Project proposal

The effect of better freight volume information on the performance of collection logistics

The Industrial Laundry Service sector

Bachelor End Project
Eindhoven University of Technology
Department of Industrial Engineering & Innovation Sciences
Operations, Planning, Accounting and Control (OPAC)

Author:	M.C.A. (Mark) van der Pas (0946552)
Supervisor TU/e:	Dr. L.P. (Luuk) Veelenturf
Supervisor TKT:	Léon Wennekes
Contact Moderna:	Gert Stroeve
Date:	April 8, 2018

Contents

1 Introduction

This document describes the project proposal for the Bachelor End Project by Mark van der Pas for *Moderna Textielservice* in collaboration with *TKT* (*Technologisch Kenniscentrum Textielverzorging*).

First, the context of the project and problem will be described. Subsequently, the definition of the problem and the research questions will be defined. Next, the steps that will be taken to come to the answers on the research questions are formulated and what the planning of the project looks like. Finally, an overview of the organization of the project is given.

2 Problem Context

This section describes the context of the problem in terms of a description of the project owner (TKT), and in more detail a description of a specific problem owner (Moderna Textielservice) and their operations. Finally, this section also defines the scope of the project and describes the corresponding problem specific context.

2.1 The Project Owner

The owner of the project is TKT (*Technologisch Kenniscentrum Textielverzorging*). TKT is an institute for technological knowledge in the context of the textile service sector, mainly consisting of laundries and dry-cleaners. Their main goal is to investigate needs for knowledge, and propose and coordinate research projects in consultation with the involved branch organisations.

Based on the 'data trend' and the idea that this creates opportunities to improve operations also in the textile service sector, they set up several projects under the heading of *Data2Move Laundry*. Under this heading they will work on projects related to the (innovative) use of (big amounts of) data, they will do this together with several involved laundries and dry-cleaners, students from the University of Technology in Eindhoven, but also companies from other industries facing similar challenges.

The project concerned in this proposal is part of one of those *Data2Move Laundry* projects. The related project is about the application of data and data collection methods in the collection of soiled laundry at customers. Basically, a laundry picks up roll containers with soiled laundry at their customers, but it is not known beforehand how many of those containers filled with soiled laundry there are at the customer. This results in performance related problems like trucks driving half empty or overfull, not being able to take all containers with them. Therefore, the goal of the project is to investigate options to predict how many of those containers there are at the customer, for instance using data collection methods like RFID tags or sharing data between the company and their customers.

For the purpose of this Bachelor End Project, the project will only concern one company, namely **Moderna Textielservice**. From now on, the term *project* will therefore refer to the Bachelor End Project for the problem owner: a textile service provider or industrial laundry.

2.2 The Problem Owner

The problem owner in this project is **Moderna Textielservice**, a textile service provider mainly active in the industrial and hospitality sector. The company started as a professional laundry, but nowadays they also provide other products and services, related to the textile cleaning.

2.2.1 General

Moderna is a family owned business, founded in 1964 in *Hardenberg*. Throughout the years the company kept growing. There were various acquisitions and expansions. In 1999 two sons-in-law of the founder became, together with the founder and his son, co-directors of the company and the partnership becomes a holding with three private companies. The following years there are again some acquisitions and internal renovations and expansions. In 2010, after the last renovation, the laundry (in *Gramsbergen*) is equipped with the latest technological developments and the main part of the process is automated.

Everything is running smoothly, but then in 2013 the company is struck by a disaster, in a few hours the entire building is destroyed by a major fire. This seemed to be a fatal blow to the company. However, already a few days after the fire the first drawings for a new building were on paper. A year after the fire, in 2014, a magnificent new building is opened in *Hardenberg*. This building is built with an eye on the future and equipped with the latest technological developments and sustainable solutions, therefore it is at that moment the most sustainable laundry in Europe.

These days the company is run by the son and two sons-in-law of the founder. One mainly active in the field of sales and the other two divide the other tasks. Next to the three directors, every department has its own head of the department. Together with about 300 employees they provide products and services in the field of textiles to about 3400 different customers. It is a company with a flat organizational structure, where the person takes a central position, both as a customer and as an employee, and where sustainability and social responsibility are of high importance.

