packing station is very difficult to determine.



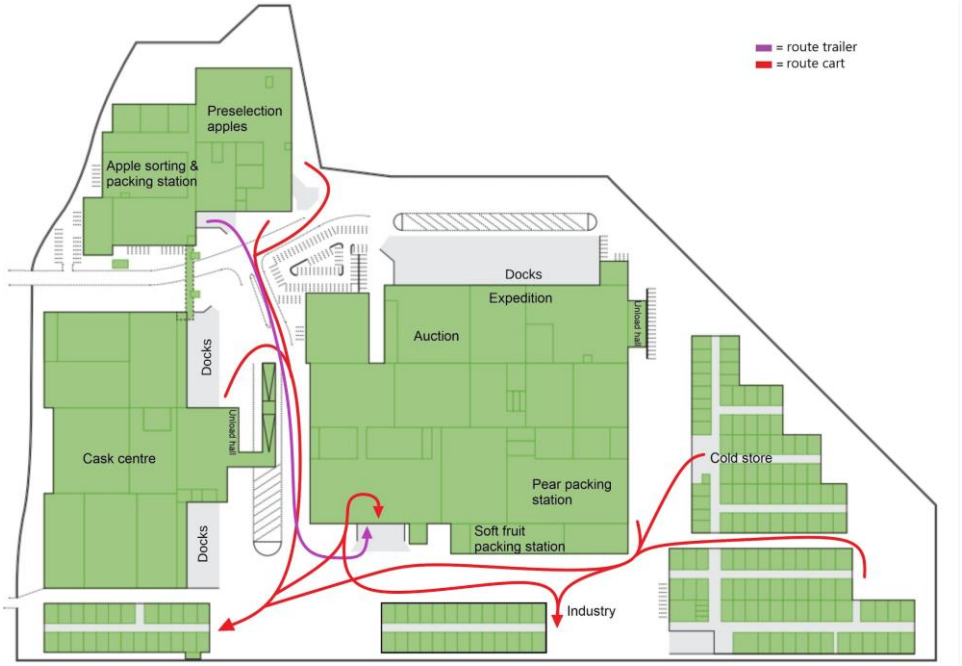
Incoming internal transport internal at the apple packing station department

In the data collecting of the data of week 25 of 2019 till week 24 of 2020, there is no differentiation between the number of routes towards the apple preselection and the apple packing station. That makes it difficult to determine the number of times the following flow occurred.



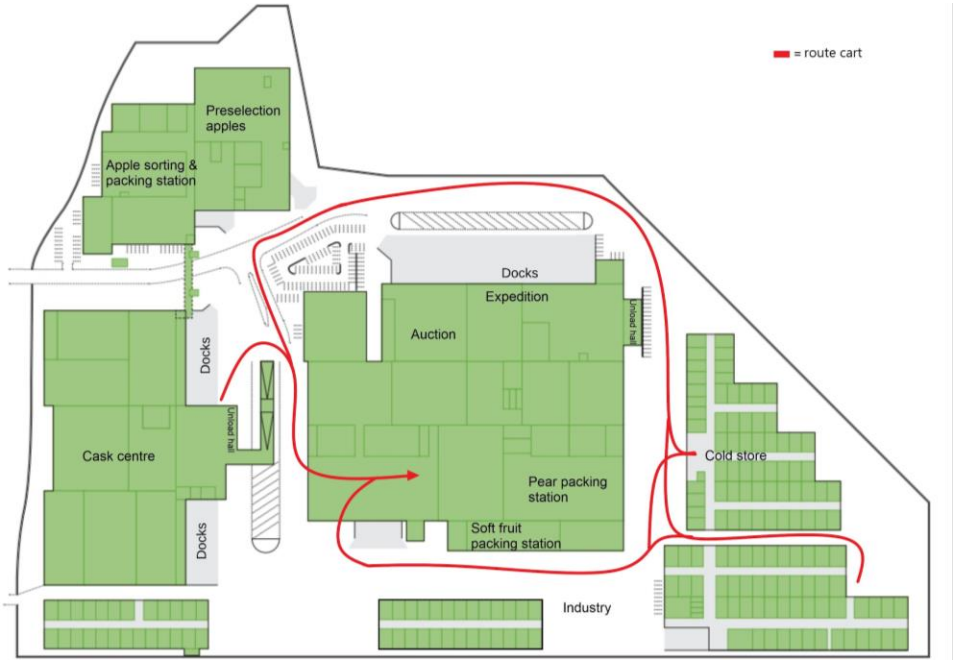
Incoming internal transport at the industry department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the apple packing station occurred 923 times, the flow from the pear packing station occurred 28 times, the flow from the cask centre occurred 12 times, the flow from the apple packing station with the trailer occurred 10 times and from the cold store occurred 10 times. The route from the industry towards the industry is when the industry needs another place to be stored and this flow occurred 17 times.



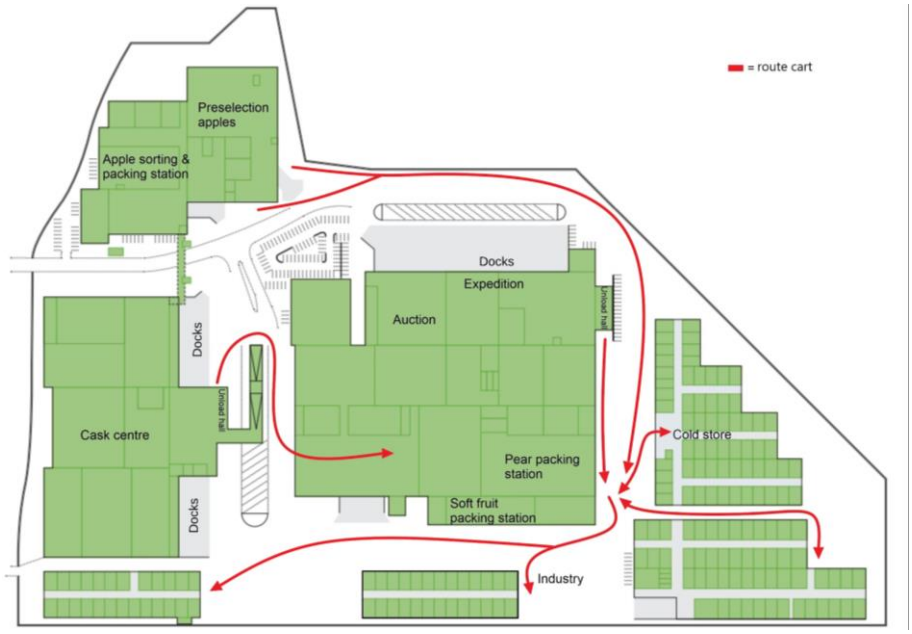
Incoming internal transport at the soft fruit packing station department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the cask centre occurred 1175 times and from the cold store with the carts occurred 15 times.



Incoming internal transport at the pears packing station department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the cold store occurred 296 times, the flow from the cask centre occurred 188 times, the flow from the expedition occurred 28 times, the flow from the auction occurred 16 times and from the apple packing station occurred 12 times.



Incoming internal transport at the expedition department

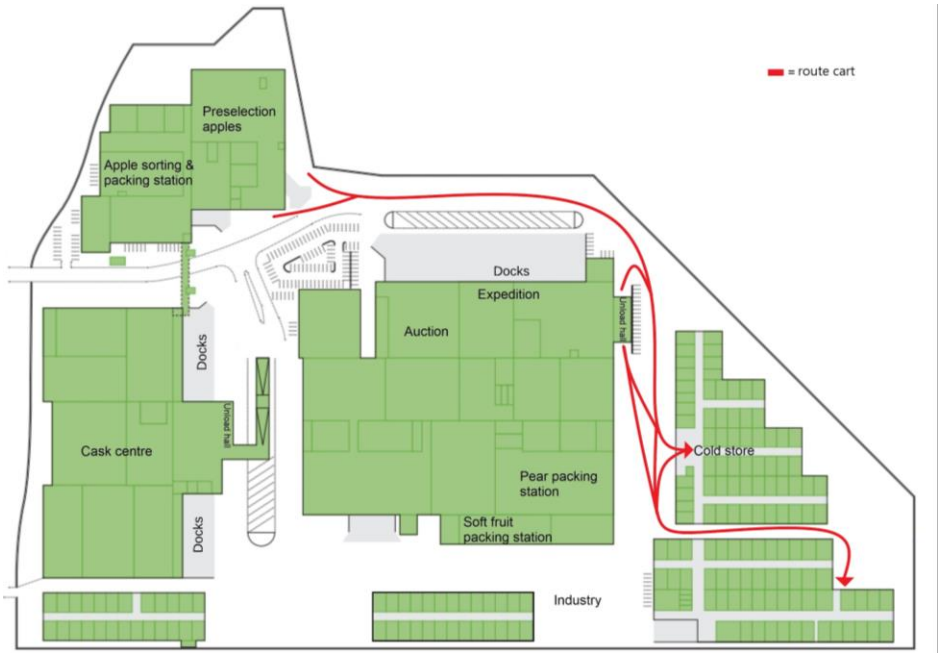
Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the apple packing station with the carts occurred 1694 times and with the trailer occurred 1544 times, the flow from the pear packing station with the trailer occurred 85 times, the flow from the cold store occurred 55 times, the flow from the pear packing station with the carts occurred 42 times and from the cask centre occurred 39 times. The route from the expedition to the cold store is when the products need a place to be stored, this flow occurred 20 times.

Incoming internal transport at the auction department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the apple packing station with the carts occurred 16 times, the flow from the apple packing station with the trailer occurred 14 times and the flow from the cask centre occurred 12 times.

Incoming internal transport at the cold store department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow from the apple packing station occurred 67 times and the flow from the expedition occurred 17 times. As was visible in all the earlier maps, when products are stored internally, this is incoming at the cold store. The total amount of internal storage flows occurred 187 times, of which 12 times products were transported from cold store to cold store.



Appendix C the maps of FruitMasters where all outgoing internal transportation of products at each department are visualised.

Outgoing internal transport at the cask centre department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the soft fruits packing station occurred 1175 times, the flow towards the apple packing station occurred 516 times, the flow towards the pear packing station occurred 188 times, the flow towards the expedition occurred 39 times, the flow towards the industry occurred 12 times and the flow towards the auction occurred also 12 times. As discussed in Appendix B the maps of FruitMasters where all incoming internal transportation of products at each department are visualised, when cask was stored internally in the industry or cold store, it could also occur that internal transport transports it back again to the cask centre. This means that the flow from that went to the industry or cold store that happened 26 times could also be towards the cask centre.

Outgoing internal transport at the apple packing station department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the expedition with the carts occurred 1694 times and with the trailer the flow occurred 1544 times, the flow towards the industry occurred 923 times, the flow towards the cask centre occurred 164 times, the flow towards the cold store occurred 67 times and the flow towards the auction with the carts occurred 16 times and with the trailer occurred 14 times, the flow towards the pear packing station occurred 13 times and the flow towards industry with the trailer occurred 10 times. The relocation of the apples from or towards the cold store, from or towards the apple packing station occurred 112 times.

Outgoing internal transport at the industry department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the cask centre occurred 31 times and the flow towards the apple packing station occurred 26 times. The relocation of industry from or towards the cold store, from or towards the industry occurred 17 times.

Outgoing internal transport at the soft fruits packing station department

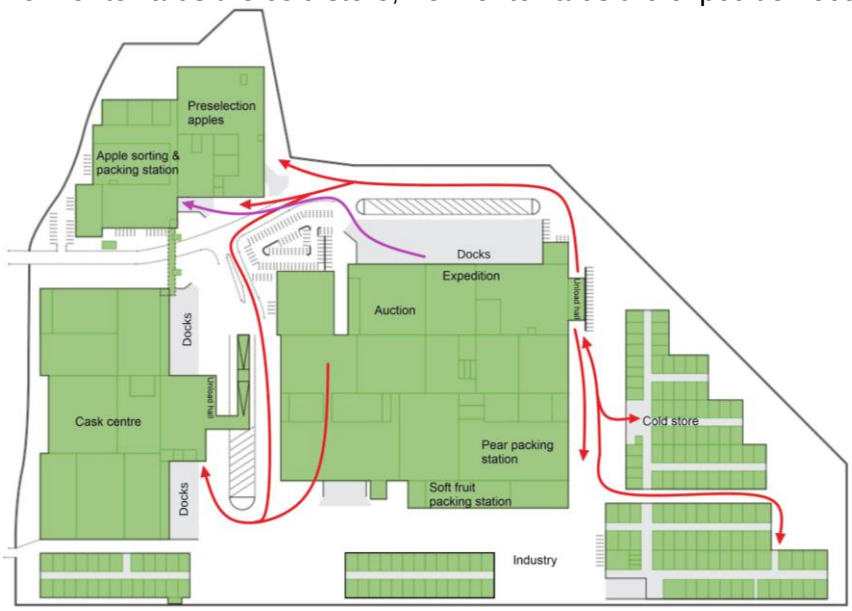
Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the cask centre occurred 373 times and the flow towards the apple packing station occurred 12 times.

Outgoing internal transport at the pears packing station department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the expedition with the trailer occurred 85 times and with the carts the flow occurred 42 times, the flow towards the apple packing station occurred 60 times, the flow towards the cask centre occurred 39 times and the flow towards industry occurred 28 times.

Outgoing internal transport at the expedition department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the apple packing station with the carts occurred 612 times and with the trailer the flow occurred 54 times, the flow towards the cask centre occurred 40 times, the flow towards the pear packing station occurred 28 times and the flow towards the cold store occurred 17 times. The relocation of the products from or towards the cold store, from or towards the expedition occurred 20 times.

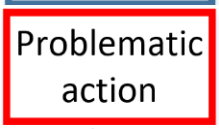


Outgoing internal transport at the cold store department

Taking the data of week 25 of 2019 till week 24 of 2020, the flow towards the apple packing station with the carts occurred 876 times, the flow towards the pear packing station occurred 296 times, the flow towards the expedition occurred 55 times, the flow towards the apple packing station with the trailer occurred 18 times and the flow towards the soft fruits packing station occurred 15 times and the flow towards the industry occurred 10 times. The relocation of the products from or towards the cold store, from or towards the cold store occurred 12 times.

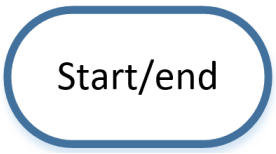
Appendix D Legend of the basic flowchart shapes used for visualisation of internal transport processes

When an action is done, it is written in the square, at the function of a department that executes it.



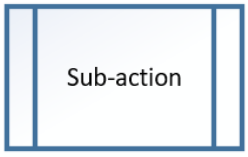
When an action was not ideal and should be tackled and removed, the square should be coloured red

When decisions are made it is written in the diamond. The connecting line from this shape needs to have the text that describes the decision that is made.



The flowchart should begin at this oval and end with this oval. The overall process might not exactly start at this point but at this point the process interfaces with internal transport. These extremities visually show the scope of this research.

This is a connecting line, it shows the flow in between the different shapes, the relationship between two shapes and constraints that are related to the shapes.

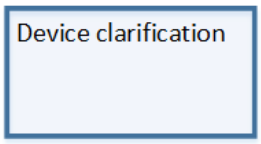


When an action consists of different smaller actions it could be visualised by a sub-action. A sub-action is most useful when these different smaller actions need to be done by different functions.

When a database is used in the process it is important to implement it into the flowchart. The database will be put at the function that puts the data into the database.

When a document is used in the process, it is implemented in the flowchart to refer to the information that is needed.