2.2.2 Customers and Services

Moderna offers various products and services, an overview:

Products

- Work-wear
- Catering linen
- Sanitary hygiene
- Entrance mats
- Other, like Personal protective equipment

Services

- Textile cleaning
- Matt cleaning
- Dry cleaning
- Closet deposit service
- Clothing repairs
- Towel roll cleaning

Next to those separate products and services they provide **Full service** in work-wear and catering linen. Full service refers to the fact that the laundry owns the textiles and provides full service to the customer who rents the textiles, including cleaning and repair/replacement of the textiles. In this case, contractual agreements are drawn up on the prices, stocks, delivery times and frequencies, rejection procedure of the textiles, etc.. Since the company also sells hygiene products this can be combined with the delivery of the textiles. Customers can order their products in the web shop of Moderna and the ordered hygiene products are delivered together with the textiles that are cleaned in that week.

Since the company provides this wide range of services, their customer base also consists of a divergent set of customers. The hospitality industry, which is about one fourth of their entire customer base, the customers vary from small *Bed & Breakfast* hotels with only a few rooms to big hotel chains and bungalow parks, but also restaurants and saunas belong to their customer base. In the hospitality industry there are various products in circulation, of which the main part, about 95% can be considered as flat-work, examples are catering linen, towels, and bed linen. The other 5% of the hospitality segment consists of clothing, like cook's clothing. Next to the hospitality industry, they also provide work-wear services to the industrial sector and, together with other laundries, they run a (dry-)clean service for individual customers with service points all over the Netherlands.

2.2.3 The Textile Service Sector (market/competitors)

The textile service sector is a cost-driven market, and especially the big customers try to push the prices down. However, Moderna has quite some regular customers and tries to keep their customers by thinking along with the customer and being as flexible as possible.

2.3 Scope and Problem specific context: The logistic operations

In this project the focus will be on the logistic operations of the company and mainly the collecting of the soiled laundry at the customers. For the purpose of this project the focus will also be on the hospitality industry. According to Moderna in this segment the most variability in the supply of soiled laundry can be seen and is therefore most relevant for this project. A concrete example for this are the customers on *Texel*, where the difference in supply between the summer and winter period is huge. However, as will be explained later, in most service routes both types of customers (hospitality and industrial/work-wear) are included.

This section gives an overview of the general logistic operations within Moderna. The process for **one route** is visualized in figure 1.

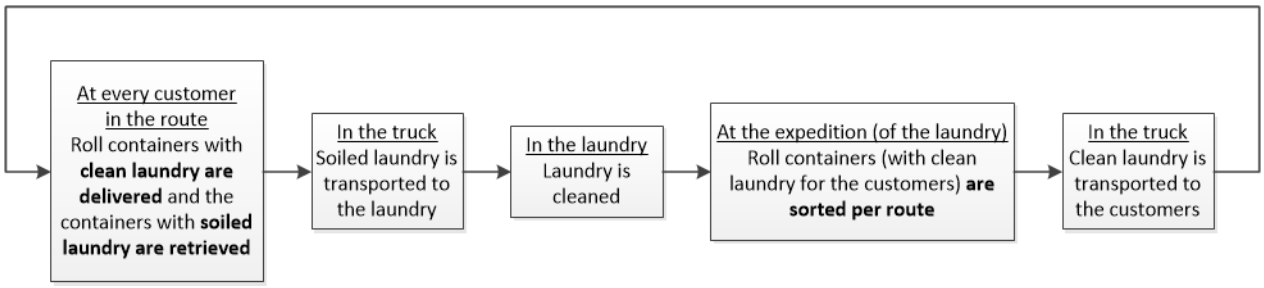


Figure 1: Flow chart of the process from the viewpoint of one route

General
In general both clean and soiled laundry is transported in (laundry) roll containers (there are some exceptions where they use bags, mostly very small customers). Roll containers with clean laundry are delivered to the customer, there the clean laundry is stored (most of the time in the roll containers), used, and again collected in a roll container. Those roll containers are picked up by the industrial laundry, cleaned, and brought back to the customer. An interesting fact is that, since clean laundry takes up less volume, the containers with clean laundry are most of the time filled for only 60%. All truck drivers are equipped with a *PDA* (*Personal Digital Assistant*), so when the truck driver has delivered and picked up the laundry, he registers this on his *PDA* and this is immediately updated in the information system. From that moment it is known how many containers are coming from that customer to the laundry. Furthermore, all trucks are equipped with GPS trackers.