When data/information is needed from another source than a database or a document, it is written in this parallelogram.



This is not one of the basic flowchart figures Visio Microsoft Office uses. FruitMasters uses this figure to dome a part of the process to clarify the device of application that is being used for that part of the process.

Appendix E Systematic literature review

The knowledge goal of this research was: “To find a way to get access to the up-to-date performance information of the internal transport.” The research question that needs to be answered to achieve this goal is “Which KPIs are valuable in evaluating the performance of the processes of internal transport?”.

Inclusion and exclusion criteria	
Include if:	**Reason for inclusion**
Source is about process KPIs	The goal is to find KPIs on processes of internal transport
Source is peer-reviewed	It creates a more reliable source. Peer-reviewed is a process by which something proposed, as for research or publication, is evaluated by a group of experts in the appropriate field.
Exclude if:	**Reason for exclusion**
Source is not about KPIs (where KPI stands for Key Performance Indicator)	Not relevant as the goal is to find KPIs on processes of internal transport
Subject is not in the subject area of process performance and internal transport	Not relevant as the goal is to find KPIs on processes of internal transport
Source is a duplicate	Source is already found
No open access	Not accessible without paying
Source is in a foreign language	I cannot understand texts that are not in English or Dutch.

Table 6 Inclusion and exclusion criteria for the articles of this systematic literature review.

Search term	**Search engine**	**Scope**	**Number of articles before use of criteria**	**Number of articles after including and excluding criteria**	**Date of search**
KPI process transport	FindUT	Keywords	324	4	24-06-2020
selection KPI	FindUT	Keywords	1208	10	25-06-2020
KPI Logistics	Scopus	Title, keywords and abstract	170	4	25-06-2020
Total number of articles before adding criteria					1702
Removed based on include and exclude criteria					1684
Total sources read					18
Sources selected after reading					4

Table 7 Articles found on search terms

The articles that were useful and will be used to answer the research question are:

- "The transport performance evaluation system building of logistics enterprises" (Wang, Chen, & Zhang, 2013)
- "Optimization of enterprise analysis model for KPI selection" (Kaganski, Eerme, & Tungel, 2019)
- "The balanced scorecard and EFQM working together in a performance management framework in construction industry" (Vukomanovic & Radujkovic, 2013)
- "Monitoring System Using GPS for Logistic's Key Performance Indicator" (Girsang & Prabowo, 2019)

A conceptual matrix

There are a lot of KPIs for internal transport processes. There are different ways to determine the useful KPIs and some examples are summarized in the following table.

Paper	Process KPIs
The transport performance evaluation system building of logistics interprises (Wang, Chen, & Zhang, 2013)	The performance evaluation of logistics transport enterprises set about service quality, service cost, market capacity, information capacity four aspects. Transportation security, convenience, accuracy, and timeliness are important aspects of service level evaluation several. We preliminarily determine the seven indicators to measure the service quality. The service quality performance indicators are correct order processing rate, on time delivery rate, communication ability, customer satisfaction, order tracking ability, flexible delivery, and cargo damage rate. Information ability, service cost performance indicators and market ability performance indicators are not useful for this research.
Optimization of enterprise analysis model for KPI selection (Kaganski, Eerme, & Tungel, 2019)	The KPIs selection process is performed as follows: - analysis of the enterprise. The enterprise analysis model (EAM) as a first phase of the selection is used to collect not only the general information about the company where study has been conducted, but also outline the weak spots faced by the management of the enterprise. The questionnaire is filled in by the employees, based on their position at the company (different amount and different questions). This allows to feature KPIs selection for companies or type of companies, etc. The following EAM goals can be outlined as follows: getting the general information about the enterprise (field of action, number of employees, etc.); discovering the critical spots (based on the answers of the questions); and providing the information which data should be collected based on the critical spots to eliminate the amount of unnecessary data (as there are links between KPIs and questions). - data collection for the analysis. A web-based questionnaire is composed as a rule – this enables to collect and analyse data more quickly and with higher efficiency (manual data collection is considered for special cases). The collected data are verified and stored in the database (server-cloud); - data analysis. Sorting and grouping by numbers of respondents, applying weights. The answers are being analysed and evaluated by their importance (the answers are ranked by the 6-point scale, where 1 means that the answer is critical and needs to be taken into account

	and 6 means that the situation described in the question is not critical for the company); - KPIs selection. The package of KPIs is selected by the expert group and two approaches: SMARTER criteria and fuzzy analytical hierarchy process (AHP); In turn, the KPIs were divided into 3 groups to simplify linking: (1) direct KPIs, indicators, which were in explicit correlation with the answers; (2) indirect KPIs, indicators, which were connected with more than one question; (3) suggested KPIs, indicators, which were proposed to the management for further study. - KPIs' implementation (the selected package of metrics is implemented by the company based on their ranks). The basic steps of the proposed KPI selection/ optimization procedure can be outlined as follows: Step 1. Forming initial questionnaire, KPIs. Step 1.1. Composing initial questionnaire based on literature, experts. Step 1.2. Composing initial KPIs. Step 1.3. Identifying links between constructs and questions. Step 1.4. Identifying links between questions and KPIs. Step 1.5. Classification of KPIs (direct, indirect, suggested). Step 2. Applying an expert group to reduce questions, KPIs. Step 2.1. Omitting questions unrelated or weakly related to KPIs. Step 2.2. Omitting questions/KPIs, with no or weak impact on production. Step 2.3. Ranking questions. Step 3. Applying outlier's method for reducing questions, KPIs. Step 3.1. Selection of outlier's methods. Step 3.2. Employing the standard deviation method. Step 3.3. Employing the Z-score method, modified Z-score method. Step 3.4. Employing Tukey's method. Step 3.5. Employing the adjusted boxplot method. Step 3.6. Selection of outliers based on the results of applying outlier's methods. Step 4. Estimating the final set of KPIs and questions.
The balanced scorecard and FQM working together in a performance management framework in construction industry (Vukomanovic & Radujkovic, 2013)	Selection process of KPIs is vague and is also an obstacle to the model's efficiency, e.g. KPIs can be selected in respect to strategic objectives, and then, as the measurement process progresses, frequently adjusted. For every strategic objective, KPIs were selected against SMARTER criteria (Specific, Measurable, Achievable, Relevant, Time-bound, Extended/Exciting and Rewarding/Recorded). SMART criteria are not new, but we added 'E' and 'R' since extended goals and rewards have proved to be simulative incentives of implementing strategy. Every strategic objective ought to have at least one KPI assigned and the KPIs must be cascaded down to lower management levels.
Monitoring System Using GPS for Logistic's Key	KPI (key performance indicator) in the logistic business sector is mainly used to measure and show gaps between fundamental logistic processes while delivering goods and the expected performance proposed by the company. Real-time data play a crucial part in this case, because obtaining information

Performance Indicator (Girsang & Prabowo, 2019)	and giving feedback to correspondents can be done more quickly (between operators and courier). Implementation of websocket may help achieve that, because its behaviour provides a full-duplex, communication channel that operates through a single connection which builds scalable and real-time applications. The proposed method is mainly aimed to identify the criteria which should be considered in vendor transporter work performance (KPI) evaluation aspect. We include relevant KPI aspects such as task assignment, manageable delivery time, completed administration and fleet availability management and its system design to achieve related aspects. There are some steps to develop a real-time monitoring and tracking system. **Business Requirement Analysis.** This phase gathers information regarding business process from process business by interview with related job description required to obtain the requirements. **User Requirement Analysis.** This phase is to obtain information from the process owner regarding the new proposed model. **Evaluation analysis.** Based on requirements analysis, the best method is chosen and transformed into suitable aspects evaluation. **Prototyping**. This step is conducted in the architectural design and development of products or services. In this case, the requirements are transformed into an application to understand the system method or concepts. **Implementation**. In this phase, the new proposed method is implemented which is customized based on existing business models and solving the current problem. **Reporting (Documentation).** Reporting or documentation is taken to track which parts of the model are proven to be successful or failed as the solution of the problems. The four aspects that are formulated to evaluate KPI are: task assignment, on-time delivery, completed administration and availability. Task Assignment (TA). Variable TA is derived from assignment (delivery order) completed by the vendor divided by total assignment given per evaluation period as shown Eq. (1). $$TA = \frac{Completed\ assignment\ (per\ evaluation\ period)}{Total\ assignment\ (per\ evaluation\ period)} x100 \quad (1)$$ On-Time Delivery Target (OTD). Variable OTD is derived from completed delivery expectation (by customer) divided by total assignment given per evaluation period as shown Eq. (2). $$OTD = \frac{Completed\ delivery\ expectation\ (per\ evaluation\ period)}{Total\ assignment\ (per\ evaluation\ period)} x100 \quad (2)$$ Completed Administration (CA). Variable CA is derived from vendor capability to submit required documents or return documents to PT. XYZ as shown Eq. (3). $$CA = \frac{Returned\ administration\ (per\ evaluation\ period)}{Total\ assignment\ (per\ evaluation\ period)} x100 \quad (3)$$

	Availability (A). Variable A is derived from total accepted assignment or delivery order given by internal staff of PT. XYZ, and vendors must provide fleet based on contract while outsourcing permission as shown Eq. (4). $$A = \frac{\begin{matrix}Total\ accepted\ assignment \\ (per\ evaluation\ period)\end{matrix}}{\begin{matrix}Total\ contracted\ unit \\ (per\ evaluation\ period)\end{matrix}} x100 \quad (4)$$ The proposed KPI calculates the overall KPI grade or score based on recorded activity data done in evaluation period time which include task assignment, on-time delivery target, completed administration and availability. The formula of the overall KPI is shown in Eq. (5). $$\text{KPI} = \frac{TA+OTD+CA+A}{4} \quad (5)$$ KPI evaluation based on real-time data monitoring is important to determine transporter performance and solution to the issues by outsourcing logistic process function.

Table 8 the useful papers and their view on KPIs of internal transport processes.

Integration of the theory

With the data gathered from the articles, the research question: “Which KPIs are valuable in evaluating the service quality performance of the processes of internal transport?” can be answered and contribute to the overall knowledge goal: “To find a way to get access to the up-to-date performance information of the internal transport.”.

From this literature review we can conclude there are different ways to determine the useful KPIs. To combine everything, the process to determine the KPIs of the internal transport processes of FruitMasters is as follows. During this process it is important to consider the SMART criteria (Specific, Measurable, Achievable, Relevant, Time-bound).

There are some steps to develop a real-time monitoring and tracking system.

Business Requirement Analysis. This phase gathers information regarding business process from process business by interview with related job description required to obtain the requirements. This is used to collect not only the general information about the company where study has been conducted, but also outline the weak spots faced by the management of the enterprise. This can be done by a questionnaire filled in by the employees, based on their position at the company. Some examples of KPIs are the service quality performance indicators: correct order processing rate, on time delivery rate, communication ability, customer satisfaction, order tracking ability, flexible delivery, and cargo damage rate.

User Requirement Analysis. This phase is to obtain information from the process owner regarding the new proposed model.

Evaluation analysis. Based on requirements analysis, the best method is chosen and transformed into suitable aspects evaluation. This phase creates the KPIs based on earlier conducted information of the company.

Prototyping. This step is conducted in the architectural design and development of products or services. In this case, the requirements are transformed into an application to understand the system method or concepts.

Implementation. In this phase, the new proposed method is implemented which is customized based on existing business models and solving the current problem.

Reporting (Documentation). Reporting or documentation is taken to track which parts of the model are proven to be successful or failed as the solution of the problems.

The content of these papers can contribute to my bachelor thesis. The KPIs of the internal transport processes from the papers will be used for the determination of the productivity of the processes.

Appendix F The data gathered to measure the performance of internal transport of week 27 of 200 till week 30 of 2020

	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
Completed orders of today	36	37	46	43	28	26	15	21	41
Completed delivery expectation of today	36	37	48	43	28	26	17	21	41
Total requested carts that could be delivered of today	27	30	25	26	15	17	11	12	27
Total carts requested per day	27	30	25	26	15	17	11	12	27
Total tracked orders of today	24	15	27	22	15	14	11	12	24
Total orders of today	36	37	48	43	28	26	17	21	41

	July 13	July 14	July 15	July 16	July 17	July 20	July 21	July 22	July 23	July 24
Completed orders of today	49	72	32	50	34	70	42	34	66	42
Completed delivery expectation of today	51	72	34	50	37	70	42	34	66	44
Total requested carts that could be delivered of today	29	42	19	30	20	37	23	17	42	23
Total carts requested per day	29	42	19	30	20	37	23	17	42	23
Total tracked orders of today	23	34	15	24	15	30	19	11	34	16
Total orders of today	51	72	34	50	37	70	42	34	66	44

Appendix G The KPIs based on the data gathered of internal transport of week 27 of 200 till week 30 of 2020 in percentages

KPIs	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
TA	100	100	95,8	100	100	100	88,2	100	100
OTD	100	100	100	100	100	100	100	100	100
A	100	100	100	100	100	100	100	100	100
OTA	66,7	40,5	56,3	51,2	53,6	53,9	64,7	57,1	58,5
IT	44,6	37,5	38,3	42,9	65	72,3	90,2	58,6	36,9

KPIs	July 13	July 14	July 15	July 16	July 17	July 20	July 21	July 22	July 23	July 24
TA	96,1	100	94,1	100	91,9	100	100	100	100	95,5
OTD	100	100	100	100	100	100	100	100	100	100
A	100	100	100	100	100	100	100	100	100	100
OTA	45,1	47,2	44,1	48	40,5	42,9	45,2	32,3	51,5	36,4
IT	33,5	28,3	35	38,8	53,1	18,5	47,9	52,5	21,9	53,8

Appendix H The collected data on the verification round during the research.

	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
Rounds where carts could be picked up	9	7	21	17	13	9	6	9	14
Rounds where carts could not be picked up	6	3	3	4	2	1	0	0	1

	July 13	July 14	July 15	July 16	July 17	July 20	July 21	July 22	July 23	July 24
Rounds where carts could be picked up	22	30	15	20	17	33	19	17	24	21
Rounds where carts could not be picked up	3	3	3	8	4	4	6	4	1	10

Appendix I The collected data on the occupation times of the carts and trailer at each department.

Depart-ment	Cask centre	Apple packing station	Apple packing station trailer	Industry	Soft fruits and pear packing stations	Expedition	Expedition trailer	Cold store
0:00-0:15	28	10	3	0	3	6	4	21
0:15-0:30	17	25	4	0	10	5	16	27
0:30-0:45	9	30	3	9	13	8	5	21
0:45-1:00	12	18	5	3	7	3	5	7
1:00-1:15	8	24	2	4	14	5	2	13
1:15-1:30	6	14	5	3	4	1	2	5
1:30-1:45	6	10	3	7	7	7	0	3
1:45-2:00	5	13	3	3	8	6	0	4
2:00-2:15	7	12	2	4	7	2	0	3
2:15-2:30	5	6	2	0	4	3	1	4
2:30-2:45	4	4	2	2	3	1	0	1
2:45-3:00	1	0	1	3	3	1	0	1
3:00-3:15	1	1	3	0	0	1	0	1
3:15-3:30	1	1	1	1	1	0	3	0
3:30-3:45	3	1	1	0	0	0	1	2
3:45-4:00	1	2	1	0	0	0	1	2
4:00-…	4	3	1	5	3	2	1	4

Appendix J The data gathered on the idle time of internal transport of week 27 of 200 till week 30 of 2020

	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
Total idle time of today in minutes	**214**	**135**	**184**	**206**	**312**	**347**	**433**	**299**	**151**
Total working time of today in minutes	**480**	**360**	**480**	**480**	**480**	**480**	**480**	**510**	**420**
Percentage of the day idle time	**44,6%**	**37,5%**	**38,3%**	**42,9%**	**65%**	**72,3%**	**90,2%**	**58,6%**	**36,9%**
The number of periods	**12**	**13**	**12**	**17**	**12**	**10**	**7**	**6**	**6**

	July 13	July 14	July 15	July 16	July 17	July 20	July 21	July 22	July 23	July 24
Total idle time of today in minutes	**161**	**136**	**168**	**186**	**255**	**89**	**230**	**252**	**105**	**258**
Total working time of today in hours	**480**	**480**	**480**	**480**	**480**	**480**	**480**	**480**	**480**	**480**
Percentage of the day idle	**33,5%**	**28,3%**	**35%**	**38,8%**	**53,1%**	**18,5%**	**47,9%**	**52,5%**	**21,9%**	**53,8%**
The number of periods	**14**	**11**	**12**	**20**	**15**	**13**	**18**	**17**	**12**	**18**

	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
The duration of each period	10	7	17	23	4	17	63	10	20
	43	12	9	7	7	72	132	59	62
	12	15	6	20	12	33	12	15	21
	12	7	20	5	6	15	140	96	20
	28	20	13	6	19	4	27	113	7
	12	11	46	11	26	33	5	6	21
	4	11	6	5	16	14	54		
	33	13	7	7	50	35			
	6	7	30	4	3	38			
	10	9	6	4	28	86			
	20	5	12	25	129				

	June 29	June 30	July 2	July 3	July 6	July 7	July 8	July 9	July 10
The duration of each period	24	10	12	10	12				
		8		20					
				13					
				11					
				24					
				11					

	July 13	July 14	July 15	July 16	July 17	July 20	July 21	July 22	July 23	July 24
The duration of each period	9	14	24	21	13	10	9	11	5	97
	22	9	27	4	15	4	16	23	11	9
	4	10	5	26	4	5	15	6	28	4
	5	8	6	3	10	5	26	4	8	4
	17	5	16	3	23	8	7	9	8	4
	11	10	34	11	6	4	6	51	7	6
	6	12	8	14	7	8	18	4	7	6
	5	9	10	9	10	4	5	7	7	4
	6	19	10	26	18	8	14	37	8	9
	4	25	6	5	11	15	4	5	6	7
	32	15	17	4	15	5	39	10	3	10
	12		5	4	12	7	34	18	7	23
	8			7	38	6	5	24		6
	20			9	8		5	24		4
				6	65		8	6		15
				5			4	4		16
				6			8	9		14
				7			7			20
				8						
				8						

Appendix K The occupation/unloading and loading times of the carts and trailer at each department

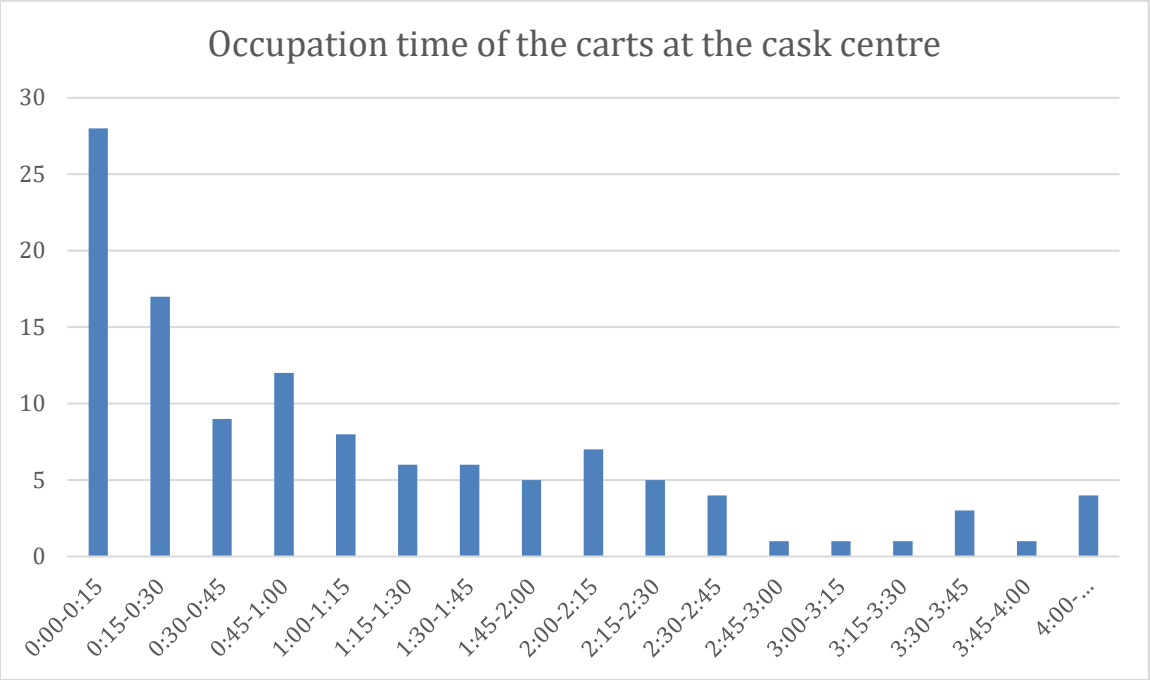


Figure 47 Occupation/unloading and loading time of the carts at the cask centre.

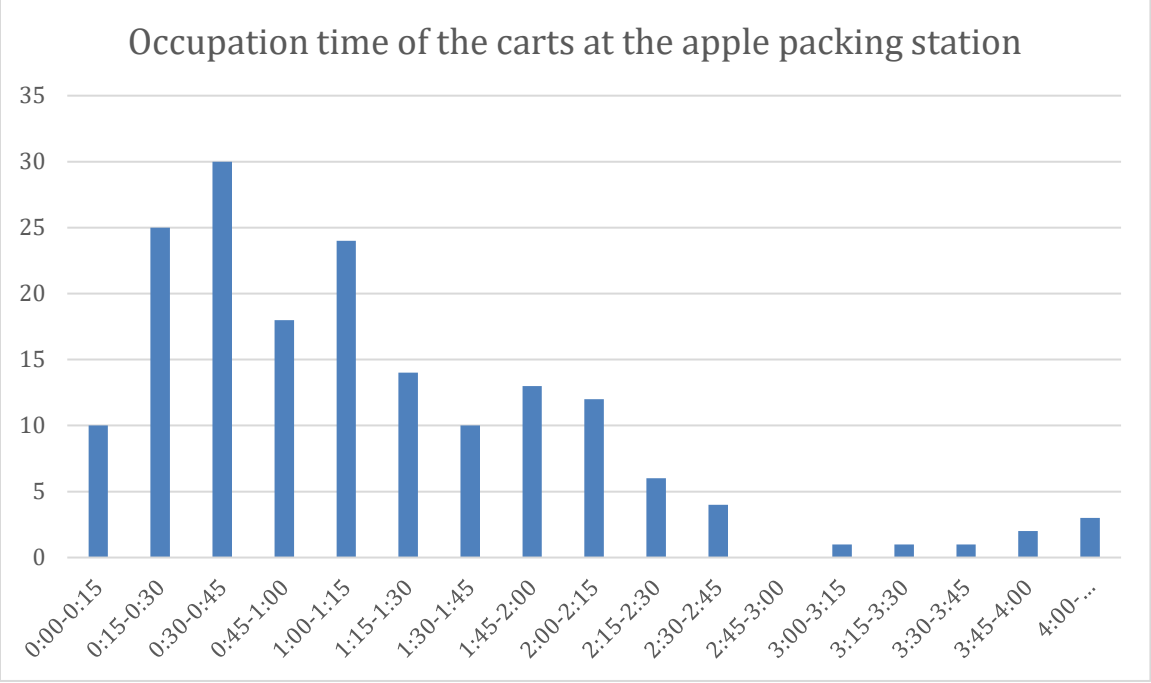


Figure 48 Occupation/unloading and loading time of the carts at the apple packing station.

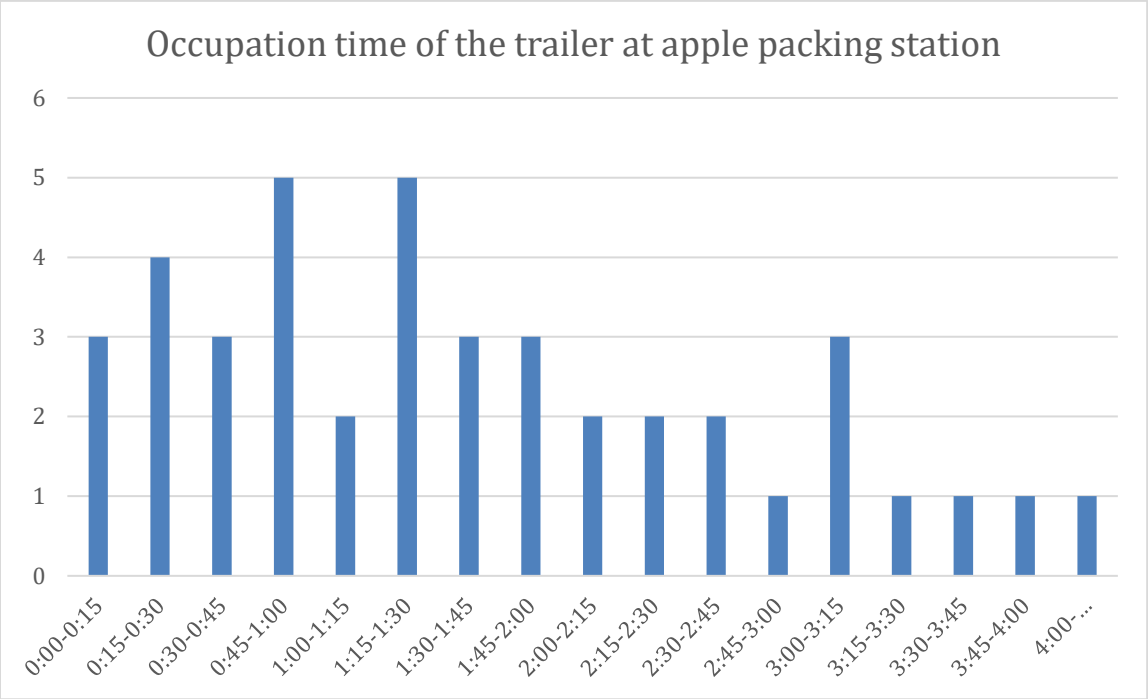


Figure 49 Occupation/unloading and loading time of the trailer at the apple packing station.

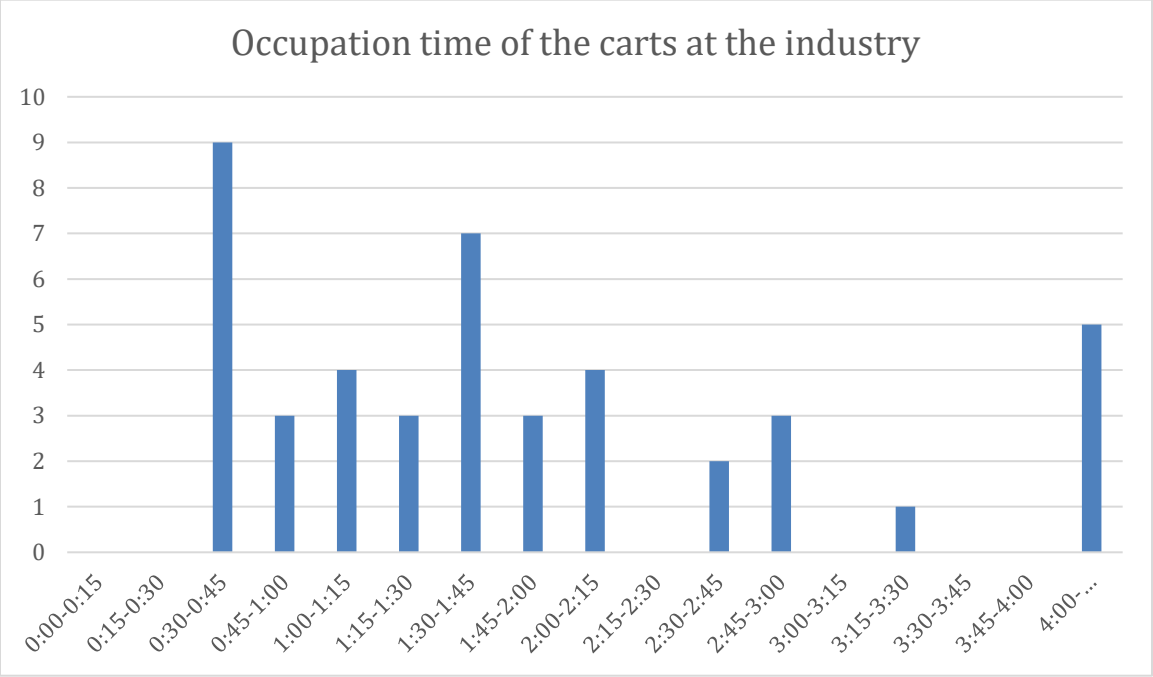


Figure 50 Occupation/unloading and loading time of the carts at the industry.

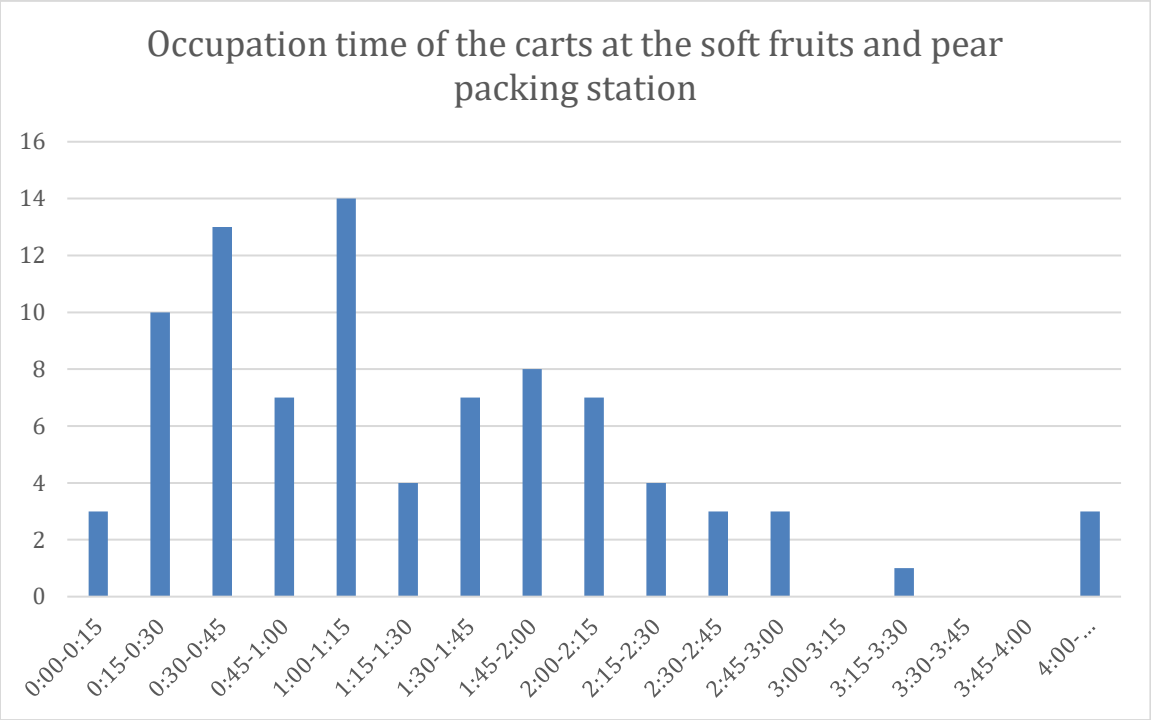


Figure 51 Occupation/unloading and loading time of the carts at the soft fruits and pear packing station.