Contractual agreements
The frequency with which and the days on which they go to the customer to deliver this clean laundry and pick up soiled laundry is recorded in a contractual agreement. In most cases this is two times a week (Monday-Thursday or Tuesday-Friday), but there are some exceptions, for instance small customers that are only visited when they call that they have some soiled laundry, or customers who don't have room for storing the laundry themselves, that are visited more often. This biweekly pattern is common, since cleaning of the laundry takes about two (working)days.

Routes
In principle all customers are served from the laundry in *Hardenberg* and there are about 140 fixed routes per week from *Hardenberg* to all the customers. Collection and delivery of the soiled and clean laundry (respectively) is in the same route, as depicted in figure 1: at every customer the clean laundry is delivered and the soiled laundry collected. The routes contain various customers, small and big, and also from both segments (hospitality and industrial). The main difference between the two segments in terms of the logistic operations, is that for the work-wear the driver spends some extra time at the customer, since the clothing is delivered to the right closets according to the arrangements with the customer. Which customers are in which route is mainly determined based on experience and knowledge about the customers. The routes themselves are optimized on distance, where the customers most close to the laundry in *Hardenberg* are mostly at the end of the route, which helps to reduce the extra costs, when the truck is full before the end of the route.

Capacity
Since not all routes have the same supply of soiled laundry, and this also varies during the year, Moderna has trucks and vans with various capacities in terms of number of roll containers that fit in a truck. This varies from 10 (van) to 38 (big truck) containers, and for some of the trucks there is the option to attach a trailer with a capacity of again 25 or 30 containers (depending on the size of the truck). Another tactic used to tackle this (mostly seasonal) varying supply is to split up or combine routes. For instance a route that is split into two separate routes during the summer season, because of the significant increase in supply of soiled laundry of a bungalow park. Both the capacity of the truck for a certain route and whether or not to split/combine the route(s) is based on experience and knowledge about the customers in the route.

Note that the final report will contain a more elaborate description of the process, since during the project more information about the process will be collected.

3 Problem Definition

In this section the problem will be defined and the corresponding research questions of interest will be formulated.

3.1 The Problem

As described in the previous section the capacity of the truck assigned to a route is determined based on experience and thus mainly on (seasonal) patterns throughout the year. However, as one can imagine, there could be other factors that increase the occupation of for instance a bungalow park significant and unforeseen, an example could be a sudden period with nice weather or a discount on the prices for a bungalow. Needless to say, this will lead to a peak in the supply of soiled laundry from that bungalow park. And since it is not known beforehand how many containers there are at the customer, such peaks are unforeseen and will lead to an overfull truck. It could be that by coincidence other customers in that route had less supply and thus all roll containers still fit in the truck. However, a significant number of times this is not the case and the truck is not able to load all the containers. Note that, since a truck has both clean and soiled laundry with him, it could happen that at one customer the truck can not take all the roll containers with him, but at the next customer he can, as roll containers with clean laundry will be unloaded there. In such a scenario, the truck driver calls the office to inform them. Several solutions are used in such scenarios:

- An extra truck is sent to the customer, especially when the customer is close to the laundry.
- Sent a truck on a route that comes near the customer anyway, by slightly adapting the route. Only possible if it is known on time that there is soiled laundry left at a customer.
- Pick up the containers on a later day

In any case it leads to extra costs and burden for the company, but also for the customer. Also the opposite scenario can occur, that there is much less supply than expected. In this case a truck drives half empty and unnecessary (fuel) costs are made.