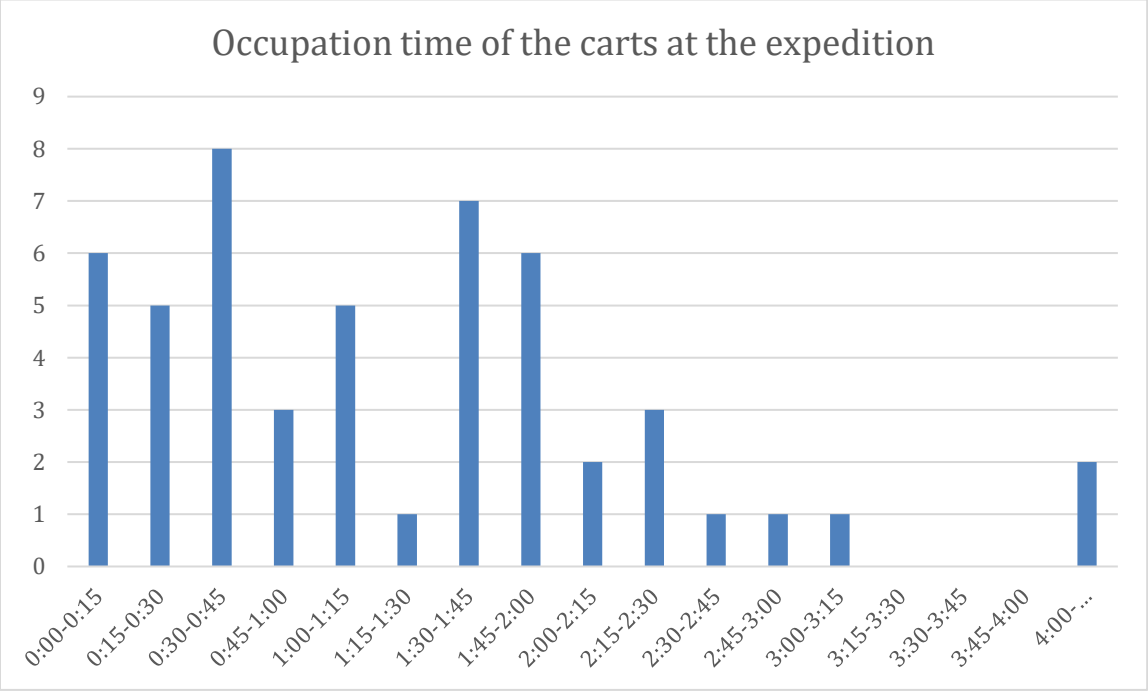


Figure 52 Occupation/unloading and loading time of the carts at the expedition.

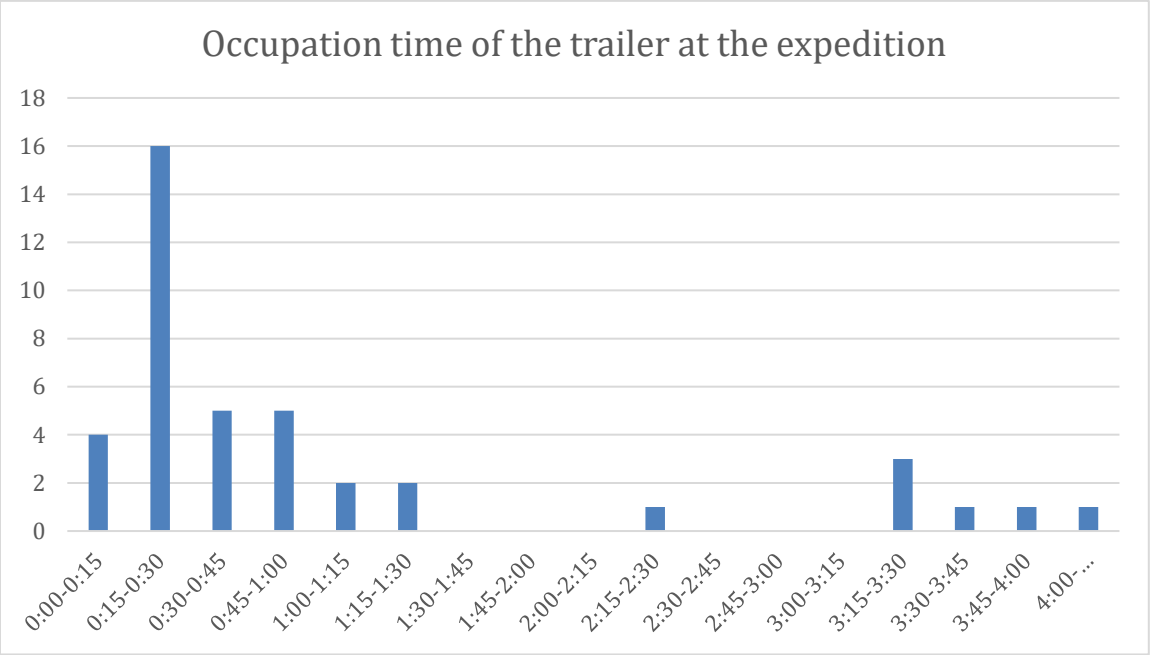


Figure 53 Occupation/unloading and loading time of the trailer at the expedition.

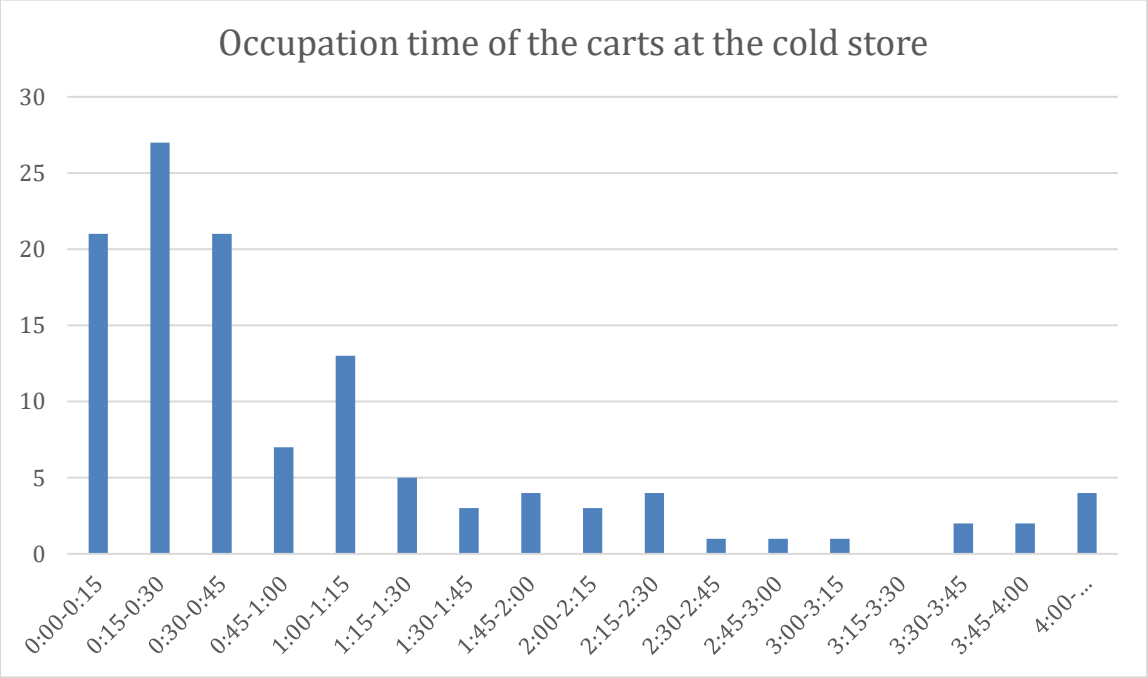


Figure 54 Occupation/unloading and loading time of the carts at the cold store.

Appendix L The responses from the employees that interface with the processes of internal transport to the questionnaire

What do you think of the current internal transport?

The first employee that was interviewed had the following response. Recently, there have been some changes to the situation. All pallets that are transported from the packing station apples to the expedition department are managed by the expedition department. The transport of that process is done by the trailer. The delivery of the apples and the cask is done by carts, but these carts have a few disadvantages. The freedom of these carts is a disadvantage because they can drive everywhere, and they will because they are needed everywhere.

The second employee had the following response. The cask centre only uses the carts and no trailers because they are easily driven into the cask centre. When there is no employee at the car of internal transport, one of the employees of the cask centre is deployed. The cask centre wants to decrease the working stock because based on space, interest, and risk, it is cheaper to keep the stock low. When orders of the packing station pear or soft fruits are done, it occurs that these products are sent back to the cask centre by the people of the next shifts.

The third employee had the following response. Currently it happens too much that carts filled with products that arrive at the packing stations, especially the apple packing station, but there are not enough employees to unload these carts. The problem here is that the filled carts cannot be used for a while at different departments when they are still filled with fruit. Another problem is when unannounced fruit is needed from the cold store. When the employees of the cold store do not have tasks, they still have a lot of cleaning to do.

The fourth employee had the following response. The reason why the apple packing station might be busier than expected is because when the expected quality of the apples that were delivered from farmers is worse and they need to request apples from the cold store to compensate with the order that is placed. It also happens, there are not enough employees to unload the apples from the carts because they are at a different location now. Lastly, it occurs that there are 3 or 4 carts for the industry department that need to be unloaded in the morning, but when trucks from outside need to be unloaded these carts will wait and cannot be used by the other departments.

The fifth employee had the following response. If you are flexible in your planning and decisions that need to be made when the situation is changing, only then does the situation stay good. It is important internal transport works as a good operator for good communication and as a good chauffeur to transport all the products.

The sixth employee had the following response. Currently, everything is going great, communication is okay and keeping it like that will contribute to the proper conduct of the situation.

The seventh employee had the following response. Different departments request for internal transport to transport products to their department. When these requests are done at the same time, the wait for the carts will increase and the processes will stagnate. It is also important to

take the closing time of the cold store into account. On Saturdays there is more trouble, the agreements with the trucks from outside are better than the agreements with the employees of internal transport.

The eighth employee had the following response. The current situation could be simplified a bit more to optimize the processes. When a truck needs to pick up some fruit, it is easier when he gets it straight from the packing stations because they have these docks that make it easier. This extra step where first all the packed fruit goes to the expedition is unnecessary to do each time. I would rather have FruitMasters skip this step. The employee that transports the fruit could also easily help with loading and unloading the carts to prevent problems from happening here. (This is non possible during the corona period.)

The ninth employee had the following response. If the tasks are unknown and the processes not visualised, it is very difficult to supervise the situation. This should change because as the current situation is like it is, it cannot improve.

The tenth employee had the following response. Currently, the situation is not very structured. What happens at the company area is not verifiable and not clear towards the other employees when they can expect the cart from internal transport. When you look at an entire year, you see a lot of ups, when the farmers are harvesting, and downs, when there is only stock in the cold store. During the ups, internal transport cannot handle the situation because it is too much work, but during the downs, we do not hear internal transport has time left. Currently, the department industry is keeping a lot of their apples outside, which is a shame for the quality of the apples, even though they are already a bit worse than the other apples.

The eleventh employee had the following response. I think a lot of matters could become more efficient. Having enough space is a large obstacle in that situation. When we finished the product, it could go directly to a dock, which will save a lot of time and money at the logistics department. The ideal situation would look a lot different when it comes to the logistics. Now everything has the same entrance as exit.

What are the advantages of the current situation?

The first employee had the following response. The advantage of internal transport in the current situation is that when internal orders are placed, internal transport is committed to process this as soon as possible. It happens sometimes that another department has just placed an order before us, and we need to wait a bit longer but that does not mean we need to wait long. When it is busy, and we do need to wait long this is noticed to us and we can respond to it.

The second employee had the following response. Through the communication with internal transport we get updated on the current situation. When agreements are made with internal transport they will be fulfilled.

The third employee had the following response. The advantage of internal transport is that they will always prioritise the internal orders that keep the primary processes ongoing.

The fourth employee had the following response. A lot of communication with intern transport and the cold store will help maintain a good situation. We can create a planning each morning and internal transport anticipates that. This means we are doing great on staying on track with the planning we make each morning because we can build on the internal transport.

The fifth employee had the following response. The advantage of the current internal transport is when problems are noticed by internal transport, these problems will be notified towards the employees that are able to solve them. This means that problems get tackled when they need to be solved. Internal transport always wants a safe situation and having an employee that does that is useful.

The sixth employee had the following response. The communication is okay, and we know what to expect from the employee of internal transport.

The seventh employee had the following response. Internal transport will prioritise the primary processes. This means that orders that keep these processes running will prioritise above the orders that do not.

The eighth employee had the following response. The advantages are that I do not really have any problems with the current situation.

The ninth employee had the following response. Internal transport always tries to process each internal order as fast as possible. Internal transport also contributes with finding the most optimal flow of the internal orders.

The tenth employee had the following response. The communication with internal transport is okay and I always know what to expect from the employee.

The eleventh employee had the following response. When an employee is working during a shift, they are reachable, and I know what the current situation is about, and I know what I can expect from internal transport.

What are the disadvantages of the current situation?

The first employee that was interviewed had the following response. There are a few things that burden this department. There is some lost time during the loading of the trailer, because when the trailer is unloading the fruit at the expedition, we need to wait for the trailer to be back before we can continue loading it again. There is also some lost time during the receive flows of apples and cask. The delivery of the apples and the cask is done by carts, these carts are also needed at different departments which means it might take a while before they arrive. The apples also only can be delivered when the cold store is open. This department only has one shift until 5, what means all apples that are needed, need to be delivered before 5.

The second employee had the following response. The disadvantage of having employees of the cask centre working on internal transport, is that smaller tasks that still need to be done at the cask centre cannot be done. When products that were requested by the packing stations are sent back to the cask centre, you need to do double work. It is unknown in advance what products are sent back to the cask centre. The picking of these articles, the delivery and putting it back in the cask centre are tasks that easily could have been prevented.

The third employee had the following response. There is not enough space at the apple packing station to drop the apples and there are not enough employees at the apple packing station to unload the carts filled with apples. Some of the orders are too short term. Usually, an order needs to be done 24 hours before they need to be at the packing station because the oxygen, that was removed, needs to return to the room where the apples are stored. A short-term order still takes 2 hours of preparation before the apples can be used for transport because of the safety regulations. Last, it happens we need to wait for the cart because it is still in use at a different department.

The fourth employee had the following response. In my situation, there is no real problem, a lot of communication with intern transport and the cold store will help maintain a good situation. With a shortage of apples in the supermarkets, these apples need to be prioritized in the process, what changes the planning.

The fifth employee had the following response. Now there is no employee for the second shift of internal transport, the tasks that still need to be done at that moment are done by employees of the expedition department. Some situations are inevitable like when the workload increases, or you need to wait in the queue of the weighbridge because farmers also go there directly. The way you respond to these situations determines the situation and is important.

The sixth employee had the following response. The shortage of the employees at the preselection of apples is a real burden when it comes to the processes of internal transport. The shortage of employees at that department creates a delay in the transport of the internal transport processes. When apples are ordered for the preselection of apples it happens a lot that the employees cannot handle the amount of carts that are placed at the department and these carts cannot be used at any other department until they are unloaded. When it is a busy time, there are different activities and more trucks from farmers they also need to process.

The seventh employee had the following response. We create this planning and we want to receive all the orders in distribution because it cannot be processed at once. The problem here is that there is no insight in where the carts are located which means we cannot estimate what the best time is to request the carts.

The eighth employee had the following response. This employee is not really burdened with the current situation but does have his opinion on the situation. He is convinced that a lot of employees want to keep the situation as it is and are scared for changes. But a lot of changes already have been made which means all the processes need to be updated too. Changes are unavoidable and people just need to accept that.

The ninth employee had the following response. It is unknown what Richard, the employee of internal transport, does, what he needs to do and there is no overview. If that is the situation, it is difficult for me to execute my own tasks.

The tenth employee had the following response. The lack of structure burdens me and the fact all tasks are not verifiable. The situation is not optimal because each department needs to consider, they need to get the products from the other departments before the closing hour. There are also a lot of people involved and we have this product of which the quality decreases when it stays out in the sun. Also, maybe an online application could be useful, but that is for you to investigate.

The eleventh employee had the following response. Now everything has the same entrance as exit. This means for my department, forklifts need to drive more to deliver the pallets where needed.

How should an ideal situation look like, and which features, or components would be good to have?

The first employee that was interviewed had the following response. Well, when the trailer is away, it only can be loaded when it returns. The current situation can be improved by an extra trailer that is delivered empty at our department when the other trailer is driving towards the expedition department to be unloaded. An extra trailer will create a circulation process. The current situation can also be improved when the apples are delivered directly to the customer from the packing station apples. Currently there is an extra trip of these products towards the department expedition before the customer can pick up the apples.

The second employee had the following response. There should be a second employee of internal transport that does the night shift, where currently the employees of the expedition department are deployed, or employees of the cask centre. Another improvement to the situation is when the packing stations only request the cask that is needed, and no double work needs to be done.

The third employee had the following response. When the packing station places an order, they need to make sure they can process this amount of fruit, otherwise they need to split the order and request the fruit in smaller quantities. A clear planning will help everywhere, but that is up to the employees that place the internal orders at the cold store. The communication between the supply department and the cold store can improve on this aspect. It happens sometimes that something was planned, but there is a misunderstanding because for instance, planning inbound misses the message or they catch up on the planning, but forget to mention it. More communication towards the farmers that deliver the fruit to the packaging stations, to know when these deliveries are expected.

The fourth employee had the following response. I do not really see any improvements, communication is key and staying updated by the internal transport and cold store will help with keeping a good situation. You cannot influence the changes that are out of your control, so adapting it in the current situation and changing the planning through communication is all you

can do. The only thing that might need to change is the number of carts prepared for the department industry, when trucks from outside are coming. Of course, internal transport already tries to create the best situation but now it does not seem to be possible to change. The improvement that was suggested is to create a clear overview where internal transport knows the amount of trucks with industry fruit will arrive in the morning. Communication might also be important here.

The fifth employee had the following response. Just keep looking for new employees is the only way to improve the shortage of employees. Keep communicating with all the departments is important and keeping an overview of the situation but that is already done now.

The sixth employee had the following response. The employees of the preselection of apples need to only order the number of apples they can process at that moment. All the departments, except for the packing station of apples, make use of the carts which increase at the preselection of the apples department.

The seventh employee had the following response. There are different improvements that can be made. It might be better to plan the internal orders for each department from the order of the customer or somebody from internal transport might look at where the requests can be done best. It might be useful to have somebody at the office that manages the employee of internal transport to be able to hand the large orders earlier.

The eighth employee had the following response. The eighth employee was not burdened with the current situation but thinks the current situation can improve by letting the employee of the trailer load and unload the trailer by himself.

The ninth employee had the following response. An overview of the situation will help visualise the current situation. To make improvements to the situation, a system could make Richards' job easier and organized.

The tenth employee had the following response. An online application could be useful to help get the situation structured and all the tasks verifiable. A second trailer could help the process at the packing station of apples because this creates a situation where there is always a trailer here, ready to be loaded and the packing station does not need to stop their process. It creates a circular process. A trailer would also be practical for the other processes of internal transport where now a cart is used.

The eleventh employee had the following response. When we finished the product, it could go directly to one of our docks, which will save a lot of time and money at the logistics department. This creates a different entrance and exit, what will help the situation become more efficient.

Have there been any attempts to improve the current situation already? If there have been attempts, what went wrong during these previous attempts? If there have not been attempts, what do you think the reason is there has not been any attempts to improve the current situation?

The first employee that was interviewed had the following response. The trailer that is currently used, is still new. Everything that needs to be arranged surrounding the trailer has not been perfectionated. When the still needed agreements involving the first trailer have been made, there is a possibility to look at a second trailer. They have already looked at the time limit of the cold store department but did not change anything. The reason why the products are delivered from the expedition department instead of the apple packing station is because there is only a limited space available.

The second employee had the following response. They are looking for a new internal transport employee, but they have not succeeded yet. There are no agreements made on returning the cask and there is no clear procedure in returning the cask. The communication between the cask centre and the packing stations can use some improvement.

The third employee had the following response. When the packing station places an order, they need to make sure they can process this amount of fruit, otherwise they need to split the order and request the fruit in smaller quantities. The reason why the apple packing station requests more than they can process at the moment is because the cold store closes at 5 and the apple packing station still needs to work 5 hours with the apples from the cold store. Communication between the supply department and the cold store can be improved when both parties know where the problems in their communication are, to know what changes need to be made. Communication towards the farmers can be improved but it is hard because usually they just arrive at their convenience.

The fourth employee did not have a lot of problems with the current situation except where internal transport should be attempting to improve the current situation by creating better communication with the industry department and an overview of the trucks from outside is needed from his point of view. This is a small problem and because of that they have not really tried to change this.

The fifth employee had the following response. They are currently looking for employees for internal transport but the employees they found previously seemed not to be able to handle it. The search for a new employee will continue in the future. Furthermore, there are no improvements to be made according to the viewpoint of the fifth employee.

The sixth employee had the following response. The reason why the apple packing station requests more than they can process at the moment is because the cold store closes at 5 and the apple packing station still needs to work 5 hours with the apples from the cold store.

The seventh employee had the following response. The reason why the problem of not knowing where the employee internal transport is or what he does has not been tackled before is because we request internal transportation and how they do it doesn’t matter for us, as long as it is done

right. This is where you come in hand, you need to look at the processes of internal transport which means they started the attempt to improve the current situation by giving you this assignment.

The eighth employee had the following response. Currently there is no employee assigned to only driving the trailer and they are looking for one. Now due to the corona virus it is also not possible to load and unload the trailer themself because people only need to stay at their own department to minimize the chance of cross-contamination.

The ninth employee had the following response. We are currently working on it by giving you this assignment. The outcome of this research will show us how we can improve the situation even more and recommendations can be tested to attempt to improve the situation.

The tenth employee had the following response. The trailer that is already in use now is still new and the agreements surrounding the trailer still can be improved and especially clarified. There are a lot of different trailers and these should all be taken into consideration. The department cold store and industry also still do not have a docking station which means the carts are still needed here.

The eleventh employee had the following response. The reason they have not tried to improve the current situation is that it is difficult to adjust and the availability of the docks does not also work in their favour.

Appendix M The data gathered on problematic transport of internal transport of week 27 of 2020 till week 30 of 2020

Date	Delivery time	From	To	Cart
29-6-2020	13:05	soft fruits/pears	cask	5
29-6-2020	13:39	cask	soft fruits/pears	6
29-6-2020	14:36	soft fruits/pears	cask	6
3-7-2020	12:17	cask	soft fruits/pears	5
3-7-2020	13:09	soft fruits/pears	cask	5
3-7-2020	14:44	cask	soft fruits/pears	5
6-7-2020	12:07	soft fruits/pears	cask	6
6-7-2020	13:25	soft fruits/pears	cask	5
6-7-2020	13:27	cask	soft fruits/pears	6
6-7-2020	13:41	cask	soft fruits/pears	5
8-7-2020	13:06	cask	soft fruits/pears	6
8-7-2020	13:13	soft fruits/pears	cask	5
10-7-2020	12:24	soft fruits/pears	cask	5
13-7-2020	12:47	soft fruits/pears	cask	5
13-7-2020	13:46	cask	soft fruits/pears	5
13-7-2020	14:33	soft fruits/pears	cask	6
13-7-2020	14:58	soft fruits/pears	cask	5
13-7-2020	15:02	cask	soft fruits/pears	6
15-7-2020	13:39	soft fruits/pears	cask	6
15-7-2020	13:43	cask	soft fruits/pears	5
15-7-2020	14:50	soft fruits/pears	cask	5

Date	Delivery time	From	To	Cart
15-7-2020	14:55	cask	soft fruits/pears	6
17-7-2020	13:16	cask	soft fruits/pears	5
20-7-2020	13:09	soft fruits/pears	cask	5
20-7-2020	13:50	cask	soft fruits/pears	5
20-7-2020	14:45	cask	soft fruits/pears	6
20-7-2020	14:48	soft fruits/pears	cask	5
24-7-2020	12:56	soft fruits/pears	cask	6
24-7-2020	13:01	cask	soft fruits/pears	5
24-7-2020	14:40	soft fruits/pears	cask	5

Appendix N Systematic literature review

In this project plan, one knowledge question is answered by conducting a systematic literature review. Before the review is conducted in the theoretical framework, a few clear steps need to be done to make sure other researchers can follow and replicate the review.

Knowledge goal and research question

The knowledge goal I would like to analyse with this literature review is “To understand the visualisation of the processes of internal transport”. The research question that needs to be answered to achieve this goal is “How are the processes of internal transport visualized?”.

Inclusion and exclusion criteria

Clear criteria are needed before the review and these criteria can be distributed into inclusion and exclusion criteria. Inclusion criteria is everything that a study must have to be included in your review and exclusion criteria are the factors that would make a study ineligible to be included in your review (GumbergLibrary, 2020). With each criterion there is an explanation given why it should be included or excluded in the review.
The inclusion criteria are:

- The papers should be focused on the visualization of processes of internal transport, because only these papers will be useful for this systematic literature review.
- The paper needs to be peer-reviewed for more reliability. Peer-reviewed is a process by which something proposed, as for research or publication, is evaluated by a group of experts in the appropriate field.
- The paper needs to be from the digital library IEEE Xplore, because the papers of this library are always useful. The IEEE Xplore digital library is a powerful resource for discovery of scientific and technical content published by the IEEE (Institute of Electrical and Electronics Engineers) and its publishing partners (IEEE Xplore, 2020).

The exclusion criteria are:

- Papers that only focus on other aspects of internal transport instead of the processes, because these papers will not be useful for this systematic literature review.
- Papers without open access, because they are not accessible without paying.
- Papers that are duplicates because they already are being used.
- The papers can be both in English, because this broadens the scope and the language will not be leading in the outcome of the review.

Used database

The used database is google scholar because it is a general search engine for scientific articles. It provides a search of scholarly literature across many disciplines and sources that could be useful in this systematic literature review.

Search Term and used strategy

The combination of different search terms is very important to find the right journals. The search terms used in this systematic literature review are:

- “business process monitoring flow visualization”
- “visualisation processes supply chain internal transport”
- “BPMN requirements”
- “BPMN internal transport”

The strategy used to find useful articles was by using different combinations of search terms to create different outcomes. While selecting the articles, I skimmed the articles and realized during the search what changes needed to be made to the search terms to find articles that solve my knowledge problem.

List of found articles

The search terms have resulted in several articles, but not all of them were useful because of different reasons.

Search term	Search engine	Scope	Number of articles before use of criteria	Number of articles after including and excluding criteria	Date of search
business process monitoring flow visualization	Scopus	Title, keywords and abstract	41	1	05-06-2020
visualisation processes supply chain internal transport	FindUT	Keywords	58	5	05-06-2020
BPMN requirements	FindUT	Keywords	508	18	08-06-2020
BPMN internal transport	FindUT	Keywords	51	2	08-06-2020
				Total number of articles before adding criteria	658
				Removed based on include and exclude criteria	632
				Total sources read	26
				Sources selected after reading	6

Table 9 Articles found on search terms

The articles that were useful and will be used to answer the research question are:

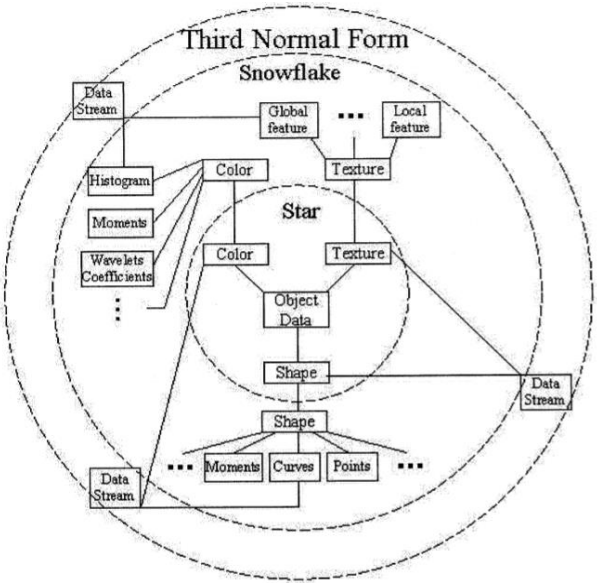
- *"Visualisation of (Distributed) Process Execution based on Extended BPMN*"* (Momotko & Nowicki, 2003)
- "*Smart Shopper: An Agent-Based Web-Mining Approach to Internet Shopping*" (Liu & You, 2003)
- "*Optimal Process Mining for Large and Complex Event Logs*" (Prodel, Augusto, Jouaneton, Lamarsalle, & Xie, 2018)
- "*Unleashing the Effectiveness of Process-Oriented Information Systems: Problem Analysis, Critical Success Factors, and Implications*" (Mutschler, Reichert, & Bumiller, 2008)
- "*Business Process Analysis and Optimization: Beyond Reengineering*" (Vergidis, Tiwari, & Majeed, 2008)
- "*Modelling Strategic Decisions Using Activity Diagrams to Consider the Contribution of Dynamic Planning in the Profitability of Projects Under Uncertainty*" (García-Fernández & Garijo, 2010)

A conceptual matrix

There are different aspects of visualisation of processes and each article tackles a different aspect. The different aspects of visualisation are summarized in the following table.