There are various reasons that it is not known how many roll containers with soiled laundry there are at the customer. The main reason is that there is (in most cases) no communication with the customer before a visit to a customer, this is not necessary since there is a fixed day and time on which the customer is visited. Moreover, a major part of the customers themselves don't even know how many containers there will be and if they (could) know it, they prefer not to put effort in it to communicate this to the laundry.

On the next page you can find an overview of the problems and their cause(s) in a cause-effect diagram, figure 2. This diagram explores the causes and effects in the context of this project, starting from the main perceived issue: the missing information from the customer side (denoted by the yellow box).

'Truck full halfway along the route' is the main performance related problem, with 'Missing information about the soiled laundry from the customer side' as the main direction for a solution, whereby the underlying causes will also be taken into account. The main points of interest for the project are marked in orange.

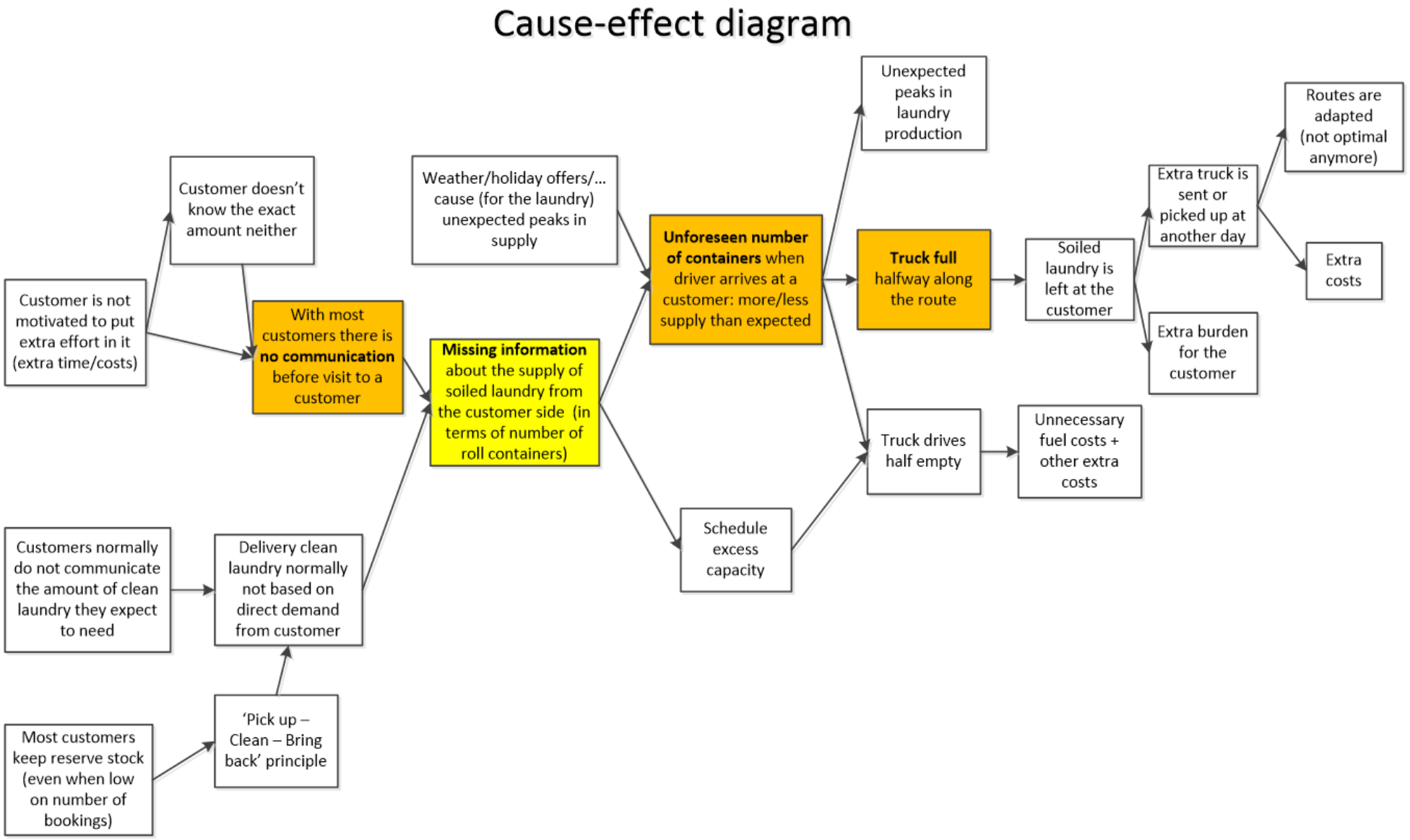


Figure 2: Cause-effect diagram exploring causes and effects of the problem at hand (denoted by the yellow box)

3.2 Research Questions

This section describes the research questions that the project will try to find an answer to. The research questions serve to further analyse and clarify the performance related problem, and find useful insights in the situation, that will lead to meaningful recommendations for the company.

The problem is that there is missing information on the number of roll containers with soiled laundry at the customers. In the problem definition already several causes were explored. Those causes can also be the directions for improvement, for instance one can think of a situation where all customers report on the amount of laundry that has to be cleaned, or a situation where this is registered at the customer using RFID tagging. In those situations there will be (almost) perfect information on the number of roll containers that have to be collected at the customer. However, what will actually be the effect of this on the performance or efficiency of the truck scheduling? Before you invest in RFID tagging or customer communication, it is useful to know if this investment is profitable or not. Therefore, the main research question is:

What performance/efficiency improvement can be gained with better information on the number of roll containers with soiled laundry at the customer?

To obtain an answer to this question, the project will look at:

- The current performance or efficiency of the truck scheduling
- The performance when there is perfect information
- But also, the performance when a basic scheduling decision model, based on insights from the historic data, is used.

Those performances for three different levels of information can be compared and from this it can be concluded if it is worthwhile to, for instance, invest in RFID technology at the customers or better communication with the customers.

To obtain the performances for the three levels of information, and find an answer to the main question, the questions below will be answered. Note that the next section, `Project approach`, will explain the goal of each research question and describe the steps that will be taken to answer the questions.

The current performance/efficiency level

1. With what frequency does the problem of the overfull truck occur?
2. What is the average fill rate of the trucks?

Insights from the data

3. What are the averages and the degrees of variation in the supply?
4. Do outliers per customer correspond with the occurrence of overfull trucks?
5. Are there trends and/or seasonal patterns in the supply?
6. Does the problem of overfull trucks occur more often at certain routes, customers, or in certain periods?
7. Can the obtained insights be used to formulate a decision model regarding the scheduling of trucks?

Performance measurement

8. What is the best way to model the situation with perfect information regarding truck scheduling?
9. How can you measure the performance of the truck scheduling for the different levels of information?

Communication with customers

10. Are there (B2B) sectors where this kind of communication between company and customers is more common? How is this organized?

4 Project Approach

This section will describe the approach per research question, so the steps that will be taken to find answers to the questions.

Before the analysis of the data can start, the data will first be pre-processed and cleaned. This includes removing entries with missing or wrong data and transforming all the data to the correct form.

4.1 The current performance/efficiency level

The first step will be to quantify the current performance. This quantification will help to better understand the severity of the problem at hand and thus illustrate the urgency to find a solution. Caplice and Sheffi (1995) identified three types of logistics performance measures:

- Utilization: `Actual input / Norm input`
- Productivity: `Actual output / Actual input`
- Effectiveness: `Actual output / Norm output`

The quantification of the current performance will be done based on the *effectiveness* and the *utilization* performance measures, related to research questions 1 and 2.

1. With what frequency does the problem of the overfull truck occur?
To get an answer to this question the historic data on the routes will be analysed. By comparing the total number of containers in the truck when at a certain customer, based on the number of containers collected before that customer and the number of containers with clean laundry still to be delivered, to the capacity of the truck that was assigned to the route, you will be able to say if the truck was overfull and thus had to leave containers at a that customer. If there is data available from all or at least a representative part of the routes and this for at least a year, you can conclude on the frequency of the occurrence of the problem. This is an *effectiveness* performance measurement, since the number of 'successful' customer visits (without leaving containers at a customer) is compared to the total number of visits.