Paper	Visualization ways
Visualisation of (Distributed) Process Execution based on Extended BPMN (Momotko & Nowicki, 2003)	The different requirements for visualisation of distributed process execution: Req. 1 Process definition and & process execution – a coherent representation The graphical representation of elements specific for process execution should be compliant with those already defined. Req. 2 Process instance information – visibility levels It should be possible to check basic process execution parameters such as progress of work, the current operational and delay status. These process parameters correspond to the workflow Quality of Service dimensions such as time and cost. Req. 3 Different visualisation of elements that have been, can be and will not be executed From an execution point of view three types of process elements can be considered: elements already executed, possible to be executed and never executed. The representation of elements of these three types should be different. The elements of the first type should be the most visible. The elements of the third type should be the least visible or even not shown. Req. 4 The current state of a process/activity instance Every process instance has its own behaviour. One of the easiest and clearest ways of expressing process instance behaviour is to use states. The states refer to the individual steps of activity instance processing, while transitions between them correspond to activity processing events

	such as ‘create’, ‘open’, ‘close’, and ‘abort’. This behaviour is further referred to as operational behaviour. It is important to provide a simple graphical mechanism to show the current state of a process/activity instance. Req. 5 Process/activity delay indication Besides operational behaviour, it is also necessary to express when a process or activity instance is delayed or when an activity is very restricted should be expressed. This kind of behaviour is referred to as timing behaviour. Representing timing behaviour for process and activity instances may warn performers of incoming deadlines and help them in finding already delayed activities. Req. 6 Activity criticality indication It is also important to give information whether a delayed activity instance also delays the whole process; this kind of behaviour is referred to as criticality behaviour Req. 7 Multiple activity performers Generally, an activity can be executed by one or more performers. Information on multiple performers should also be presented in one place, together with information on a given activity. It should be possible to switch the context of the activity to read information pertaining to individual performers. Req. 8 Multiple activity instantiation An activity that belongs to a process can be instantiated more than once. It occurs if there is a loop that includes the activity, or the activity is executed by more than one performer. On the process diagram, all activity instances should be presented together, by a single graphical element. It should be also possible to switch the context of the activity to read information pertaining to individual activity instances. The presented activity instances should be ordered by time of their creation. Req. 9 Loops In some real business processes, there is a need for repeating some activities. In the case when this repetition concerns more than one activity and depends on some conditions, it can be expressed by loops. Since activities and transitions belonging to a loop may be executed more than once, it is necessary to express their multiple instantiations. The mechanism to express multiple instantiations must be readable.
Smart Shopper: An Agent-Based Web-Mining Approach to Internet	This paper describes the use of a data warehouse schema to integrate multiple objects features for visual information representation. Data warehousing is viewed as a technology that not only functions as a data superstore, but also processes data to create a data warehouse, an operational data store, or a data mart stored on traditional servers, Intranet servers, or Internet servers. In other words, data warehouses are not just large databases; they are large and complex environments that

Shopping (Liu & You, 2003)	integrate many technologies. A major advantage of using a data warehouse is being able to store data at different levels of granularity along different dimensions such as data type, time, etc. Thus, data warehouse systems require a lot of maintenance and management. Developing a data warehouse is like other software projects. The schema is initially developed for the database design. It is a representation of a database, which gives semantics to the data to model the database. In relational databases, there are two types of schema – conceptual schema and logical schema. A conceptual schema often refers to an entity-relationship diagram, and a logical schema represents the structure and connection between the relational tables. In object-oriented databases, conceptual models are usually used. A schema is also used to construct a data warehouse. Facts and dimensions are two basic concepts related to a data warehouse schema. Although the concept of a data warehouse originated from traditional business information systems, it can be extended to visual information systems. The description of an object is regarded as fact data in a visual data warehouse, and multiple object features constitute dimension data. In a general description of a visual object, features such as the colour, texture, and shape are dimension data. Colour can be further represented by a colour histogram, colour moments and colour component features. Texture can be further described by its global and local statistical measurements or structural semantics. Shape can be further decomposed into a representation of surface moments, boundary curves and salient points. Fig. 1 illustrates a star flake schema that shows the relationship between fact data and dimension data, where the center table represents the fact table (object description) and the surrounding (reference) tables are dimension tables (individual object features).  Fig. 1. Starflake schema for visual object representation.

It is noted that, in real life it may be difficult to restructure all the components within a visual data model into a set of distinct dimensions. In other words, there are situations where there are several components or relationships that span one or more dimensions. To represent the data more effectively, a star flake schema allows a degree of crossover between dimensions. In our proposed system, the fact table defines three major data streams of visual information, namely colour, texture, and shape. Using the hierarchies of the visual data streams, a multidimensional data cube can be used to visualize the visual information and its OLAP (online analytical processing) data, where the cells hold the quantifying data (often referred to as facts), while the qualifying data describe the axes of the cube and can be used for addressing individual cells or groups of cells. Such a multidimensional data cube is shown in Fig. 2, and Table I illustrates a typical image dimension table for content description. To facilitate the management and decision support of the data warehouse, the above star flake schema is used, which uses a combination of denormalized star and normalized snowflake schemas. In these cases, a series of combinations of database views is created to allow user access tools to treat the fact table partitions as a single, large table for fast information retrieval.

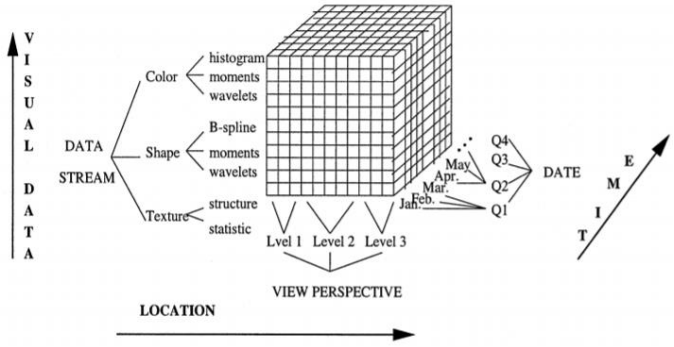
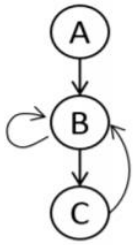


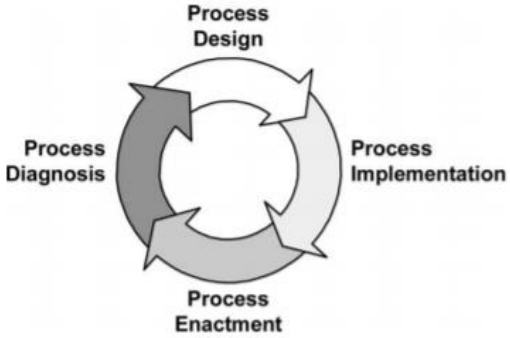
Fig. 2. Multidimensional data cube.

In addition, key reference data is structured into a set of dimensions that are referenced from the fact table. Each dimension is stored in a series of normalized tables (snowflake), with an additional denormalized star dimension table.

TABLE I
THREE MAJOR IMAGE FEATURE CATEGORIES FOR CONTENT DESCRIPTION

Color	Texture	Shape
histogram	structural description	moments
moments	statistical description	B-spline
wavelet coefficients	wavelets	wavelets
...	...	...

	The major features of the proposed data structure are summarized as follows: • support multiple visual data streams using different dimensions • represent visual data in a hierarchical structure using normalized snowflake schemas at different levels • integrate multiple visual features using overlay between the dimensions • speed up visual data query and manipulation processing by data partitioning.
Optimal Process Mining for Large and Complex Event Logs (Prodel, Augusto, Jouaneton, Lamarsalle, & Xie, 2018)	A process model (PsM) is an abstracted and simplified way to represent a real process. It is useful if the model is the representative of the data of the log. A model is always created by using a notation formalism. Several notations are available (Petri nets, Markov chain, flowchart, and so on). Petri nets are often used in the context of process mining. They are used for process discovery by the alpha algorithm and the region-based techniques, and for conformance checking. Definition 7: (Process Model) A process model PsM is composed of a set N of nodes (event classes) and a set E of arcs (transitions). Let T be a set of events, L be a log over T, and PsM = (N, E) = ({n1,..., nx },{e1,..., ey }), where ∀i ∈ 1, x, ni ∈ C(L), and ∀ j ∈ 1, y, e j ∈ Emax. Example: Let T = {A, B, C, D, E} be a set of events, and L = {ABCD, ABB, ABCB} be a log over T containing three traces. Then, PsM(L) = ({A, B,C}, {(A, B), (B,C), (B, B), (C, B)}) is a process model of L. Fig. 1 gives a graphical representation of PsM(L).  Fig. 1. Example of a process model with three nodes and four arcs. An advantage of this notation is to be simple to represent and straightforward to interpret. Nodes represent tasks in the process. Arcs, connecting the nodes, represent ordering relations upon the tasks. No theoretical knowledge is required to read a model, unlike Petri nets and BPMN. Here, all the incoming joins and the outgoing splits of the nodes are exclusive disjunction (XOR): exactly, one path is chosen in the flow. There is no need to define complex structures to deal with combinations of XOR/XAND splits or joins. When the process model is written as a

	Petri net, the token game is often chosen as the reference quality metric. The complexity of a process model is usually defined as the number of its components. Nodes and arcs are considered separately. Let PsM = (N, E) be a process model, and then, Node Complexity (PsM) = |N| and Arcs Complexity (PsM) = |E|. These measures are directly linked to the readability of the model. Models with higher complexity necessarily have higher replay ability as they allow for more traces. Hence, maximizing replay ability and minimizing the complexity are contradictory objectives. To balance replay ability and complexity, our approach is to set a complexity threshold (a maximum number of nodes or arcs) and to maximize the replay ability under this constraint. It provides different levels of insight in the model.
Unleashing the Effectiveness of Process-Oriented Information Systems: Problem Analysis, Critical Success Factors, and Implications (Mutschler, Reichert, & Bumiller, 2008)	The process life cycle (cf. Fig. 1) starts with the (re)design of a business process. Process modelling and process analysis tools can be used during this phase. Thereafter, the business process must be implemented resulting in a process-oriented information system (IS).  Fig. 1. Process life cycle [7]. We will consider business process support as being effective, if the following two goals are achieved: 1) the cost-effective implementation or customization of processes and 2) the availability of a technical infrastructure supporting all phases of the process life cycle. Based on this, our empirical work has been guided by the following two research questions: Research Question 1: What are the major problems leading to ineffective process support by IS? Research Question 2: What are the critical success factors enabling effective process support by IS? To cope with these research questions, we conducted three empirical studies (cf. Fig. 2): one exploratory case study and two online surveys. While the first two studies address Research Question 1, the second survey is associated with Research Question 2.

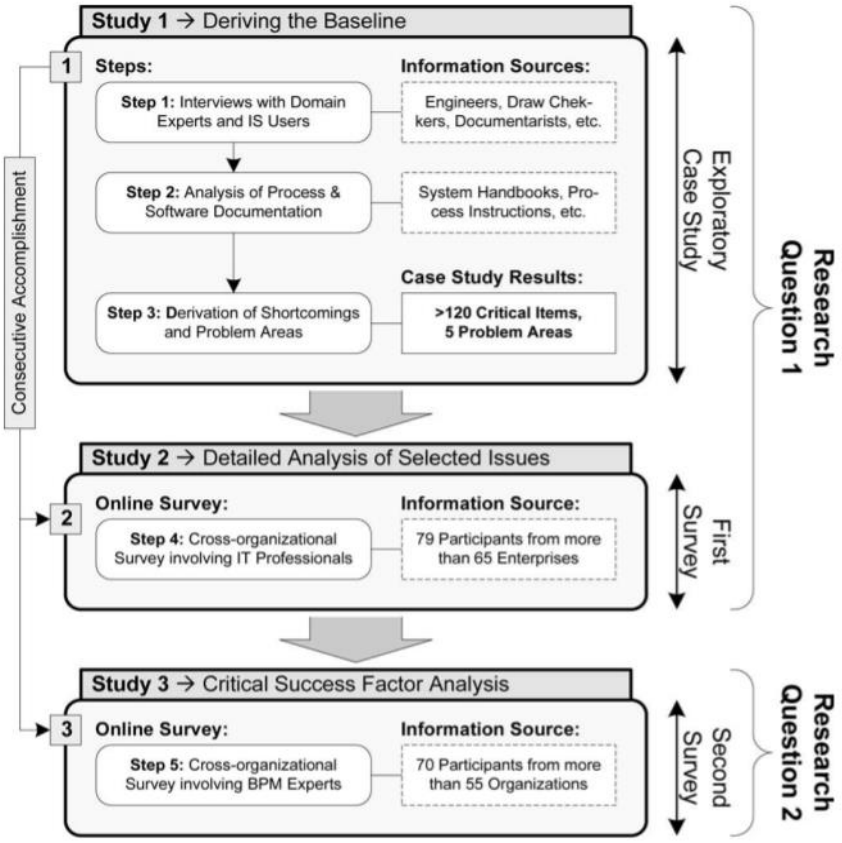


Fig. 2. Three empirical studies.

Our empirical studies (cf. Fig. 18) indicate that providing effective business process support by IS a difficult task to accomplish. What we need instead, are process aware IS (PAIS), IS that support all phases during all the process life cycle. PAIS can be implemented in two ways 1) by developing an organization-specific process support system or 2) by configuring a generic process support system. In the former case, the PAIS is built “from scratch” and incorporates organization specific information about the structure and processes to be supported.

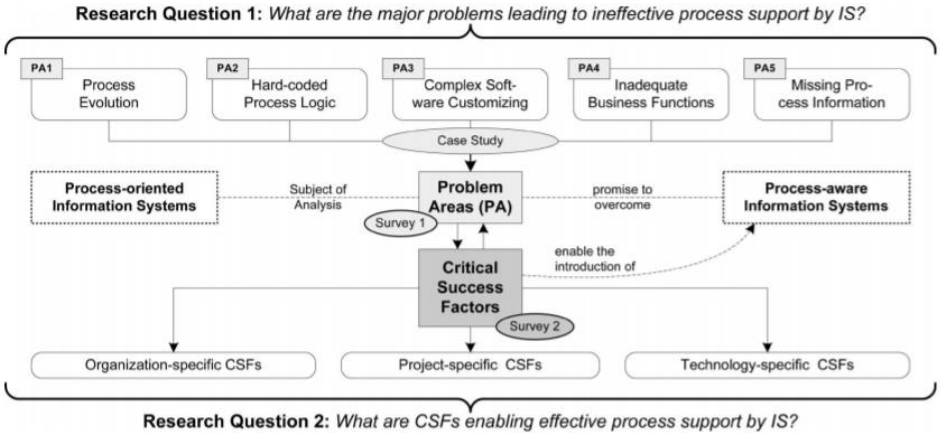


Fig. 18. Three empirical studies: The big picture.

Business Process Analysis and Optimization: Beyond Reengineering (Vergidis, Tiwari, & Majeed, 2008)	Business process modelling plays a major role in the perception and understanding of business processes. In most of the cases, a business process is as expressive and as communicative as is the technique that has been used to model it. Therefore, the elements and the capabilities of a business process model play a significant role in describing and understanding a business process. There is an abundance of business process modelling techniques with approaches that capture different aspects of a business process, each having distinctive advantages and disadvantages. There are four different perspectives for understanding the nature of business processes and the most common modelling approaches for each perspective is identified. The first perspective views business processes as deterministic machines, that is, as a fixed sequence of well-defined activities that convert inputs to outputs to accomplish clear objectives. For this perspective, static process modelling is sufficient, with techniques such as integrated definition methods (IDEF0, IDEF3) and role activity diagrams (RADs). The second perspective views business processes as complex dynamic systems, assemblies of interchangeable components. This second viewpoint focuses on the complex, dynamic, and interactive features of business processes. The authors suggest discrete event simulation as a suitable way to model the dynamic behaviour of this approach. The third perspective of business processes is interacting feedback loops that highlight the information feedback structure of business processes. System dynamics modelers are recommended for this perspective. The last perspective of the business process is social constructs and emphasizes more on the people side. It is the people who make and enact business processes, people with different values, expectations, and roles. This soft side of business processes can be modelled with soft unstructured illustrative models. However, a real-life business process involves elements for all the four perspectives, and therefore, it is evident that there is no such modelling technique that can embrace all this variety of characteristics that constitute a business process. The classification of Figure 1 is done for the business process models according to their structural characteristics and their capabilities for analysis and optimization.