2. What is the average fill rate of the trucks?
In a similar way as in the previous question you can find the average fill rate of the trucks. This is an *utilization* performance measurement, since you compare the capacity used to the available truck capacity.

4.2 Insights from the data

The next step will be to get insights from the data that can be used to formulate a (basic) prediction model or scheduling rules. The answers to the questions will also give the company a better insight in the customers they are dealing with.

3. What are the averages and the degrees of variation in the supply?
To get a better idea of the situation and if there are differences between customers or routes, the averages and the standard deviations of the supply per customer and per route can be calculated. These results can be compared to see if there are customers or routes that show a deviant average or variation in the supply. In addition, the customers can be clustered based on their volume and variability in supply, using some simple clustering technique (Berkhin, 2006). This clustering can give useful insights in the customer types the company is dealing with. For this question it will be beneficial to take data of as much customers and routes as possible into account, since then the comparison is most meaningful.

4. Do outliers per customer correspond with the occurrence of overfull trucks?
Based on the averages and standard deviation outliers can be identified. Combined with knowledge if the truck was overfull or half empty (determined in `question 1 and 2`), those outliers may match with those occurrences or not. This gives insight in if it is always the case that peaks and troughs in the supply cause the problem or that there may be other factors that play a role. Also for this analysis holds

that a bigger amount of data will result in more significant findings and conclusions, since then you can filter contingencies out of the results.

5. Are there trends and/or seasonal patterns in the supply?
It is expected and also common sense that there are seasonal patterns in the supply of soiled laundry (since the hospitality and tourism sector are part of the customer base). For this question the patterns will therefore be visualized, this way the seasonal patterns can be seen, but it may also reveal other (unforeseen) patterns and/or trends. Using statistical tests the patterns and/or trends can be validated (Douglas C. Montgomery, 2014). Data of several years is needed to make significant and meaningful statements about yearly seasonal patterns.

6. Does the problem of overfull trucks occur more often at certain routes, customers, or in certain periods?
To find out if there are certain routes/customers/periods where or when the problem of overfull trucks occurs more often, the data obtained in `question 1` can be used. If there are significant differences in the occurrence of the problem between the routes, then one can have a look at possible causes of the problem, for instance the number of, or types of customers in the route.

7. Can the obtained insights be used to formulate a decision model regarding the scheduling of trucks?
The main decision in the scheduling of the trucks is to decide which truck to assign to which route. In case there is no perfect information available, two main directions to improve the decisions are possible:

- Predictions on the number of roll containers that have to be collected. Based on the insights gained from the previous questions a basic prediction model can be formulated. Those predictions can be used to improve the scheduling, since more information is available.
- Use a decision support model or decision rules. An example of decision support can be the moddeling of the situation as a newsboy problem. Reimer, Sodhi, and Jayaraman (2006) modelled the assigning of trucks (capacity) to given routes in the collection of recyclables as a newsboy problem. This can be obtained by fitting a (discrete) probability distribution to the data (Adan, van Eenige, & Resing, 1995) on the supply per customer or route. The situation as discussed by Reimer et al. is similar to the context of this project, except that the context of this project is complexer, because of the simultaneous delivery and pickup. Therefore, more in-depth research has to be done on this subject, to see if there are more accurate models available. An alternative could be to formulate basic scheduling decision rules, using the insights from previous patterns. For instance if there appear to be some customers with a high variability in supply, this can be anticipated on in the scheduling of the trucks.

Since creating a accurate prediction/forecasting model is quite complex, this topic goes beyond the scope of this project. Therefore, this project will focus on the second direction, regarding the scheduling decision model/rules.

4.3 Performance measurement

8. What is the best way to model the situation with perfect information regarding truck scheduling?
One goal of the project is to find out what the performance of the scheduling of trucks is, when there is perfect information on the number of roll containers at the customers. To achieve this goal it is needed to simulate the scheduling when this perfect information is available. Since Moderna does not use some kind of algorithm to schedule the trucks, the question is how this information will be used. Based on interviews with the company an answer to this question has to be found. Subsequently, this information has to be translated to some logic decision rules that can be used in a simulation, for instance: `if customer X has 5 containers, schedule truck Y for the route with that customer`.