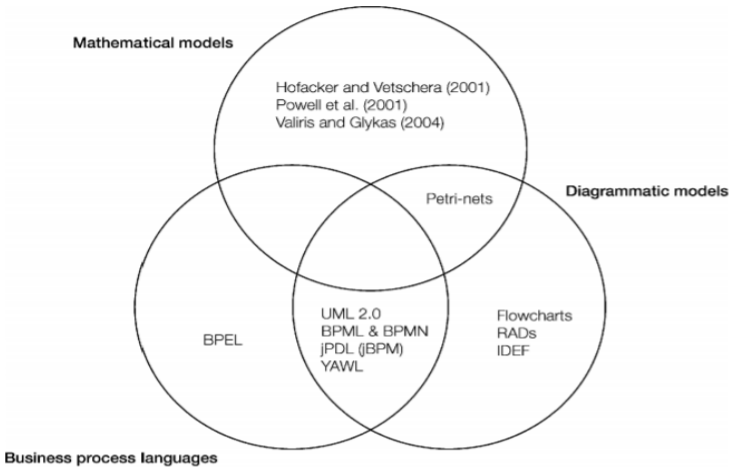


Fig. 1. Classification of business process modeling techniques.

The first set (i.e., diagrammatic models) involves business process models that sketch a business process using a visual diagram. The second set (i.e., mathematical models) corresponds to models in which all the elements have a mathematical or a formal underpinning. Finally, the third set (i.e., business process languages) contains software-based languages that support business process modelling and most of the time process execution.

The first techniques that were used for business process modelling were plain graphical representations (i.e., flowcharts) that were initially developed for software specification. These simplistic diagrams depicted a business process, but most of the time without using a standard notation. These techniques are useful for fast and informal process representation, but they lack the necessary semantics to support more complex and standardized constructs. Although visual inspection of diagrams tends to be highly subjective, these diagrams are still widely used in business process environments. The unbeatable advantage to visually depict the flow of a business process in a way that no technical expertise is required is very appealing to the business analysts. Even advanced and more sophisticated modelling techniques are influenced by this perspective, and they support apart from formal semantics and a visual representation of the modelled processes.

Formal models are the ones in which process concepts are defined rigorously and precisely, so that mathematics can be used to analyse them, extract knowledge from them, and reason about them. An advantage of formal models is that they can be verified mathematically and can be checked for consistency and other properties. However, there is a lack of formal methods to support the design of processes because business process elements and constraints are mostly of qualitative nature, and it is hard to characterize them in a formal way amenable to analytical methods. This explains the difficulty of developing “parametric” models of business processes and the fact that only a few practical

	examples are found in relevant literature. Coming to the approaches that use mathematical models only, there is not a widely accepted model. Building a formal business process model can prove much more complex and demanding compared to traditional techniques where a process diagram is sufficient. The representation of real-life processes using mathematical models may be complex and sometimes not possible as these include complex features such as decision points, feedback loops, and parallel or hierarchical flow. The third generation of business process modelling techniques came as an attempt to tackle the complexity of the formal models but retain their consistency and potential for further analysis. New approaches facilitate the natural transition from declarative input by the business analyst to the programming logic needed to implement a business process, thus simplifying business process development, and allowing even nonprogrammers to develop business processes using visual tools. Therefore, business process languages prove a reliable tool to formally model and visualize a business process in terms of constructing standardized and reusable models.
Modelling Strategic Decisions Using Activity Diagrams to Consider the Contribution of Dynamic Planning in the Profitability of Projects Under Uncertainty (García-Fernández & Garijo, 2010)	To use the unified modelling language (UML) activity diagrams for modelling in the proposed framework, it is necessary to relate the concepts involved in defining the strategic decisions that are to be adopted in the dynamic planning process of a project, to the concepts used in UML activity diagrams. The whole business strategy can be modelled as follows. 1) Strategy: It can be defined as a concrete plan of action for any situation that may arise and is applied to fulfil some specific goals. This plan of action is made up of a set of decisions taken during different situations that occur throughout the project and which imply carrying out a sequence of activities with the goal of obtaining good profitability. The implementation of a strategy is, in fact, made by using a business process that can be modelled by means of a UML activity diagram. 2) Activities: The set of actions that are accomplished to fulfil a specific goal. An activity can represent a phase or task in a project. Activities can be carried out in sequence or in parallel. UML activity diagrams contemplate specific notation to model concurrent or sequential activities. Fig. 1 summarizes the graphical representation of each of the defined concepts in a UML activity diagram. 3) Transitions: The change from one activity to another over time. This change can take place unconditionally or because of deciding from the initial activity. 4) Decisions: A decision allows a point in the flow of activities to be specified, where it is possible to take different options or paths (make different transitions) according to the conditions that are fulfilled.

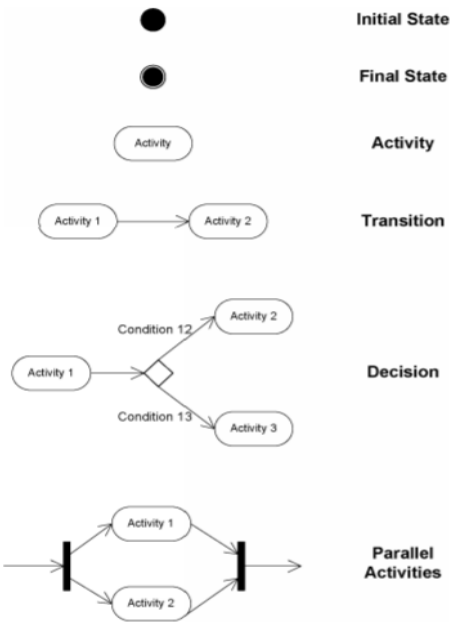


Fig. 1. Basic UML activity diagram graphical symbols.

5) Conditions: Decisions are made up of conditions. A condition is a logical expression that must be fulfilled when deciding. In UML activity diagrams, conditions are called guards. Conditions apply to one or more of the indicators of the project and/or events that occur during the project. We can define an indicator as a numerical value that allows some aspect of the project to be described and is useful when making any decision. An indicator is calculated through different variables of the project, by means of a formula or expression that relates them. A variable is a non-derivable parameter of the project that influences it, for instance, demand, prices, the cost of a given project resource, etc. We are interested in the uncertainty variables of the project that evolve over time.
6) Time: Time must be considered when implementing the activity diagram of a strategy in a simulation environment. A unit of time must be defined within the model. Variables are defined to evolve with time. Considering that ti is the present moment in time, transitions can take place when time evolves from ti to ti+1 . Decisions, which bring about transitions, are taken at ti, in accordance with the conditions that are fulfilled exactly at that moment. These conditions, in turn, are calculated from indicators that must be calculated from known values of the project variables (values for t<ti, ti being the present moment in time) or by estimated future values of the variables (which should be derived from the already known values of these variables). If these rules are fulfilled when defining the activity diagram, we can assure that the result describes an operational strategy that can be implemented in the real world to control the project.

Table 10 The useful papers and their view on visualisation of processes.

Integration of the theory

With the data gathered from the articles, the research question “How are the processes of internal transport visualised?” can be answered and contribute to the overall knowledge goal: “To understand the visualisation of the processes of internal transport”.

From this literature review we can conclude there are a lot of different ways to visualise the processes of internal transport. The business process modelling technique I will be using during this research are diagrammatic models. This technique is used for business process modelling where plain graphical representations that were initially developed for software specification. These simplistic diagrams depicted a business process, but most of the time without using a standard notation. These techniques are useful for fast and informal process representation. Symbolism should be added to support more complex and standardized constructs and to leave out some restrictions. First, when you start to visualise a process you need to determine what the strategy is. Second you need to collect all the activities that are done, all transitions and decisions that are made, and the conditions that need to be fulfilled before the decisions. Last, time must be considered when implementing the activity diagram of a strategy in a simulation environment. A unit of time must be defined within the model.

The content of these papers can contribute to my bachelor thesis. The requirements of visualising processes from the papers will be used during my visualisation.

Appendix O Solution on putting the statuses of the carts in the new ERP system including the processes of internal transport

The solution that was discussed in Section 5.1.1.4, should give the following options after scanning the cart.

Scanned by: *The executive department*
Name employee: *The executive employee*
Current status of the cart: Done (for example)

New status:

- ❑ Picked up
- ❑ Dropped off
- ❑ In progress
- ❑ Done

Current location: *The executive department*

New location:

- ❑ Company area
- ❑ Apple preselection
- ❑ Apple packing station
- ❑ Auction
- ❑ Cask centre
- ❑ Cold store
- ❑ Expedition
- ❑ Industry
- ❑ Pears packing station
- ❑ Soft fruits packing station
- ❑ Air compressor
- ❑ Technical services
- ❑ Weighbridge

Current determined receiving department: *The receiving department*

Receiving department:

- ❑ Undetermined
- ❑ Apple preselection
- ❑ Apple packing station
- ❑ Auction
- ❑ Cask centre
- ❑ Cold store

- ❏ Expedition
- ❏ Industry
- ❏ Pears packing station
- ❏ Soft fruits packing station
- ❏ Air compressor
- ❏ Technical services
- ❏ Weighbridge

Action started at: *The current time*

Appendix P The results of the interview on the opinions of the employees on the solutions

What do you think about the solution in general?

In general, you have a good idea of the bottlenecks in the relevant departments. The subsequent solutions are workable. Some things, such as the new construction at the packing station, is a solution for delivering packaging during auction hours. This has already been achieved.

In my opinion, you have worked out the solutions nicely and they will become feasible when the system is ready.

I think that the solution regarding the battery is a quick win that can be realized quite quickly + prevents a lot of frustration. Hiring a second person for internal transport to fill the “team” is a tactical move that provides more peace of mind and check.

I have too little insight into how other departments deal with it, but it is important that coordination can be improved, earlier / better planning gives more peace of mind, resulting in fewer waiting times.

Critical but justified.

What do you think about the solution specific towards your department?

The packaging that has been ordered too much and must be returned to the packaging later, this is the right solution, I think. Nevertheless, it sometimes remains difficult when it concerns an open order. It may be that more can be packed than what is in the order, then they also need more packaging and order here. We cannot rule that out completely.

For the packaging center it is simply important that there are always 1 or 2 empty trolleys present, so that loading can take place immediately and the order is not placed on the ground first.

Registering all flows in the ERP system would certainly offer a solution in terms of “managing” internal transport. This also improves monitoring, which is currently not possible live.

Picking up a full cart immediately and returning an empty cart in front of it can work more efficiently, now they must wait in between because they do not know when an empty cart will arrive.

Good and clear.

What is good about the solutions that were recommended?

Difficult to answer this, we also give deadlines but are not always met.

The aim is to improve that the flows will improve internally, the departments will work together better in this.
I think that the solution regarding the battery is a quick win that can be realized quickly + prevents a lot of frustrations. Hiring a second person for internal transport to fill the “team” is a tactical move that provides more peace of mind and control.

Coordination with each other to have the correct occupation of the wagons as much as possible, coordination during shift change.

Structure is important.

What could improve the solutions that were recommended?

The recommended solutions stand or fall with the occupation of the car and therefore the staffing. This week we will take the carts away ourselves.

I do not have recommended solutions.

In particular, the implementation of internal transport flows ensures that it can be monitored. There is a real need for this so that you can ultimately organize the process more efficiently.

Try to have the right staff on the car as much as possible, it sometimes seems that it is only a side issue.

This means that you rest and prevent frustration.

After hearing about the bottlenecks of the processes of internal transport, do you think something that is not mentioned before could help improve the situation?

For the most part, as a packaging center, we have it sorted out, load with a cart and then call internal transport and it will be taken away.

The solutions in general look good, in my opinion we should start at the beginning and first ensure that the staffing of internal transport consists of two permanent people who are on duty alternately day or evening, in addition there must be spare people who are being able to fill in like this and then just leave their own work to someone else.

This has already been considered from the perspective of sustainable employability, but this project also always stops because these people can / only want to workday shifts.
Every time it gets stuck on the evening shifts / Saturday shifts, the departments must drive themselves and this does not always fit in with the work.

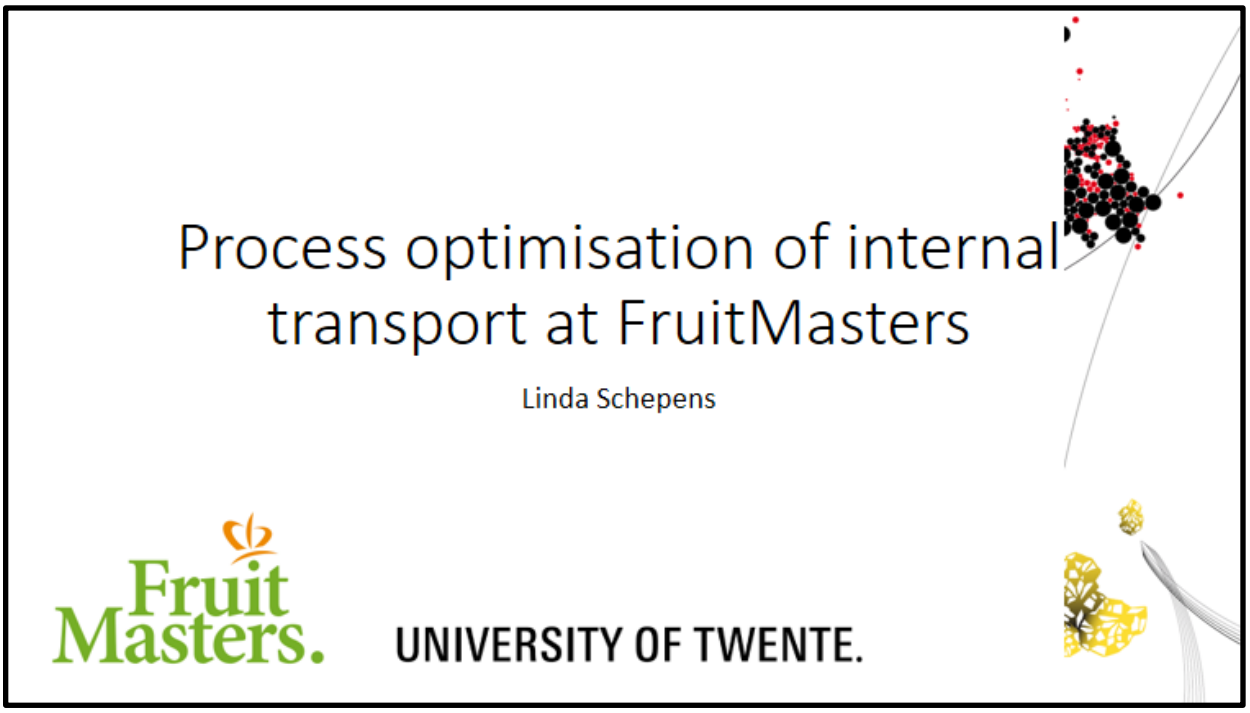
The answers to question 1 are a significant improvement for the process + easier to realize.

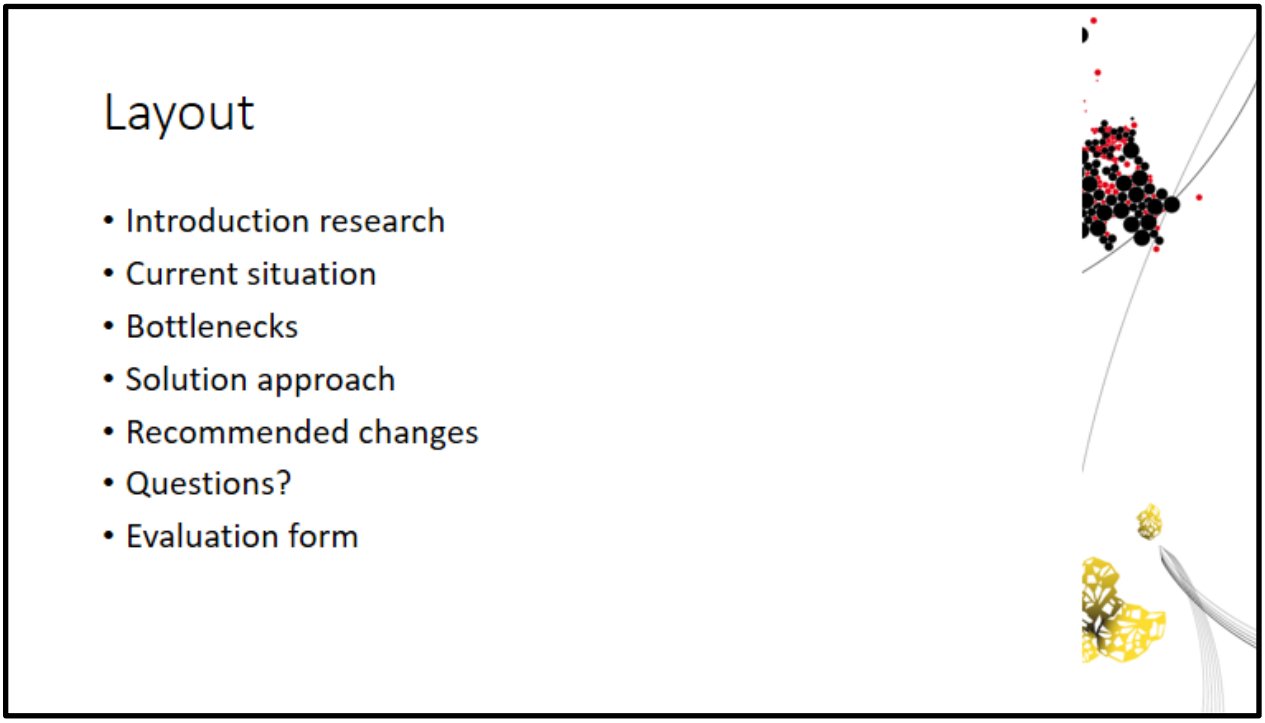
Now, coordination and continuity are, in my opinion, the key to steer it on a better track.

I have no further recommendations.

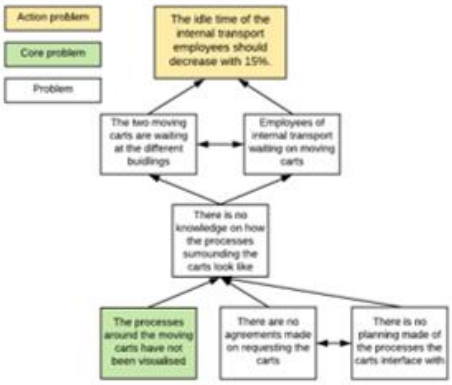
Appendix Q The presentation on the results of this research to collect the evaluation results of the employees.

The text that was told was basically the slightly more detailed version of the management story.





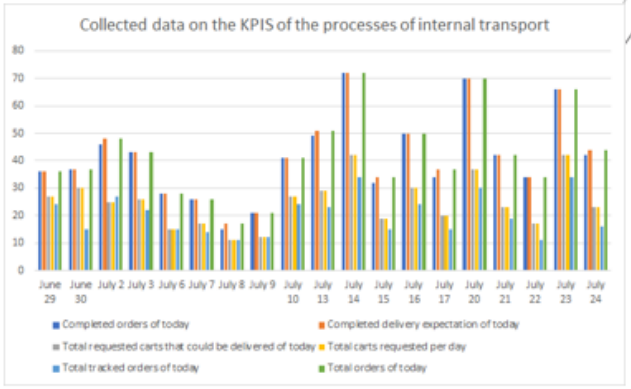
Introduction research



How should a visualisation of the processes of internal transport look like at FruitMasters?

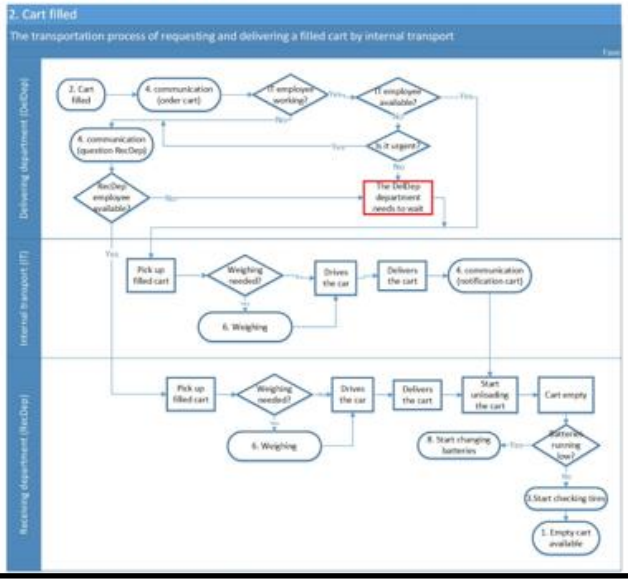
Current situation

- Tasks assignments per day
- On-time delivery per day
- Availability per day
- Order tracking ability per day
- Idle time per day



Department	Cask centre	Apple packing station	Industry	Soft fruits and pear packing station	Expedition	Cold store
Number of unload/load times	118	174	44	87	92	119
Unload/load times that took to long	73	139	44	74	60	71
Average unload/load times collected	1:25	1:15	1:58	1:24	1:25	1:03

Current situation



Bottlenecks

Internal transport

- Lacking employees
- Change batteries when needed
- No insight on the carts
- No insight on internal transport

No specific department

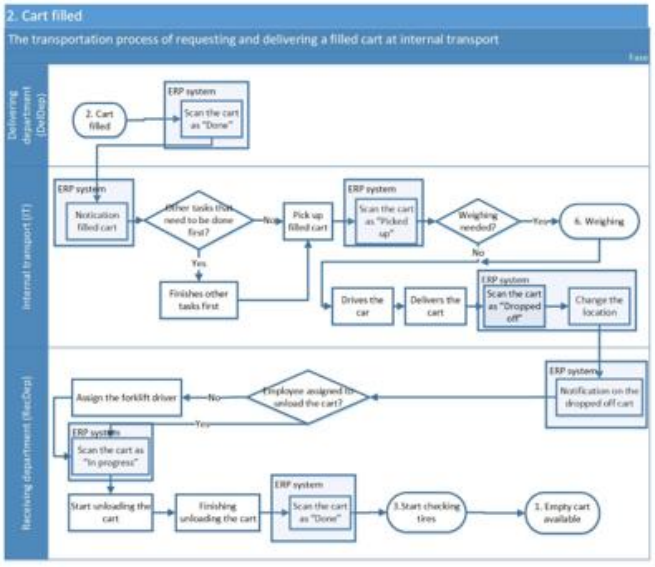
- Missing knowledge on takeover tasks
- Missing deadlines

Bottlenecks

Other departments

- Loaded carts cannot be unloaded yet
- Missing communication after tasks
- Getting unnecessary retour
- Communication differs per employee
- Loaded cart can not be dropped off yet
- Delivers cask during auction hours

Solution approach



Recommended short term changes

Hire employees

Change batteries

Create insight

Changing parking location

Create deadlines

Impact short term changes

No extra work

Full batteries

Less retour

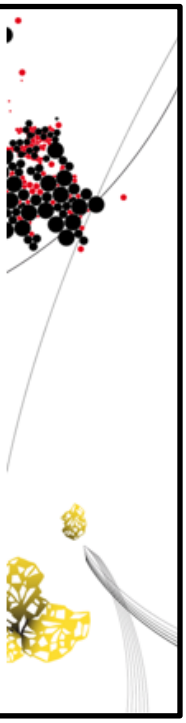
Less annoyances

Easier management

Shorter unloading/loading time

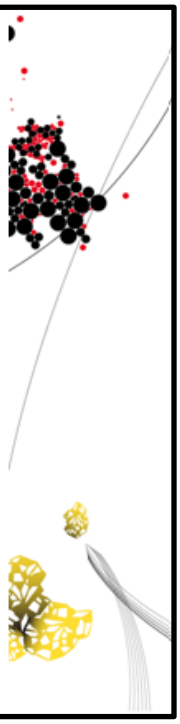
Recommended long term changes

Statuses of the carts
Add internal orders
Add the deadlines
Collect data



Impact long term changes

More insight
Notifications
Easier management
Improve processes
Shorter unloading/loading time



Questions?

Evaluation form

Appendix R The evaluation form

This evaluation form has been conducted in Dutch in order to make it more accessible for the employees of FruitMasters. Questions have been translated for the purpose of this report. I am interested in your opinion about the recommended changes. You will be asked to answer some questions about the functionality, usability and motivation of these recommended changes. Please be assured that your responses will be processed anonymously. The evaluation consists of 20 questions divided over 3 subjects. Your participation in this evaluation form is voluntary, but this does give you the possibility to influence the outcome and the usage of the outcome of this research.

◯ I acknowledge that my participation in the study is voluntary, I am an employee of FruitMasters and am involved with internal transport, and I am aware that I may choose to terminate my participation in the study at any time and for any reason.

To specify the answers that could be given to each closed question, the five dots in between disagree and agree represent the answers from left to right as: strongly disagree, disagree, neutral, agree and strongly agree.

Functionality

1. The recommended changes contain unnecessary changes. Disagree ◯◯◯◯◯ Agree
2. Important changes are missing at the recommended changes. Disagree ◯◯◯◯◯ Agree
3. I know what the given information is about. Disagree ◯◯◯◯◯ Agree
4. All recommended changes are clear. Disagree ◯◯◯◯◯ Agree

5. Which changes are unnecessary in your opinion? (when relevant)

6. Which information is missing at the recommended changes in your opinion? (when relevant)

7. Which information do you find unclear? (when relevant)

Usability

8. Information is presented in a logical order. Disagree ◯◯◯◯◯ Agree
9. The information is coherent. Disagree ◯◯◯◯◯ Agree
10. The recommended short term changes are useful. Disagree ◯◯◯◯◯ Agree
11. The recommended short term changes are feasible. Disagree ◯◯◯◯◯ Agree
12. The recommended long term changes are useful. Disagree ◯◯◯◯◯ Agree
13. The recommended long term changes are feasible. Disagree ◯◯◯◯◯ Agree

14. I want to give an explanation to the above answers by saying the following: (when relevant)

15. What are the advantages of the recommended changes?

16. What are the disadvantages of the recommended changes?

Motivation

17. I am convinced on the positive impact of the changes. Disagree ◯ ◯ ◯ ◯ ◯ Agree
18. I will implement the changes that apply to me. Disagree ◯ ◯ ◯ ◯ ◯ Agree
19. The other employees will also implement the changes. Disagree ◯ ◯ ◯ ◯ ◯ Agree

When assuming that all changes are feasible and the other employees are able to adjust their changes, answer the following two questions based on the changes that apply to you.

20. The short term changes are easy to apply for me. Disagree ◯ ◯ ◯ ◯ ◯ Agree
21. The long term changes are easy to apply for me. Disagree ◯ ◯ ◯ ◯ ◯ Agree

22. What convinces you about the stated impact of the changes?

23. What convinces you to implement the changes that apply to you?

24. What convinces the other employees to implement the recommended changes, or not, in your opinion?

Appendix S Results of the evaluation forms

The answers the participants could give were strongly disagree, disagree, neutral, agree and strongly agree. The strongly disagree had a score of 1 and the strongly agree had a score of 5.

	Respondent							
Questions	1	2	3	4	5	6	7	8
1 - PE1	1	2	1	1	5	1	2	1
2 - PE2	1	4	2	3		3	2	2
3 - FC1	5	5	5	5	5	4	5	5
4 - FC2	5	4	4	5	5	4	5	4
8 - FC3	5	5	5	5	5	4	5	5
9 - FC4	5	4	5	5	5	4	5	5
10 - SI1	4	4	4	5	5	5	4	5
11 - SI2	3	3	4	5	5	3	3	5
12 - SI3	5	4	5	5	5	3	5	5
13 - SI4	5	4	5	5	5	5	5	5
17 - SI5	5	4	4	5		4	4	5
18 - BI1	5	4	5	5		4	3	4
19 - BI2	3	3	4	5	5	3	4	4
20 - EE	3	3	5	5	5	2	3	4
21 - EE	4	3	3	5	5	4	3	4

Table 11 The result of the multiple-choice questions of the 8 respondents.

Respondent 5 did not answer all multiple-choice questions, there were question marks added to these questions, but no questions were asked. The multiple-choice questions that were answered were strangely all 5 (I completely agree) and did not respond to any of the open questions. I made the evaluation form anonymous and because of that I could not track down who was respondent 5, but because not all answers were there, this evaluation form could be inapplicable.

Question 5 Which changes are unnecessary in your opinion? (when relevant)

Respondent 3: Regarding deadlines I miss in the presentation depth. Are there any short-term possibilities to better planning/communication?
Respondent 6: Communication adjustments.

Question 6 Which information is missing at the recommended changes in your opinion? (when relevant)

Respondent 2: How are we going to improve the communication? ⇒ action plan?

Respondent 3: Same answer as to question 5.
Respondent 6: Planning.
Respondent 7: How much money does it generate?

Question 7 Which information do you find unclear? (when relevant)

Respondent 3: Same answer as to question 5.
Respondent 6: Queueing times give a distorted image.
Respondent 7: The graphic that was inserted contained too much information.

Question 14 I want to give an explanation to the above answers by saying the following: (when relevant)

Respondent 1: Good communication is very important and better for everybody.
Respondent 3: Regarding long term, are there concrete examples of internal movements in the logistics. Where should we pay attention to when implementing the ERP system?
Respondent 6: Alignment and scanning.

Question 15 What are the advantages of the recommended changes?

Respondent 1: Better cooperation.
Respondent 2: Better planning and time distribution.
Respondent 3: Clear and accurate.
Respondent 6: Less inactive time.
Respondent 7: Better use of all the equipment.
Respondent 8: The communication will improve over the diverse departments.

Question 16 What are the disadvantages of the recommended changes?

Respondent 1: Everybody needs to adjust the changes.
Respondent 7: Costs increase?

Question 22 What convinces you about the stated impact of the changes?

Respondent 1: We should change if we want to improve.
Respondent 3: Are specific bottlenecks. I am curious about the specific solutions.
Respondent 4: Leads to better communication.
Respondent 6: Less queueing times.

Respondent 8: More structure and communication and the shortening of times.

Question 23 What convinces you to implement the changes that apply to you?

Respondent 1: Better cooperation whereby it is going to a fluent process.
Respondent 3: Necessity is huge, the bottlenecks are painful.
Respondent 6: Better mutual alignment.
Respondent 8: Needs to happen to get to uniform the processes that were discussed.

Question 24 What convinces the other employees to implement the recommended changes, or not, in your opinion?

Respondent 1: Working together is always better.
Respondent 3: Change of behaviour is required, and management should be responsible for it.
Respondent 6: Also, less queueing times and more productive hours.
Respondent 8: Changes should be picked up and discussed in teams.