9. How can you measure the performance of the truck scheduling for the different levels of information?
To compare the performance for the levels of information, it is necessary to define a performance measure. As a basic measure the performance measures from `question 1` (and eventual `question 2`) can be used, but this only gives an indication of the frequency of the occurrence of a full truck, which does not give sufficient information if you would like to find out if investing in 'perfect information' is profitable.

Therefore, you have to look at the performance in terms of costs. The *productivity* performance measure: the `actual output` can be the number of containers collected or the number of customers served, and the `actual input` can be the costs. Since it will be difficult to take the exact costs, as they are in reality, into account, 'imaginary' costs can be modelled with the correct ratio's between the costs in terms of the relative importance of various aspects. To come up with this cost model, some research has to be done on the relative costs of for instance the scheduling of extra capacity compared to leaving roll containers at a customer.

4.4 Communication with customers

This part is somewhat separated from the other steps, since it includes a more qualitative and theoretic question that looks more specific into one of the directions for a solution.

10. Are there (B2B) sectors where this kind of communication between company and customers is more common? How is this organized? What are the achieved benefits?
This is a somewhat more theoretic question and will involve some literature research to find out if there are other *Business to Business* sectors were data sharing between a company and its customers is more common, how this is organized and what the achieved benefits are.

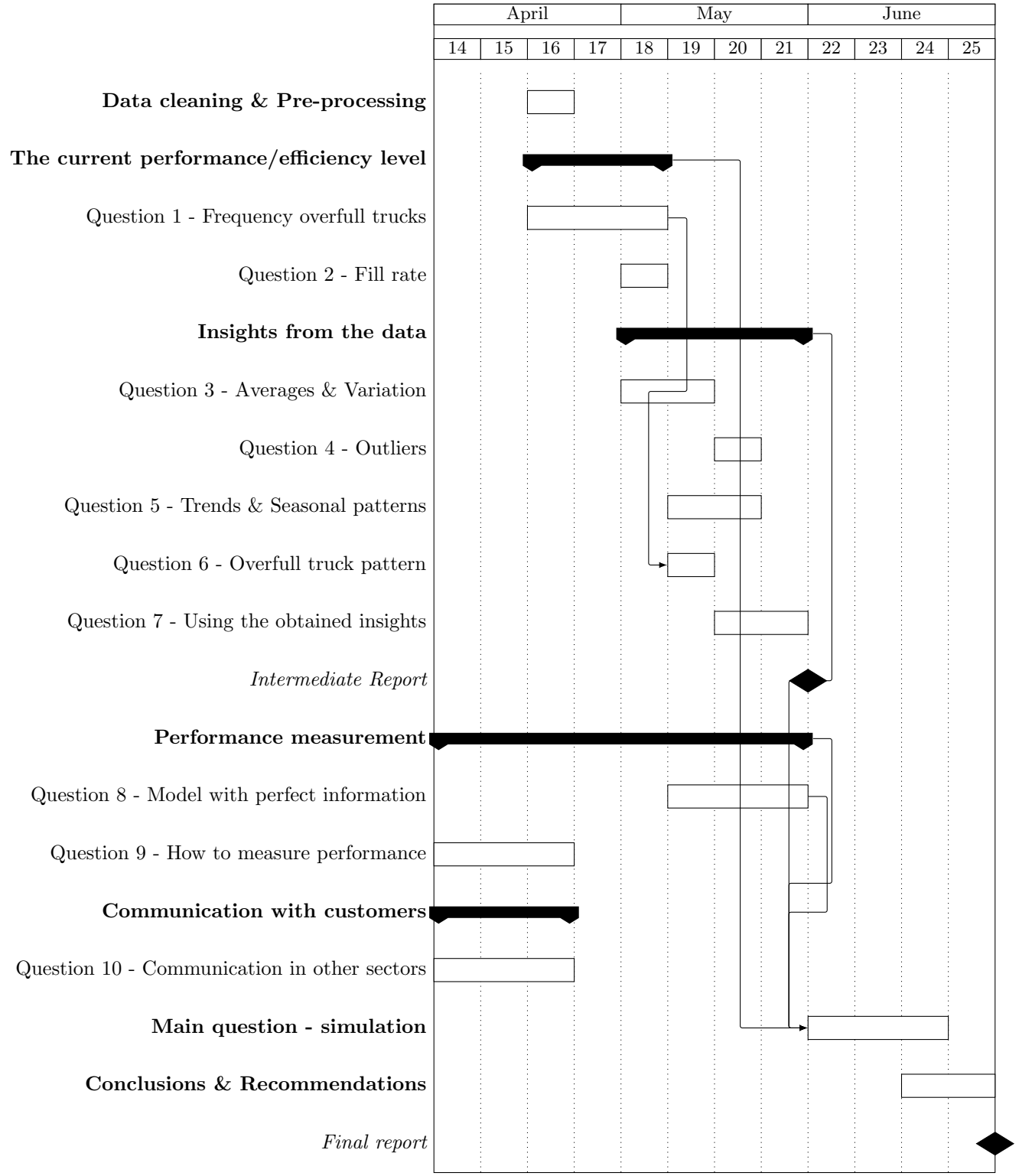
4.5 The Main Research question

What performance/efficiency improvement can be gained with better information on the number of roll containers with soiled laundry at the customer?
When above questions are answered, the actual performance for the three levels of information can be compared. The performance will result from a simulation on one year of the data.

The resulting insights will lead to directions for further investigation and a set of recommendations or points for improvement for the company.

5 Project Plan

This section describes which steps will be taken or questions from the `Project Approach` will be answered in which week. Assuming the project proposal is approved in week 15 (the second week of April) and the first data is available in week 16, the project can follow the (weekly) schedule as depicted in the Gantt chart below. In this schedule the intermediate report is planned to be finished at the end of week 21 (25th of May) and the final report at the end of week 25 (22th of June). Note that an entire Bachelor End Project covers 280 hours of which about 220 hours will be spent in the 12 weeks depicted here.



6 Organisation of the Project

Overview of persons involved in the project, with contact details.

Student

M.C.A. (Mark) van der Pas

Eindhoven University of Technology (TU/e)

Student Bachelor Industrial Engineering

m.c.a.v.d.pas@student.tue.nl

Supervisor University

Dr. L.P. (Luuk) Veelenturf

Eindhoven University of Technology (TU/e)

Department of Industrial Engineering & Innovation Sciences (IE&IS)

Assistant Professor - Operations, Planning, Accounting and Control

l.p.veelenturf@tue.nl

Supervisor Project owner

Léon Wennekes

Technologisch Kenniscentrum Textielverzorging (TKT)

leon@menp.nl

Contact person Problem owner

Gert Stroeve

Moderna Textielservice

Technical director

gert.stroeve@moderna.nl

References

Adan, I., van Eenige, M., & Resing, J. (1995). Fitting discrete distributions on the first two moments. *Probability in the Engineering and Informational Sciences*, *9*(4), 623–632. doi: 10.1017/S0269964800004101

Berkhin, P. (2006). Survey of Clustering Data Mining Techniques. *Grouping Multidimensional Data: Recent Advances in Clustering*, 25–71. doi: 10.1007/3-540-28349-8_2

Caplice, C., & Sheffi, Y. (1995). A Review and Evaluation of Logistics Performance Measurement Systems. *The International Journal of Logistics Management*, *6*(1), 61–74. doi: 10.1108/09574099510805279

Douglas C. Montgomery, G. C. R. (2014). *Applied Statistics and Probability for Engineers* (6th ed.). Singapore: Wiley.

Reimer, B., Sodhi, M., & Jayaraman, V. (2006, dec). Truck sizing models for recyclables pick-up. *Computers and Industrial Engineering*, *51*(4), 621–636. doi: 10.1016/j.cie.2006.06.007

End of the document